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TechTalk
SERVING THE MIT COMMUNITY

MIT finds key to avian flu in humans

Anne Trafton
News Office

MIT researchers have uncovered a critical difference between flu viruses that infect birds and humans, a discovery that could help scientists monitor the evolution of avian flu strains and aid in the development of vaccines against a deadly flu pandemic.

The researchers found that a virus's ability to infect humans depends on whether it can bind to one specific shape of receptor on the surface of human respiratory cells.

"Now that we know what to look for, this could help us not only monitor the bird flu virus, but it can aid in the development of potentially improved therapeutic interventions for both avian and seasonal flu," said Ram Sasisekharan, MIT Underwood Prescott Professor of Biological Engineering and Health Sciences and Technology, and the senior author of a paper on the work that appears in the Jan. 6 issue of Nature Biotechnology.

Flu viruses come in many strains, and not all of them can infect humans. Strains known as H1 or H3 have "jumped" from birds to humans and hence are tailored to attack cells of the human upper respiratory tract. H5 strains are usually confined to birds, but when they do infect humans they can have very high fatality rates.

In the past decade, isolated outbreaks of avian flu (H5N1) in humans have raised concerns that a deadly pandemic could arise if the avian flu evolves to a form that can easily infect humans and pass from person to person. Some scientists believe such an outbreak could rival the 1918 "Spanish flu" that killed 50 million to 100 million people worldwide.

Scientists already knew that whether an influenza virus infects humans depends on whether its hemagglutinin, a protein found on the virus surface, can bind to sugar (or glycan) receptors in the respiratory tract. Human respi-

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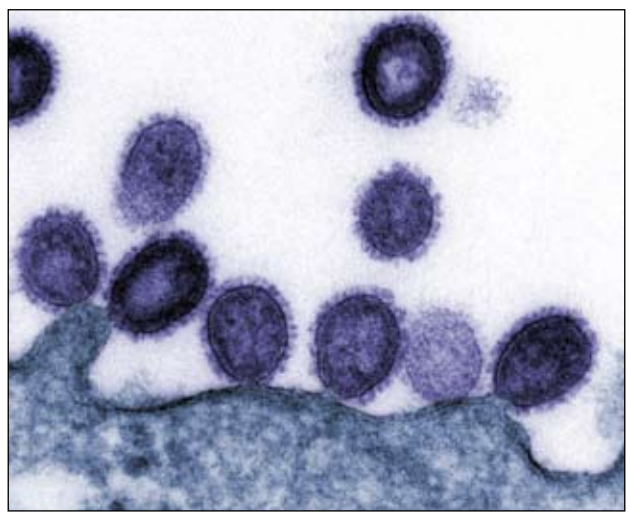

IMAGE COURTESY / **CDC**

This magnified image shows avian influenza A H5N1 viruses being released from an infected human cell, below.

Inherited retardation, autism corrected in mice

Research points to potential drug treatment for humans

Deborah Halber
News Office Correspondent

Researchers at MIT's Picower Institute for Learning and Memory have corrected key symptoms of mental retardation and autism in mice.

The work, which will be reported in the Dec. 20 issue of Neuron, indicates that a certain class of drugs could have the same effect in humans. These drugs are not yet approved by the FDA, but will soon be entering into clinical trials.

Fragile X syndrome (FXS), affecting 100,000 Americans, is the most common inherited cause of mental retardation and autism. The MIT researchers corrected FXS in mice modeling the disease. "These findings have major therapeutic implications for fragile X syndrome and autism," said study lead author Mark F. Bear, director of the Picower Institute and Picower Professor of Neuroscience at MIT.

PHOTO / **DONNA COVENEY**

Mark Bear, director of the Picower Institute and Picower Professor of Neuroscience (right), and Gül Dölen, a graduate student at Brown University, report the correction of fragile X syndrome in mice.

The findings support the theory that many of FXS's psychiatric and neurological symptoms—learning disabilities, autistic behavior, childhood epilepsy—stem from too much activation of one of the brain's chief network managers, the metabotropic glutamate receptor mGluR5.

"Fragile X is a disorder of excess—excess synaptic connectivity, protein synthesis, memory extinction, body growth, excitability—and remarkably, all these excesses can be reduced by reducing mGluR5," said Bear, a Howard Hughes Medical Institute investigator.

Individuals with FXS have mutations in the X chromosome's FMR1 gene, which encodes the fragile X mental retardation protein, FMRP. The MIT study found that FMRP and mGluR5 are at opposite ends of a kind of molecular seesaw. They keep each other in check and, without FMRP, mGluR5 signals run rampant.

Bear and colleagues study how genes and environment interact to refine connections in the brain. Synapses are the brain's connectors and their modifications are the basis for all learning and memory. There's a growing consensus among researchers that developmental brain disorders such as FXS, autism and schizophrenia should be considered "synapsopathies"—diseases of synaptic development and plasticity (the ability to change in response to experience).

Dendritic spines—little nubs on neurons' branchlike projections—receive many of the synaptic inputs from other neurons. Abnormal spines have long been associated with various forms of human mental retardation. In FXS, spines are more numerous, longer and more spindly than they should be. Thin spines tend to form weak connections.

The research team found that a 50 percent reduction in mGluR5 fixed multiple defects in the fragile X mice. In addition to correcting dendritic spines, reduced mGluR5

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MITEI announces first seed grant winners

More than $1.6 million to fund energy research projects at MIT

David Chandler
News Office

From harnessing microbes to developing new materials, from curbing pollution to harvesting wasted watts, a wide variety of MIT research projects in solar technology, climate change impacts and power transmission were among those chosen to receive more than $1.6 million in the MIT Energy Initiative's (MITEI) first round of campus seed grants.

The grants, which range from $30,000 to $150,000 and last anywhere from one semester to two years, are intended to help launch new or early stage projects that, it is hoped, will then produce enough results to be able to secure outside funding for further development. In all, 11 projects were selected to receive major grants totaling some $1.4 million, while six other projects proposed by junior faculty members were chosen for shorter-term grants. (See page 6 for a list of recipients.)

MITEI selected the winners from 54 proposals submitted by members of all of MIT's departments, and multidisciplinary projects were especially encouraged. MITEI Director Ernest Moniz said he and his colleagues were pleased at the "overwhelming response" after expecting fewer than 20 proposals.

"The results of our call for proposals were so impressive, we were able to almost double the funding," Moniz said, by getting additional money from the Chesonis Foundation, MITEI's own funding, the MIT-Singapore programs, the deans of science and engineering, and private donors.

Among the novel projects selected is one aimed at doing basic research that could lead to a whole new approach to the production of biofuels. Sallie "Penny" Chisholm, professor of environmental studies, will conduct a study of Prochlorococcus, the smallest and the most abundant creature capable of photosynthesis. The hope is that this ubiquitous marine microbe could someday be used as a way of harnessing the power of sunlight to grow biofuels on an industrial scale.

Another solar-energy project, headed by Tonio Buonassisi, assistant professor of mechanical engineering, and Gerbrand Ceder, professor of materials science and engineering, will explore novel materials for making solar cells, focusing on materials that are abundant and could be easily scaled up to widespread production and that could produce low-cost, extremely efficient photovoltaic panels.

One team, pairing two economists and an engineer, will study the health effects of energy use in India—which largely consists of the very smoky indoor combustion of wood and cow dung—and will explore alternatives that could mitigate these effects. Others will look at various approaches to curbing global warming: harnessing collective intelligence to develop solutions, using the model of massive, open collaborative projects like Wikipedia and Linux; using microbially produced enzymes to control pollutants and greenhouse gases—and maybe produce fuel in the process; and investigating how microbial life will respond if carbon sequestration becomes a major tool for limiting carbon emissions.

Some of the grants will be used to study materials and technologies that could improve electric power systems. These include superconducting transmission systems and using nanotubes to produce improved ultracapacitors for energy storage. Another project, colorfully titled "No Watt Left Behind," will develop new technology for minimizing waste in the use of electricity, for example by using fluorescent lamps to detect the presence of people and

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PEOPLE

AERO-ASTRO

Ian Waitz named next head of the Department of Aeronautics and Astronautics.

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FASHIONABLY FUNCTIONAL

Grad students create clothing as useful as it is striking.

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ENERGY

SURVIVING HIGH OIL PRICES

Macroeconomist Olivier Blanchard thinks the U.S. will weather record oil prices.

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A MITEI COLLABORATION

$50 million partnership with Italy's Eni will fund projects including a new solar program.

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RESEARCH

FLY ME NEAR THE MOON

MIT-led satellite mission will map the moon's interior.

