Wednesday – April 4, 2007

TechTalk

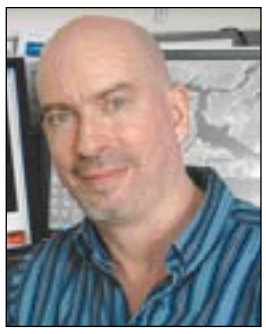
SERVING THE MIT COMMUNITY

Neuroscientists locate brain regions that fuel attention

Work could aid treatment of ADD

Deborah Halber
News Office Correspondent

If you spotted an anaconda poised to strike, the signal to pay attention would originate in a different part of your brain than if you gazed at an anaconda in the zoo, neuroscientists at MIT's Picower Institute for Learning and Memory report in the March 30 issue of Science.



Earl K. Miller

The work, which could have implications for treating attention deficit disorder (ADD), is the first concrete evidence that two radically different brain regions—the prefrontal cortex and the sensory cortex—play different roles in these different modes of attention.

What's more, when you focus your attention, the electrical activity in these two brain areas oscillates at different frequencies. "It's as if the brain is using two different stops on the FM radio dial for different types of attention," said study co-author Earl K. Miller, Picower Professor of Neuroscience.

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Biologists find B12 puzzle's final piece

Anne Trafton
News Office

Solving a mystery that has puzzled scientists for decades, MIT and Harvard researchers have discovered the final piece of the synthesis pathway of vitamin B12—the only vitamin synthesized exclusively by microorganisms.

B12, the most chemically complex of all vitamins, is essential for human health. Four Nobel Prizes have been awarded for research related to B12, but one fragment of the molecule remained an enigma—until now.

The researchers report that a single enzyme synthesizes the fragment, and they outline a novel reaction mechanism that requires cannibalization of another vitamin.

The work, which has roots in an MIT undergraduate

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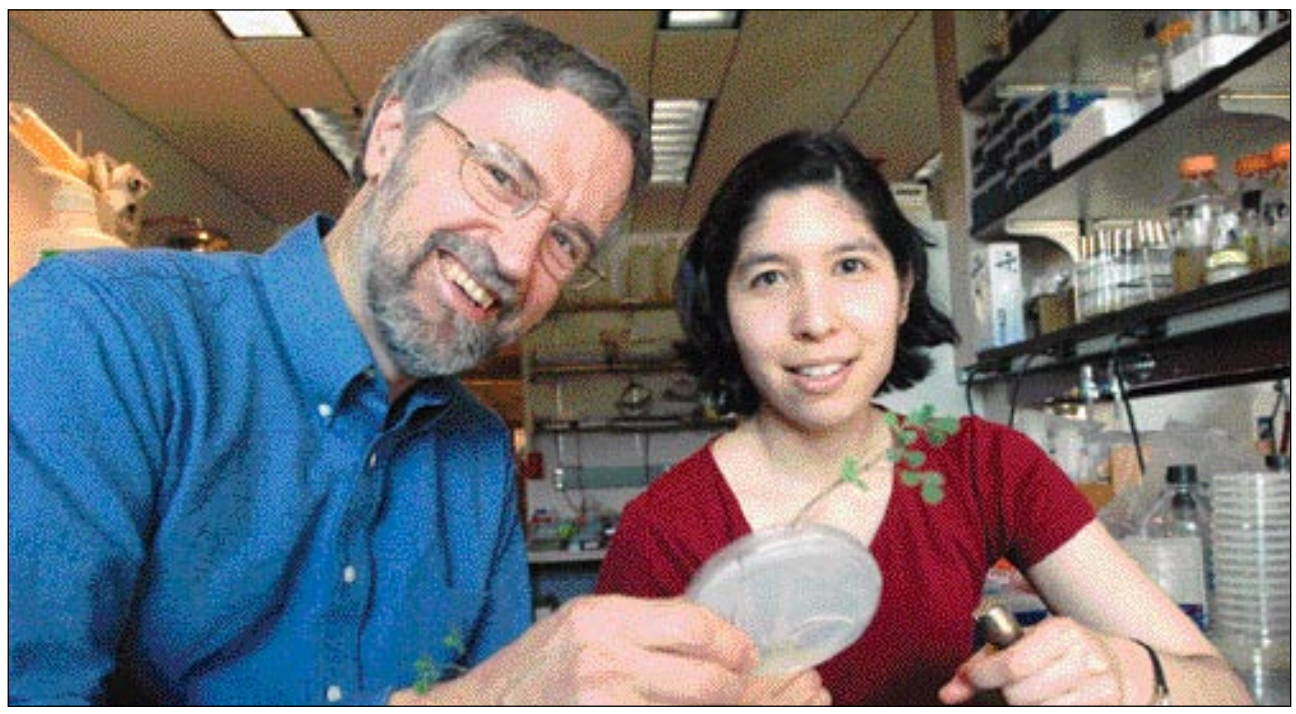

PHOTO / **DONNA COVENEY**

Professor Graham Walker and postdoctoral fellow Michiko Taga have discovered the last unknown step in the production of vitamin B12. The vitamin is synthesized by soil microbes that form symbiotic relationships with plant roots.

Engineer, humanitarian wins Truman Fellowship

Stephanie Schorow
News Office Correspondent

An MIT junior who launched a program to help Sri Lankan victims of rape and incest has won a 2007 Harry S Truman Scholarship, which she vows to use for graduate studies in sustainable development.

Alia Whitney-Johnson, 20, a junior majoring in environmental engineering, learned she was a winner of the $30,000 scholarship via her cell phone while walking in New York City. "I shrieked in the middle of the street; everyone stared at me," said Whitney-Johnson, laughing, who recently returned from Sri Lanka.

Alia Whitney-Johnson

The Truman Scholarship is awarded to college juniors who demonstrate a sense of community and who are committed to public service.

Public service has marked Whitney-Johnson's years at MIT. As a freshman, she helped to organize "Pulse," a multimedia celebration of African-America culture. In the summer of 2005, she traveled to Sri Lanka through the MIT Public Service Center to help with tsunami relief. While there, she did some volunteer work for a home for girls, age 10 to 18, who had become mothers through rape or incest. An amateur jewelry maker herself, Whitney-

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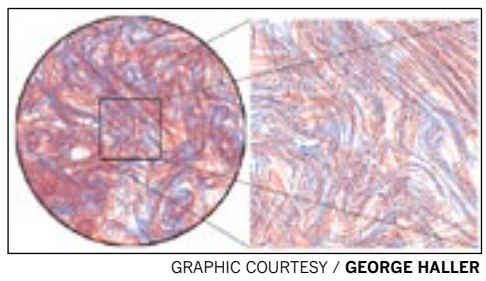
MIT reveals the tangle under turbulence

Deborah Halber
News Office Correspondent

Picture the flow of water over a rock. At very low speeds, the water looks like a smooth sheet