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BIGGER ISN'T BETTER

Researchers are developing tiny, energy-efficient gas sensor.

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PHOTO / **DONNA COVENEY**

A star is born

Professor Walter Lewin of MIT's physics department achieved celebrity status after the MIT News Office and OpenCourseWare secured a front page story on him in The New York Times on Dec. 19. The piece, which examined the popularity of his free online lectures, became the most e-mailed article on the Times' web site for two consecutive days and led to features about him on the CBS Evening News, The Boston Globe, Forbes and the Guardian—not to mention requests for him to appear on talk shows with Jay Leno, Conan O'Brien and Ellen DeGeneres. Numerous book publishers and agents also approached Lewin to tell his story.

Waitz to lead Department of Aeronautics and Astronautics

Ian Waitz, the Jerome C. Hunsaker Professor of Aeronautics and Astronautics, has been named the next head of the Department of Aeronautics and Astronautics, effective Feb. 16.

"Ian is an outstanding teacher and internationally known scholar whose principal fields of interest include propulsion, fluid mechanics, thermodynamics, reacting flows and aeroacoustics, particularly with respect to the environmental issues associated with aircraft design and operation," said School of Engineering Dean Subra Suresh, who announced the new appointment.

Since 2004, Waitz has served as director of the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER), an FAA/NASA/Transport Canada-sponsored Center of Excellence.

Waitz served as deputy head of the Department of Aeronautics and Astronautics from 2002 to 2005 and led the development of the department's 2007 strategic report. Waitz holds degrees from the California Institute of Technology, George Washington University and the Pennsylvania State University. He is a Fellow of the American Institute of Aeronautics and Astronautics, and was recently honored with the FAA 2007 Excellence in Aviation Research Award. In 2002, he received the MIT Class of 1960 Innovation in Education Award, and was appointed as an MIT MacVicar Faculty Fellow in 2003.

Ian Waitz

"I am honored to have the opportunity to lead the Department of Aeronautics and Astronautics, and to contribute to the tradition of excellence in the department and the Institute," Waitz said. "Our faculty, students and staff are making significant contributions in important and challenging areas of aerospace research and education. They enjoy what they are doing, they enjoy working with each other and they enjoy working with colleagues across the Institute and the world. This collaborative problem-solving approach allows us to tackle more challenging, multidisciplinary problems, and it amplifies our capabilities and our impact. Moreover, it makes it a fun and rewarding place to work. I'm looking forward to it."

AWARDS AND HONORS

William Wheaton, a pioneer in the field of urban economics who helped organize MIT's Center for Real Estate, is a co-winner of the 2007 Graaskamp Award, given by the Pension Real Estate Association.

Wheaton shares the award with his business partner, Raymond Torto; they have designated MIT's Center for Real Estate as the recipient of the award's $10K scholarship.

An authority on regional economics, Wheaton holds joint appointments in the Department of Urban Studies and Planning and in the Department of Economics. A member of MIT's faculty since 1972, Wheaton helped pioneer the theory of how land, location and housing markets jointly operate. He also specializes in the problems of urban infrastructure and local government finance.

The Graaskamp Award, granted every other year, is among the most prestigious in the real estate industry.

Graduate students **Jason Greenberg** and **Yanbo Wang** have received Kauffman Dissertation Fellowships. The Ewing Marion Kauffman Foundation awarded 16 fellowships in the amount of $20,000 each to current Ph.D. students who are engaged in the study of entrepreneurship at U.S. universities.

Kelly Engineering Resources, a global provider of engineering staffing solutions, announced that MIT mechanical engineering student **Michaelle Mayalu** is the winner of its fifth annual $5,000 Future Engineers Scholarship.

Mayalu "illustrates the forward thinking and ingenuity our future workforce is capable of offering potential employers," said Teresa Carroll, vice president of Kelly Engineering Resources. "There is an eminent shortage of talent in our industry, so Kelly Engineering applauds students like Michaelle for their hard work and commitment to the field of engineering."

MIT involved in two of top 10 physics stories of 2007

Anne Trafton
News Office

Two research projects involving MIT physicists are among the top 10 physics stories of the year, as ranked by the American Institute of Physics.

Among the year's highlights is research led by Nergis Mavalvala, associate professor of physics at MIT and a member of MIT's LIGO (Laser Interferometer Gravitational-wave Observatory) Laboratory. In April, Mavalvala and others reported that they had cooled a coin-sized object to 0.8 degrees Kelvin (0.8 degrees above absolute zero).

To reach such extreme temperatures, the researchers combined two previously demonstrated techniques—optical trapping and optical damping. Two laser beams strike the object, one to trap it in place, as a spring would (by restoring the object to its equilibrium position when it moves), and one to slow (or damp) the object and take away its thermal energy.

Nergis Mavalvala

The study marked the coldest temperature ever reached by laser-cooling of an object of that size, and the technique holds promise that it will experimentally confirm, for the first time, that large objects obey the laws of quantum mechanics just as atoms do.

Also on the American Institute of Physics' top-10 list is the MinibooNE experiment, which confirmed a critical aspect of the Standard Model of particle physics. MIT postdoctoral associate Jocelyn Monroe, a Pappalardo fellow, was a member of the MinibooNE research team and presented the results on April 11 at MIT.

Jocelyn Monroe

The MinibooNE experiment, conducted at the Fermi National Accelerator Laboratory outside Chicago, was designed to investigate the possibility of the existence of a fourth type of neutrino (tiny elementary particles that are components of atoms).

The Standard Model predicts the existence of three types of neutrinos, but results of experiments conducted in the 1990s offered indirect evidence for the possibility of a fourth type of neutrino. The MinibooNE experiment confirmed that there are only three types of neutrino.

To see the rest of the top 10 list, visit www.aip.org/pnu/2007/split/850-1.html.

American Mathematical Society honors Lusztig

George Lusztig, the Norbert Wiener Professor of Mathematics, has been awarded the 2008 Leroy P. Steele Prize for Lifetime Achievement.

The award, given by the American Mathematical Society, is one of the highest distinctions in mathematics. Lusztig received the award Jan. 7 at the Joint Mathematics Meetings in San Diego.

Lusztig, who has been at MIT since 1978, is best known for his work on representation theory, which explores the properties of abstract groups and has a wide range of applications in physics, chemistry, probability and number theory. He has developed fundamental new concepts including the Deligne-Lusztig theory and the Kazhdan-Lusztig polynomials.

The AMS said Lusztig's work had "entirely reshaped representation theory" and, in the process, prompted changes in much of the field of mathematics.

"His work has touched widely separated parts of mathematics, reshaping them and knitting them together. He has built new bridges to combinatorics and algebraic geometry, solving classical problems in those disciplines and creating exciting new ones," the society said in its citation. "This is a remarkable career, and as exciting to watch today as it was at the beginning more than 30 years ago."

CORRECTION

An article in the Dec. 12, 2007, issue of Tech Talk mistakenly referred to Suzanne Flynn as a professor of foreign languages and linguistics. She is a professor of linguistics and language acquisition. Tech Talk regrets the error.

No Tech Talk next week

In honor of Martin Luther King Jr. Day, there will be no Tech Talk on Wednesday, Jan. 23. The next Tech Talk will be published on Jan. 30. For ongoing MIT news updates, please go to the News Office web site, web.mit.edu/newsoffice/.

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DIGITALK: Where IT's at

IS&T Community Forum

Information Services and Technology (IS&T) will host its annual community forum Feb. 13 from 3:00 p.m. to 4:30 p.m. in the Student Center. Starting in the Mezzanine Lounge (W20-307), MIT community members will have the opportunity to hear about and give feedback on IS&T's FY09 strategic plan and key strategic initiatives.

At 3:30 p.m., immediately following the presentation, IS&T staff will host a services trade show in Twenty Chimneys (W20-306), featuring next-generation mobile devices, the MITvoip telephone system, Thalia image management and many other IS&T offerings. For more information on IS&T services, see web.mit.edu/ist/services/brochure.pdf.

MIT Regional Optical Network

It's huge and it's fast and it's just been unleashed. The new MIT Regional Optical Network provides connectivity to key Internet exchange points with speeds exceeding 10 Gbps, the equivalent of transmitting 10 full-length, high-definition movies in 30 seconds. This adaptive, all-optical network is one of the world's largest institutional networks for research and collaboration.

IS&T partnered with Nortel to create this next-generation network, acquiring already-laid fiber-optic lines ("dark fiber") from Level 3 Communications and Vermont Telephone. The network is designed to accommodate faster technologies and upgrades as they become available. Initially, it is being deployed across the northeast United States, connecting MIT's main campus to New York, Washington and Baltimore via 1,500 miles of fiber, with optical equipment at 17 locations across seven states. Plans include linking to LHCnet, the research network maintained by the European Organization for Nuclear Research (CERN), the Energy Sciences Network (ESnet) and the National LambdaRail.

To see a map of the regional network in its first stage of development, go to web.mit.edu/ist/news/spotlight.

MIT on the Access Grid

If you're an MIT researcher with a grant from the National Science Foundation (NSF), chances are good that you share that funding with partners at other universities. When it's time to make a presentation on your research to the NSF, everyone involved can participate without having to travel—thanks to the Access Grid, an advanced web-conferencing resource that allows multiple camera feeds from each of the participating Access Grid nodes to appear on the high-resolution displays at every site.

Funded by IS&T, MIT's node on the Access Grid is a state-of-the-art facility in 9-152. Managed by the Libraries' Academic Media Production Services (AMPS), the room is equipped with several large projection systems, cameras, a Crestron control panel and a high-end microphone system for clear transmission.

While key to communications with the NSF, the AMPS' facility can be used for web conferencing with any of the numerous other sites on the Access Grid. For information about tapping into this high-tech facility, including scheduling and fees, visit web.mit.edu/amps/facilities/accessgrid.htm. To learn more about the Access Grid itself, visit www.accessgrid.org.

New service levels for TSM backup

To complement its standard TSM backup service, IS&T has introduced a "basic" level of service and will soon round out its TSM offerings with an "enterprise" level of service.

The basic service, for desktops and laptops, lets users back up 15 gigabytes (GB) of data in selected directories and folders. This service is offered at no cost to new TSM users and existing subscribers who switch to it.

Under the standard offering, which has been in place at MIT for over 12 years, users can back up 300GB of data. The fee for this service level is now $15 per month, an increase of $7.50 per month.

Later in the first quarter of 2008, IS&T will launch the enterprise service for server-class machines. Departments, labs and centers that sign up for the Enterprise service will be able to back up 10 terabytes of data for a monthly fee of $65.

Note that you can now check how much data you're storing on the TSM server by going to https://backup-w.mit.edu/cgi-bin/nodeinfo.cgi. To learn more about the upcoming changes, go to http://itinfo.mit.edu/article.php?id=8641.

Digitalk is compiled by Information Services and Technology.

PHOTO / **DONNA COVENEY**

Winter wonderland

Killian Court took on a fairy-tale feel as it was blanketed with snow during Monday's nor'easter.

Faculty debate communications measure at Dec. 19 meeting

Reif discusses minority faculty, grad students

At their Dec. 19 meeting, MIT faculty debated and voted down a resolution regarding Institute communications. They also received an update from Provost L. Rafael Reif on MIT's efforts to recruit and retain underrepresented minority and women faculty and graduate students.

The resolution, originally presented at the Oct. 17 faculty meeting by Kenneth Manning, Thomas Meloy Professor of Rhetoric and the History of Science, and Patrick Winston, Ford Professor of Engineering, was defeated by a 36-31 vote.

The measure asked the MIT administration to refrain from characterizing "the behavior and motives of members of the MIT community whose actions are the subject (real or potential) of pending criminal investigation."

In his update on minority faculty and graduate students, Reif indicated that steady progress has been made toward meeting the goals of a May 2004 faculty resolution advocating for sharp increases in underrepresented minority faculty and graduate students.

He reported that the faculty had experienced a net growth of 41 members in the last five years. Of this increase, 85 percent were women and 24 percent were underrepresented minorities. Even with this growth, the provost emphasized that more rapid progress is needed.

"There is still a great deal of work for us to do … to come closer to the goals of the 2004 resolution," Reif said, noting that underrepresented minorities currently make up 5.3 percent of faculty at MIT.

The provost said a key element in raising the percentage of underrepresented minorities among graduate students appears to be encouraging more to apply. He reported that only 3.4 percent of applications to MIT's graduate programs for the Fall 2007 class came from underrepresented minorities. Underrepresented minority students constituted 5.3 percent of admitted and 5.4 percent of enrolled graduate students.

Reif said women currently make up about 45 percent of MIT's undergraduate student body, 30 percent of its graduate students, 20 percent of its overall faculty and about 15 percent of its science and engineering faculty.

MIT research among Nature magazine's 2007 favorites

Nature's editors have picked their favorite research papers of 2007, and three studies involving MIT scientists are among the 18 selected.

Topics covered by the MIT papers include the search for extrasolar planets, a new technique for weighing single cells and the future of irregular verbs.

IMAGE COURTESY / **NATURE**

Feb. 22

A research group including MIT Associate Professor Sara Seager reported new information about the atmosphere of an extrasolar planet located about 904 trillion miles from Earth.

The team, based at Goddard Space Flight Center, used NASA's Spitzer Space Telescope to capture the most detailed information yet about an extrasolar planet.

The researchers analyzed the light emitted from a planet known as HD 209458b. They expected the planet to have water vapor, but the analysis did not show any signs of water vapor in the atmosphere. The team's other major finding was evidence of sandy particles known as silicates in the planet's atmosphere. NASA scientists hypothesize that clouds of those particles could be blocking emissions from water vapors.

April 26

MIT researchers reported a new way to measure the mass of single cells with high accuracy. The new technique, developed by Scott Manalis, associate professor of mechanical and biological engineering, and others at MIT, allows cells to remain in fluid while they are measured.

In the new system, cells or particles are pumped through a microchannel that oscillates within a vacuum. As the sample is pumped through, the frequency of oscillation changes slightly, and the mass of the sample can be calculated by measuring that change.

So far, the researchers have weighed particles with a resolution down to slightly less than a femtogram (10^{-15} grams). The work could lead to the development of inexpensive, portable diagnostic devices.

Oct. 11

A team from MIT and Harvard exploring language evolution reported on the pressures on irregular verbs to evolve over time.

The researchers, including Erez Lieberman, a graduate student in the Harvard-MIT Division of Health Sciences and Technology, developed a formula to predict how long it takes irregular verbs that do not take an "-ed" ending in the past tense to "regularize" as the language evolves.

Their study, based on an analysis of the English language as it evolved from Old English, found that English verbs are regularized at a rate that is inversely proportional to the square root of their usage frequency. In other words, a verb used 100 times less frequently will evolve 10 times as fast.

MIT to lead ambitious lunar mission

Twin satellites will study the moon's gravitational pull

David Chandler
News Office

MIT will lead a $375 million mission to map the moon's interior and reconstruct its thermal history, NASA announced last month.

The Gravity Recovery and Interior Laboratory (GRAIL) mission will be led by MIT professor Maria T. Zuber and will be launched in 2011. It will put two separate satellites into orbit around the moon to precisely map variations in the moon's gravitational pull. These changes will reveal differences in density of the moon's crust and mantle, and can be used to answer fundamental questions about the moon's internal structure and its history of collisions with asteroids.

The detailed information about lunar gravity will also significantly facilitate any future manned or unmanned missions to land on the moon. Such data will be used to program the descent to the surface to avoid a crash landing and will also help target desirable landing sites. Moreover, the mission's novel technology could eventually be used to explore other interesting worlds such as Mars.

"After the three-month mission is completed, we will know the lunar gravitational field better than we know Earth's," says Zuber, who is head of MIT's Department of Earth, Atmospheric and Planetary Sciences and the E.A. Griswold Professor of Geophysics. She will be the principal investigator for the GRAIL mission.

Former astronaut Sally Ride, the first U.S. woman in space, will lead the project's educational outreach phase, which will include five live MoonKam cameras on each satellite that will be targeted by young students—especially middle-school girls—in their classrooms to get close-up still and video views of the moon's surface.

So far, even such fundamental questions as whether or not the moon has a separate, differentiated core, as Earth does, are unknown, Zuber says. In addition to answering that question, the new mission should reveal details about lunar history, including the relative timing and effects of the myriads of huge impacts that created the craters and basins seen on the surface today. The moon, with its airless, uneroded surface, serves as a kind of Rosetta stone for understanding the history of all the solar system's inner planets—Mercury, Venus, Earth and Mars—so the mission should also help to unlock secrets of the evolution of these planets.

"The moon has the best-preserved record of the solar system's early history," Zuber says, while on other planets much of that record has been lost through erosion and other surface changes.

The technology used in the mission is a direct spinoff from the highly successful Gravity Recovery and Climate Experiment (GRACE) mission, which has been mapping Earth's gravitational field since 2002. Using that technology made this a low-risk mission for NASA because the necessary instruments had already been developed and tested.

IMAGE / **JPL–NASA**

The twin GRAIL satellites will orbit the moon close together and constantly monitor the exact timing of radio transmissions between them to reveal any perturbations in their motion caused by variations in the moon's gravity field.

As with that mission, GRAIL measurements of the gravitational field will come from precise monitoring of changes in the distance between the two satellites. The resulting measurements will map the moon's gravitational field up to 1,000 times more accurately than any previous mapping.

The main new technology needed to make GRAIL possible was a way to calibrate the timing of the satellites accurately. The Earth-orbiting GRACE satellites use the GPS satellite navigation system, but there is no such system at the moon. Instead, the team adapted a technique that involves precise monitoring of radio signals originally designed for a different purpose for another planetary mission in development, named Juno.

The same technology could be applied to future missions to map the gravitational fields of other interesting worlds such as Mars, where it could reveal the exchange of carbon dioxide between the polar caps and atmosphere or the movement of flowing subsurface water, Zuber says. "We could learn amazing things" from such follow-up missions, she says. "Since we solved the GPS problem for the moon, we could propose this with little modification for other planets."

NASA selected the MIT-led mission from among two dozen original proposals. NASA Associate Administrator for Science Alan Stern noted that "GRAIL's revolutionary capabilities stood out in this Discovery mission competition owing to its unsurpassed combination of high scientific value and low technical and programmatic risk."

The satellites will be built and operated by Lockheed Martin Space Systems. NASA's Jet Propulsion Laboratory (JPL) will handle project management and development of the communications and navigation systems.

The mission's science team also includes David E. Smith of NASA Goddard Space Flight Center (GSFC), who will be the deputy principal investigator, and other researchers from JPL, GSFC, the Carnegie Institution of Washington, the University of Arizona, the University of Paris and the Southwest Research Institute.

MIT, Harvard offer solution to Mars enigma

How Mars could have been warm and wet but limestone-free

David Chandler
News Office

Planetary scientists have puzzled for years over an apparent contradiction on Mars. Abundant evidence points to an early warm, wet climate on the red planet, but there's no sign of the widespread carbonate rocks, such as limestone, that should have formed in such a climate.

Now, a detailed analysis in the Dec. 21 issue of Science by MIT's Maria T. Zuber and Itay Halevy and Daniel P. Schrag of Harvard University provides a possible answer to the mystery. In addition to being warmed by a greenhouse effect caused by carbon dioxide in the atmosphere, as on Earth, the early Mars may have had the greenhouse gas sulfur dioxide in its atmosphere. That would have interfered with the formation of carbonates, explaining their absence today.

It would also explain the discovery by the twin Mars rovers, Spirit and Opportunity, of sulfur-rich minerals that apparently formed in bodies of water in that early Martian environment. And it may provide clues about the Earth's history as well.

The challenge was to interpret the planet's history, based on the data gathered by the Mars rovers—and especially Opportunity's discovery of sulfate minerals—from just tiny fractions of the surface, says Zuber, who is head of MIT's Department of Earth, Atmospheric and Planetary Sciences and the E.A. Griswold Professor of Geophysics. "How do you take very detailed measurements of chemical composition at one tiny place on Mars," she says, "and put it into the context of the broad evolution of the planet?" The breakthrough, she said, was when she and her colleagues realized "we'd been after the wrong molecule."

After several years of exploring the role of carbon dioxide and the carbon cycle, she said, they realized "maybe the key is sulfur dioxide, not carbon dioxide."

It was Opportunity's discovery of the mineral jarosite, which only forms in highly acidic water, that set them thinking about how that acidic environment could have come about. Sulfur provided the answer.

The new analysis suggests that on Mars, sulfur went through a whole cycle through the atmosphere, bodies of water on the surface, and burial in the soil and crust, comparable to the well-known carbon cycle on Earth. Through most of Earth's history, carbon dioxide has been released in volcanic eruptions, then absorbed into seawater, where it fosters the formation of calcium carbonate (limestone), which gets buried in ocean sediments.

Much evidence suggests Mars may once have had an ocean that covered about a third of the planet, in its northern hemisphere. Sulfur dioxide dissolves easily in water, so after being spewed into the atmosphere by the giant volcanoes of Mars' Tharsis bulge, much of it would have ended up in the water, where it inhibited the formation of carbonate minerals but led to the formation of silicates and sulfites, such as calcium sulfite.

These minerals degrade relatively rapidly, so they would not be expected on the surface of Mars today. But they also allow formation of clays, which have been found on Mars, and which added to the puzzle since clays are usually associated with the same conditions that produce carbonates.

See **MARS** Page 7

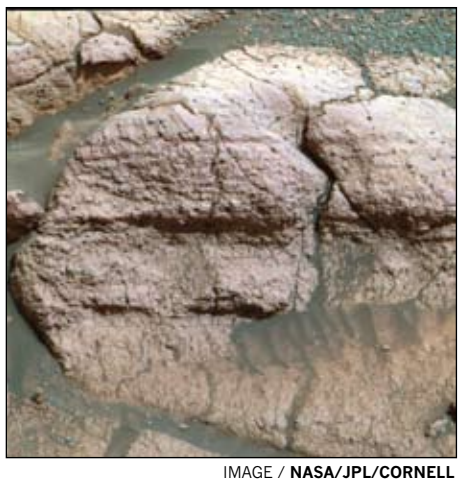

IMAGE / **NASA/JPL/CORNELL**

Taken by the panoramic camera on the Mars Exploration Rover Opportunity, this image shows a close-up of the rock dubbed 'El Capitan.' The iron-bearing mineral jarosite, which was found in the rock, led MIT and Harvard researchers to posit that early Mars may have had the greenhouse gas sulfur dioxide in its atmosphere.

PHOTO / **DONNA COVENEY**

Research scientist Luis Velasquez-Garcia, left, and Akintunde Ibitayo Akinwande, professor of electrical engineering and computer science, are developing a tiny sensor that can detect hazardous gases, including biochemical terror agents.

MIT gas sensor is tiny, quick

Energy-efficient device could quickly detect hazardous chemicals

Anne Trafton
News Office

Engineers at MIT are developing a tiny sensor that could be used to detect minute quantities of hazardous gases, including toxic industrial chemicals and chemical warfare agents, much more quickly than current devices.

The researchers have taken the common techniques of gas chromatography and mass spectrometry and shrunk them to fit in a device the size of a computer mouse. Eventually, the team, led by MIT Professor Akintunde Ibitayo Akinwande, plans to build a detector about the size of a matchbox.

"Everything we're doing has been done on a macro scale. We are just scaling it down," said Akinwande, a professor of electrical engineering and computer science and member of MIT's Microsystems Technology Laboratories.

Akinwande and MIT research scientist Luis Velasquez-Garcia plan to present their work at the Micro Electro Mechanical Systems 2008 conference this week. In December, they presented at the International Electronic Devices Meeting.

Scaling down gas detectors makes them much easier to use in a real-world environment, where they could be dispersed in a building or outdoor area. Making the devices small also reduces the amount of power they consume and enhances their sensitivity to trace amounts of gases, Akinwande said.

He is leading an international team that includes scientists from the University of Cambridge, the University of Texas at Dallas, Clean Earth Technology and Raytheon, as well as MIT.

Their detector uses gas chromatography and mass spectrometry (GC-MS) to identify gas molecules by their telltale electronic signatures. Current versions of portable GC-MS machines, which take about 15 minutes to produce results, are around 40,000 cubic centimeters, about the size of a full paper grocery bag, and use 10,000 joules of energy.

The new, smaller version consumes about four joules and produces results in about four seconds.

The device, which the researchers plan

See **ANALYZER** Page 7

MIT works toward engineered blood vessels

Vessels could be used in human body

Anne Trafton
News Office

MIT scientists have found a way to induce cells to form parallel tube-like structures that could one day serve as tiny engineered blood vessels.

The researchers found that they can control the cells' development by growing them on a surface with nanoscale patterning. A paper on the work was posted this month in an online issue of Advanced Materials.

Engineered blood vessels could one day be transplanted into tissues such as the kidneys, liver, heart or any other organs that require large amounts of vascular tissue, which moves nutrients, gases and waste to and from cells.

"We are very excited about this work," said Robert Langer, MIT Institute Professor and an author of the paper. "It provides a new way to create nano-based systems with what we hope will provide a novel way to someday engineer tissues in the human body."

The work focuses on vascular tissue, which includes capillaries, the tiniest blood vessels, and is an important part of the circulatory system. The team has created a surface that can serve as a template to grow capillary tubes aligned in a specific direction.

The researchers built their template using microfabrication machinery at Draper Laboratory in Cambridge. Normally such technology is used to build microscale devices, but the researchers adapted it to create nanoscale patterns on a silicone elastomer substrate. The surface is patterned with ridges and grooves that guide the cells' growth.

"The cells can sense (the patterns), and they end up elongated in the direction of those grooves," said Christopher Bettinger, MIT graduate student in materials science and engineering and lead author of the paper.

The cells, known as endothelial progenitor cells (EPCs), not only elongate in the direction of the grooves, but also align themselves along the grooves. That results in a multicellular structure with defined edges, also called a band structure.

Once the band structures form, the researchers apply a commonly used gel that induces cells to form three-dimensional tubes. Unlike cells grown on a flat surface, which form a network of capillary tubes extending in random directions, cells grown on the nano-patterned surface form capillaries aligned in the direction chosen by the researchers.

The researchers believe the technique works best with EPCs because they are relatively immature cells. Earlier attempts

See **VESSELS** Page 7

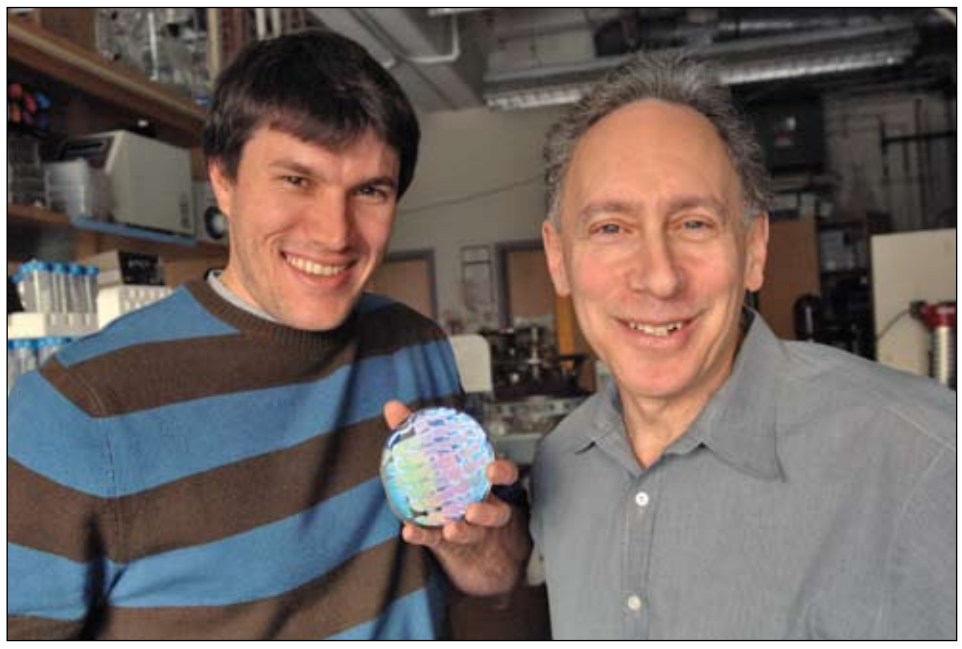

PHOTO / **DONNA COVENEY**

Graduate student Christopher Bettinger and Robert Langer, Institute Professor and professor of chemical engineering and bioengineering, have developed a way to make capillaries grow on a nano-patterned surface.

'What would E.T. see?'

Team analyzes how alien astronomers would study Earth

David Chandler
News Office

As astronomers become more adept at searching for, and finding, planets orbiting other stars, it's natural to wonder if anybody is looking back. Now, a team of astronomers that includes a professor from MIT has figured out just what those alien eyes might see using technologies being developed by Earth's astronomers.

According to their analysis, among other things E.T. could probably tell that our planet's surface is divided between oceans and continents, and learn a little bit about the dynamics of our weather systems.

"Maybe somebody's looking at us right now, finding out what our rotation rate is—that is, the length of our day," says Sara Seager, associate professor of physics and the Ellen Swallow Richards Associate Professor of Planetary Sciences at MIT.

Sara Seager

Seager, along with Enric Palle and colleagues at the Instituto de Astrofísica de Canarias, in Spain, and Eric Ford (S.B. 1999) of the University of Florida, have done a detailed analysis of what astronomers here and on other worlds could learn about a planet from very distant observations, using telescopes much more powerful than those currently available to Earth's astronomers. Their study, which has just been published online in the Astrophysical Journal, will appear in the journal's print edition in April.

Most of the planets astronomers have discovered beyond the solar system have not actually been seen; rather, they have been indirectly observed by looking at the influence they exert on stars they orbit. But even using the most advanced telescopes planned for use over the next several years, a planet orbiting another star would only appear as a single pixel—that is, a single point of light, with no detail except its brightness and color. By comparison, a simple cellphone camera typically takes pictures with about a million pixels, or one megapixel.

"The goal of [our] project was to see how much information you can extract" from very limited data, Seager says. The team's conclusion: a great deal of information about a planet can be gleaned from that single pixel and the way it changes over time.

The way of analyzing the data that Seager and her co-authors studied would work for any world that has continents and bodies of liquid on its surface plus clouds in its atmosphere, even if those were made of very different materials on an alien world. For example, icy worlds with seas of liquid methane, like Saturn's moon Titan, or very hot worlds with oceans of molten silicate (which is solid rock on Earth), would show up similarly across the vastness of space.

However, the method depends on clouds covering only part of a planet's surface, regardless of what each world is made of. So Titan, covered by perpetual global smog, would not give up the mysteries of its weather or rotation, nor would the hellishly hot Venus, with its complete shroud of clouds.

The key, the astronomers learned after studying data from Earth's weather satellites, is that while clouds vary from day to day, there are overall patterns that stay relatively constant, associated with the location of arid or rainy landmasses. Detecting those patterns would allow distant astronomers to figure out the planet's rotation period because a brightening associated with clouds above a particular continent would show up regularly once each "day," whatever the length of that day might be. Once the day's length is determined, then any variations in that period would reveal the changing weather—that is, clouds in a different place than the average.

No telescope now in operation is capable of making the measurements that Seager and her team analyzed. But planned telescopes such as NASA's Kepler, set for launch in 2009, would be able to discover dozens or hundreds of Earth-like worlds. Even-more-advanced space observatories being considered, such as NASA's Terrestrial Planet Finder, would allow the follow-up studies to learn about these planets' rotation and weather, and the composition of their atmospheres, Seager says.

The research was funded in part by a Ramon y Cajal fellowship for Palle and a Hubble Fellowship grant for Ford, and by NASA.

FLU

Continued from Page 1

ratory cells have glycan receptors classified as alpha 2-6; avian respiratory cells' glycan receptors are known as alpha 2-3. This classification is based on how the sugars are linked together when they are displayed on cells.

Until now, scientists had believed that a genetic switch that allows the virus to bind to alpha 2-6 receptors instead of alpha 2-3 receptors is responsible for avian viruses' ability to jump to humans.

The MIT study shows that that view does not adequately explain how viruses evolve to infect humans. The new work reveals that, more specifically, it is the ability of a flu virus to bind to a certain shape, or topology, of specific alpha 2-6 glycan receptor that determines whether it will infect humans.

Alpha 2-6 glycan receptors come in two shapes—one that resembles an umbrella, and another that resembles a cone. The MIT team found that to infect humans, flu viruses must bind to the umbrella-shaped alpha 2-6 receptor.

Thus, Sasisekharan and his team have redefined the host receptor for influenza and the criteria for how H5N1 can jump to humans. They did so by showing that the shape of the sugars—and not the type of linkage—is the key determinant for human adaptation of these deadly viruses.

This new interpretation explains inconsistencies that plagued the previous model, according to Sasisekharan. For example, some flu strains that can bind to alpha 2-6 receptors do not infect humans very well. It turns out that those viruses bind to cone-shaped alpha 2-6 receptors, which are present in the human respiratory tract but in much smaller numbers than umbrella-shaped alpha 2-6 receptors.

This new paradigm should help researchers develop a better way to track the evolution of avian flu leading to human adaptation, Sasisekharan said. Now, they know to look for avian viruses that have evolved the ability to bind to umbrella-shaped alpha 2-6 receptors.

That knowledge could help them create vaccines tailored to combat a potential pandemic. Similarly, these findings will help in the development of more-effective strategies for seasonal flu, which still is a leading cause of death.

"Subtle changes in influenza viruses over time can dramatically influence the likelihood that these viruses will be able to infect human populations, and this is a huge concern," said Jeremy Berg, director of the National Institute for General Medical Sciences, which funded the research. "This work enables researchers to look at flu viruses in an entirely new way. Dr. Sasisekharan's team achieved this through a multifaceted approach that combines laboratory experiments with the 'mining' of NIH-supported databases, leading to new insights into how the flu virus can adapt to a human host."

Other authors of the Nature Biotechnology paper are Terrence Tumpey of the Centers for Disease Control and Prevention; Aarthi Chandrasekaran, graduate student in MIT's Department of Biological Engineering (BE); Aravind Srinivasan and Karthik Viswanathan, postdoctoral associates in BE; Rahul Raman, research scientist in BE; S. Raguram, visiting scientist in BE; and Viswanathan Sasisekharan, visiting scientist in the Harvard-MIT Division of Health Sciences and Technology.

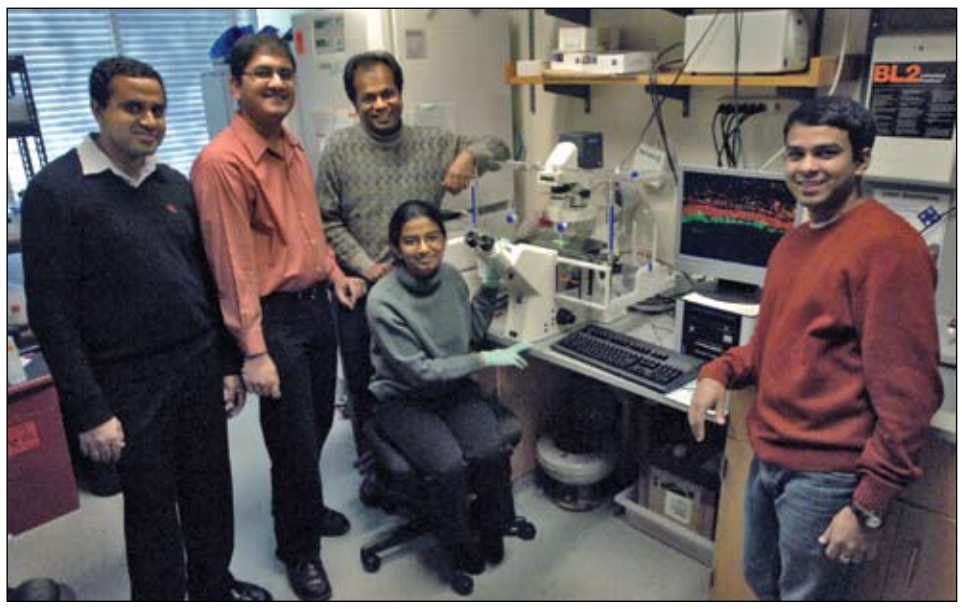

PHOTO / **DONNA COVENEY**

Shown, from left, are postdoc Karthik Viswanathan, research scientist Rahul Raman, Ram Sasisekharan, MIT Underwood Prescott Professor of Biological Engineering and Health Sciences and Technology, postdoc Aravind Srinivasan and, seated, graduate student Aarthi Chandrasekaran. The researchers have discovered a new way to monitor whether avian flu strains are evolving into a form that could infect humans.

Q&A: Macroeconomist Olivier Blanchard sees U.S. weathering $100 oil

Olivier Blanchard

As the price of oil doubled over the last year, hitting the $100 mark for the first time on Jan. 2, it may have looked like 1973 all over again to some observers. But research by MIT macroeconomist Olivier Blanchard, Class of 1941 Professor of Economics, shows that a return to 1970s-style gas lines and stagnant economic growth isn't in the cards.

Blanchard's paper, "The Macroeconomic Effects of Oil Price Shocks: Why are the 2000s so different from the 1970s?" outlines changes in U.S. and global economic policies between the two eras. Cited in The Economist (Nov. 17) as an explainer for the current situation, the paper was co-written by Blanchard's colleague Jordi Gali (Ph.D. 1989) of the Center for International Economic Research in Barcelona.

Blanchard discussed the differences between the oil shocks in the 1970s and in the 2000s during a recent interview with Sarah H. Wright of the MIT News Office.

Q. *Four price-doubling oil shocks have occurred in 35 years—1973, 1979, 1999 and now. How have economic reactions differed?*

A. In the 1970s, there were two sharp recessions and sharply higher inflation. This time around, the economy has remained strong, and inflation has barely bulged.

Q. *What's behind the differences? Why was 1973 so different from 2007?*

A. In the 1970s, the adverse effects of oil price increases were compounded by other adverse shocks—a sharp slowdown in productivity growth and large increases in the price of raw materials.

In the 2000s, the effects of oil price increases have been partly offset by other shocks, this time favorable—sustained productivity growth and strong Asian growth, for example.

Q. *Higher oil prices make dramatic news, yet your research indicates oil actually affects the U.S. economy less than it did 35 years ago. Why is that?*

A. Those previous large increases in the price of oil did their job: they led to decreased demand. The share of oil and gas in U.S. production and consumption today is roughly two-thirds of what it was in the 1970s. Thus, any given increase in the price of oil has only two-thirds of the impact it had then.

Q. *The Economist, citing your research, notes the role of wages has changed, changing the role of oil. What happened?*

A. We found that oil doesn't have the impact it did because workers don't have the bargaining power they did. In the 1970s, oil price increases led workers to try to maintain their purchasing power by seeking higher wages, which they often won through union contracts. This increase in wages led in turn to an increase in the price of all goods, which led to a further increase in wages and so on.

In the 1970s, wage increases were also made easier by the fact that, in many countries, wages were indexed to inflation, so they automatically went up. To fight inflation, central banks tightened monetary policy, leading in turn to declines in output.

Things are very different now: Indexation clauses are largely gone. And workers' bargaining position is much weaker than in the 1970s. Thus, for the most part, wages have not gone up with the price of oil, and inflation has remained low. There has been no need—so far—for tighter monetary policy.

Q. *What role has monetary policy played in differentiating the 1970s from the 2000s?*

A. For the last 25 years, monetary policy has aimed at stabilizing inflation, and people have come to rely on it as a credible policy. Now, when the price of oil increases, workers do not anticipate impending inflation and thus do not feel they have to ask for large wage increases.

Q. *Are there any macroeconomic benefits to higher oil prices?*

A. Higher oil prices have many complex implications for the world economy. Let me just take one, which may seem paradoxical: The increase in the price of oil helps finance the U.S. current account deficit. The reason is that oil producers know that oil revenues will not last forever, so they save a good part of those revenues. Not having great investment opportunities at home, they are eager to lend outside their country and, in particular, to lend to the U.S.

Such willing creditors allow the U.S. to continue to borrow abroad and to run a large current account deficit. Were it not for oil-producing countries, the demand for U.S. assets would be smaller, and the dollar would be even weaker than it is today.

Q. *What if oil-producing countries suddenly took their money out?*

A. The dollar would plunge. But so would the value of their dollar investment, so they are very unlikely to use this tool/threat.

Q. *Will the price of oil keep going up?*

A. I truly have no clue—despite talking to many of the people whose job it is to forecast oil prices. Most believe that based on what we know about the elasticity of supply and the elasticity of demand, the current price is surprisingly high. At 90 or 100 dollars a barrel, there is a lot of oil worth extracting, and a lot of alternative energy sources worth exploiting. Futures markets do not predict much change from current levels; this seems a reasonable assumption.

MITEI

Continued from **Page 1**

adjust lighting accordingly.

In addition to the major seed grants, junior faculty were awarded smaller Ignition grants, which are "a way to kick-start new research for them in the energy area," said Robert Armstrong, deputy director of MITEI. Those grants included projects aimed at designing more energy-efficient buildings, new thermoelectric materials for more-efficient heating and cooling, and improving the longevity of advanced nuclear power plants.

"We had outstanding submissions both in terms of the innovative ideas and in terms of the variety of faculty who applied," Armstrong said. "This has helped us identify new ideas and new people to involve in MITEI as well as valuable collaborations we can foster across campus."

New grants will be awarded twice each year, and over the course of the next five years the program will cover the whole spectrum of energy-related research, including environmental research related to energy production, delivery and use, and research that involves not only technology but also science, policy and systems design issues.

FRAGILE X

Continued from **Page 1**

improved altered brain development and memory, restored normal body growth and reduced seizures—many of the symptoms experienced by humans with FXS.

The researchers used genetic engineering to reduce mGluR5, but a drug could accomplish the same thing. Although not yet approved by the FDA, mGluR5 blockers are entering into human clinical trials. "Insights gained by this study suggest novel therapeutic approaches, not only for fragile X but also for autism and mental retardation of unknown origin," Bear said.

Earlier this year, MIT Picower Institute researcher Susumu Tonegawa and colleagues reported positive results using a different approach to reversing FXS symptoms. Tonegawa and colleagues identified a key enzyme called p21-activated kinase, or PAK, that affects the number, size and shape of connections between neurons.

In addition to Bear, authors include Brown University graduate student Gül Dölen; Picower Institute postdoctoral fellow Emily Osterweil; B.S. Shankaranarayana Rao of the National Institute of Mental Health and Neuroscience in India; MIT graduate students Gordon B. Smith and Benjamin D. Auerbach; and Sumantra Chattarji of the National Center for Biological Sciences and Tata Institute of Fundamental Research in India.

This work is supported by the National Institute of Mental Health; the National Institute of Child Health and Human Development; the National Fragile X Foundation; FRAXA, a Fragile X research foundation; and the Simons Foundation.

Recipients of MITEI's first round of campus seed grants

SEED GRANTS

Ultra-high efficiency thin film heterojunction solar cells using earth-abundant, scalable materials
Tonio Buonassisi (Mechanical Engineering) and Gerbrand Ceder (Materials Science and Engineering)

Advancing our understanding of Prochlorococcus, the Earth's smallest and most abundant photosynthetic machine
Sallie "Penny" Chisholm (Civil and Environmental Engineering and Biology)

Enzymatic control of pollutants and greenhouse gases
Catherine Drennan (Chemistry)

The health consequences of energy consumption in India
Esther Duflo and Michael Greenstone (Economics) and Amy Smith (Mechanical Engineering)

No watt left behind
Steven Leeb and James Kirtley (Electrical Engineering and Computer Science) and Les Norford (Architecture)

Harnessing collective intelligence to address global climate change
Thomas Malone and John Sterman (Sloan School of Management), Hal Abelson, Mark Klein and David Karger (Electrical Engineering and Computer Science)

Superconducting DC power transmission and distribution
Joseph Minervini and Leslie Bromberg (Plasma Science and Fusion Center)

Characterization of phonon mean free path and thermal transport in thermoelectric materials
Keith Nelson (Chemistry) and Gang Chen (Mechanical Engineering)

Microbial synthesis of pentanol as a biofuel
Kristala Jones Prather (Chemical Engineering)

Electrochemical cell evaluation and design for MIT nanotube-enhanced ultracapacitor
Joel Schindall and John Kassakian (Electrical Engineering and Computer Science) and Donald Sadoway (Materials Science and Engineering)

Investigation of subsurface microbial processes during and after geological carbon sequestration
Janelle Thompson and Roman Stocker (Civil and Environmental Engineering)

IGNITION GRANTS

Towards a balance between light, heat and comfort: angularly and spectrally selective envelopes for energy-efficient buildings
Marilyne Andersen (Architecture)

Semiconductor nanowires for thermoelectric applications
Silvija Gradecak (Materials Science and Engineering)

Nitride-based electronics for high-efficiency power conversion
Tomas Palacios (Electrical Engineering and Computer Science)

Demonstrating biomimetic self-repair in photoelectrochemical energy production systems
Michael Strano (Chemical Engineering)

Structural characterization of organic photovoltaics and fuel-forming catalysts via designer force fields
Troy Van Voorhis (Chemistry)

Nano-structured alloys against corrosion in advanced nuclear plants
Bilge Yildiz (Nuclear Science and Engineering)

MIT, Eni announce energy research partnership

Advanced solar program planned

MIT and Italian energy company Eni this week announced a major energy research partnership focused on developing advanced solar technologies, from novel photovoltaic materials to the design of solar power plants.

Eni will also become a founding member of the MIT Energy Initiative (MITEI), supporting a portfolio of diverse energy research projects at the Institute.

Total funding for the partnership will be $50 million over five years. Of those funds, $25 million will establish the Eni-MITEI Solar Frontiers Research Program. The remainder will support Eni's founding membership in MITEI.

MIT President Susan Hockfield voiced strong support for the collaboration, noting that "Eni's commitment to meeting the world's energy needs through new technologies is inspiring, and we're honored by Eni's confidence in MIT as a partner. We look forward to working with Eni on the science, technology and analysis critical to advancing energy security and environmental stewardship."

Hockfield also praised the agreement as an opportunity to vault forward in the development of advanced solar technologies.

"For a global oil and gas company like Eni to invest in renewable energy options speaks volumes about the urgent need for large-scale carbon-free energy options like solar," she said.

Eni CEO Paolo Scaroni said the partnership is part of a broader initiative originated in late 2006 with the long-term objective of building up a leadership role for Eni in the field of innovation and advanced technologies.

The Eni-MITEI Solar Frontiers Research Program will include six areas of focus: nano-structured thin film photovoltaics; luminescent solar concentrators; self-assembling photovoltaic materials; water splitting; materials for solar energy capture and storage; and maximizing the return on investment for solar thermal plants.

As a founding member of MITEI, Eni will also support a range of other research projects at the Institute, spanning the energy spectrum from traditional oil and gas to methane hydrates to global change to transportation options. This portfolio will include a large research project in multi-scale reservoir science for enhanced oil recovery.

Eni will support MITEI's Energy Research Seed Fund program and 10 "Eni-MIT Energy Fellows" at MIT for each year of its five-year commitment.

Leonardo Maugeri, group senior vice president for strategies and development at Eni, welcomed the new collaboration as "a great opportunity to team Eni's expertise with MIT's first-class ability in fostering new research and education in science and technology in order to jointly develop innovative, powerful tools, technologies and solutions to address global energy needs and challenges."

Professor Ernest J. Moniz, director of MITEI, also applauded the collaboration. "This is an exciting partnership, notable for its boldness in addressing a multiplicity of key challenges at the energy-environment frontier. We deeply appreciate Eni's confidence in MIT faculty and students to carry out this research and educational agenda in close cooperation with Eni's researchers," he said.

As part of its founding-member research portfolio, Eni will also be supporting research in evaluation methodologies for the commercial potential of energy startups and novel energy technologies. Moniz noted that "to meet the world's energy needs we will likely need partnerships between entrepreneurial energy technology innovation companies and companies with global distribution networks, such as Eni. This investment, while a relatively small part of the Eni-MITEI research portfolio, could pay big dividends in the future by strengthening a key link in the energy innovation chain."

New federal chemical rules to impact MIT

The MIT Environment, Health and Safety Office (EHS) is asking departments, laboratories and centers at the Institute for help in responding to new federal regulations aimed at preventing the misuse of certain chemicals.

While the new regulations from the U.S. Department of Homeland Security (DHS) most directly apply to chemical plants and similar facilities, the department's broad definition of a "chemical facility" means colleges and universities are also subject to the requirements.

"MIT will definitely have to take action to comply with these regulations, and we'll need the assistance of our departments, laboratories and centers to coordinate MIT's response," said Zhanna Davidovitz, environmental officer with EHS.

According to the recently published "Chemical Facility Anti-Terrorism Standards," facilities like MIT must report to DHS if they possess certain levels of some 370 chemicals. The complete list of chemicals can be found in Appendix A of the DHS rule: www.dhs.gov/xlibrary/assets/chemsec_appendixa-chemicalofinterestlist.pdf.

DHS will use the reports to rank facilities by their perceived level of risk. Those facilities deemed "high risk" based on this initial assessment will have to perform vulnerability assessments, develop site security plans and potentially implement additional security measures that satisfy the DHS' risk-based performance standards.

As the federal requirements are finalized, EHS will be in contact with MIT groups that use the DHS-listed chemicals. In preparation, EHS recommends that these groups inventory their chemical stocks. EHS, which provides inventory software at no charge to the MIT community, notes that comprehensive chemical inventories save MIT groups money by accurately representing available stocks, thereby avoiding redundant orders of expensive reagents.

"By securing dangerous materials from misuse or release, MIT can better protect its community," said William VanSchalkwyk, managing director of EHS Programs. "Over the past several years, MIT has improved security measures and implemented access control to several lab areas. Increasing any security element is of course balanced with our culture of providing an open atmosphere for our community to learn, work and live. These new DHS regulations will assist all of us at MIT in having more context in the overall view of security and vulnerability as related to chemicals in use at MIT."

For more information, please contact Zhanna Davidovitz at x2-2510 or visit web.mit.edu/environment/ehs/chemical_security.html.

NEWS YOU CAN USE

Express yourself this January in video, photography

Video and photography enthusiasts in the MIT community have two opportunities in January to create and share their work.

MIT TechTV presents the second IAP Video Contest for MIT students, as well as YourMIT, an opportunity for the broader community to contribute to a multimedia extravaganza reflecting the MIT experience.

The video contest enables students to show the world what they love about engineering, science or just MIT in general, via online video. The contest kicks off at 2:00 p.m. Wednesday, Jan. 9 with an information session in Room 9-057. Videos may be uploaded from Jan. 9-27, with a final show on Wednesday, Jan. 30. The winner of the contest will receive a new Apple iPod Touch. For full information about submissions, voting and judging, see web.mit.edu/techtv/IAPVideoContest.

YourMIT aims to reflect the rich and diverse residential, academic and workplace experiences at MIT. Faculty, staff and students are invited to contribute as many photos and short videos as they like; TechTV staff will edit them and the resulting video will be shown on Friday, Feb. 1. Submissions are due on Wednesday, Jan. 30. After the showing, a web gallery with more information about the individual works will be available. For more information, go to web.mit.edu/techtv/yourmit.

BLOGGING IAP

MIT students both near and far blog about their experiences during IAP.

- Hard times
- Global warming?
- Greetings from Honduras
- A sadly beautiful sight

Check out the latest posts at:

web.mit.edu/newsoffice

Do you have an IAP blog? Let us know!
newsoffice@mit.edu

CLASSIFIED ADS

Members of the MIT community may submit one ad each issue. Ads should be 30 words maximum; they will be edited. Submit by e-mail to ttads@mit.edu or mail to Classifieds, Rm 11-400. Deadline is noon Wednesday the week before publication.

FOR SALE

Men's jacket: Size large, brown-leather look, below hip length, warm fleece lining throughout. Made in Italy. New, $35. Call Rosalie at 781-391-1307.

Beautiful, antique (ca. 1910) loveseat with café au lait upholstery. In excellent condition. $150 cash-and-carry from West Cambridge. For photos, e-mail jstein@mit.edu.

Brand new, highly durable, Swiss-made Whip-it! whipped cream dispenser that instantly transforms cream into a whipped topping. ½ liter size. Includes two decorating tips and cleaning brush. $25. Contact Cheryl at 258-5673 or cheryl@mit.edu.

Lexington, 6-rm contemporized cape, $569,000, master BR suite, study, 2 BRs and bath upstairs, skylights, hdw flrs, AC, 2-car gar. 781-981-2671.

FOR RENT

2+ BR unit in Newton. $1575/mo. + util. Includes parking. Access to Green Line and easy to Rte. 9 and into town. No broker fee. Contact Greer at 617-308-6583 or greer.swiston@commonmoves.com.

House for rent in Bethel Village in Sunday River Ski Area in Maine. Sleeps 10 (4 bdrm, 2 bath). Walk to restaurants and shops. Take free shuttle bus to mountain. $275/night or $1600/week. Contact Janine at 339-227-3074 or janine@mit.edu.

ANALYZER

Continued from Page 4

to have completed within two years, could be used to help protect water supplies or for medical diagnostics, as well as to detect hazardous gases in the air.

The analyzer works by breaking gas molecules into ionized fragments, which can be detected by their specific charge (ratio of charge to molecular weight).

Gas molecules are broken apart either by stripping electrons off the molecules or by bombarding them with electrons stripped from carbon nanotubes. The fragments are then sent through a long, narrow electric field. At the end of the field, the ions' charges are converted to voltage and measured by an electrometer, yielding the molecules' distinctive electronic signature.

Shrinking the device greatly reduces the energy needed to power it, in part because much of the energy is dedicated to creating a vacuum in the chamber where the electric field is located.

Another advantage of the small size is that smaller systems can be precisely built using microfabrication. Also, batch-fabrication will allow the detectors to be produced inexpensively.

The research, which started three years ago, is funded by the Defense Advanced Research Projects Agency and the U.S. Army Soldier Systems Center in Natick, Mass.

VESSELS

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with other types of cells, including mature epithelial cells, did not produce band structures.

Growing tissue on a patterned surface allows researchers a much greater degree of control over the results than the classic tissue-engineering technique of mixing cell types with different growth factors and hoping that a useful type of tissue is produced, said Bettinger.

"With this technique, we can take the guesswork out of it," he said.

The next step is to implant capillary tubes grown in the lab into tissues of living animals and try to integrate them into the tissues.

Other authors of the paper are Jeffrey Borenstein, director of the Biomedical Engineering Center at Draper Laboratory; Zhitong Zhang, an MIT senior in the Department of Chemical Engineering; and Sharon Gerecht of Johns Hopkins University.

The research was funded by the National Institutes of Health, Draper Laboratory and the Juvenile Diabetes Research Foundation.

MARS

Continued from Page 4

The new picture of a sulfur cycle helps to solve another mystery, which is how early Mars could have been warm enough to sustain liquid water on its surface. A carbon dioxide atmosphere produces some greenhouse warming, but sulfur dioxide is a much more powerful greenhouse gas. Just 10 parts per million of sulfur dioxide in the mostly carbon dioxide air would double the amount of warming and make it easier for liquid water to be stable.

The analysis may also tell us something about our own planet's past. The early Earth's environment could well have been similar to that on Mars, but most traces of that era have been erased by Earth's very dynamic climate and tectonics. "This might have been a phase that Earth went through" in its early years, Zuber says. "It's fascinating to think about whether this process may have played a role" in the evolution of the early Earth.

The work was funded by NASA, a Radcliffe fellowship, the George Merck Fund and a Harvard graduate fellowship.

PHOTO / **DONNA COVENEY**

Graduate student Mary Hale floats around in her Monumental Helium Inflatable Wearable Floating Body Mass, a means of mental escape and personal ease.

Wearing their art on their sleeves

Grad students design clothing with quirky functionality

Sarah H. Wright
News Office

MIT students are always in motion, so their projects for the advanced visual design course, Give Me Shelter, featured clothes and accessories to help navigate the gaps between work and home, self-confidence and unease, and under- or over-stimulation.

Adam Kumpf, graduate student in media arts and sciences, designed EscHome, a wearable office consisting of a chair and a desk embedded in a pair of black pants. A garment that provides the comforts of work—structure, stability, solitude—amid the pressures at home, EscHome's chair and desk are made from lightweight carbon fiber rods, aluminum joining blocks and fabric to match the pants.

PHOTO / **DONNA COVENEY**

With microphones hidden in her garment, graduate student Angela Chang demonstrates how her movement in this glorious silk tunic dictates how she sounds.

Kumpf (S.B. 2005, M.Eng. 2007) deconstructed EscHome with glee. "The structural rods are hidden within small zipped pockets and situated along the femur, so they don't interfere with walking or sitting. Unzip the pockets; position the rods; in a minute, you're hiding in work."

Mary Hale, graduate student in architecture and planning, took on space, gender and mobility in her plastic dropcloth and electrician-tape pantaloons, the Monumental Helium Inflatable Wearable Floating Body Mass.

Hale, whose modeling session required a 15-minute bond with the Shop-Vac to inflate Body Mass, wanted to create body-wear that functioned like a book for mental escape, subverted physics (especially gravity), and enhanced mobility and personal ease.

Body Mass achieves all this, Hale said, tipping forward and back on her personal sea. "But it's with a twist: she who dons this body gains its lightness and freedom by assuming a culturally undesirable physical proportion—a volume at least 10 times greater than her actual size. It's a means of mental escape and an envelope of new personal space," Hale said.

For Angela Chang, graduate student in media arts and sciences, the ripple of silk, the scratch of linen and the hush of polar fleece convey information about the wearer's identity and activities. The experience of a blind friend who could only hear a circus performance inspired Chang to amplify these sounds.

She designed a garment for hiding and a garment to dramatize dancing. Her wool isolation scarf is equipped with two speakers, ambient noise circuits, conductive thread and a microphone in the back to control the volume in relation to ambient noise. It cocoons the wearer inside a white-noise bubble—like having a therapist's waiting room on your head.

Chang also designed and sewed a raw silk, bell-sleeved, dance-party shirt—with thanks to Regina Moeller, visiting associate professor of architecture, for the sewing instruction. "The basting stitch, pattern language, sewing machines—these were technologies I didn't know," said Chang.

Chang augmented the shirt's typical rustling sound with an amplification circuit, sewing two microphones inside the sleeve-ends and two speakers near the neck. Movement broadcast through the speakers dramatizes dance-floor action for the vision-impaired.

Moeller, a German artist, author and publisher, co-taught Give Me Shelter with Ute Meta Bauer, director of the visual arts program. Moeller delighted in the interdisciplinary ferment of the body-wear class, she said.

"What I loved about this class and about MIT is that the 12 students came from different fields and they all helped each other," said Moeller.

PHOTO / **DONNA COVENEY**

Graduate student Adam Kumpf demonstrates the wearable office he created for the advanced visual design class Give Me Shelter.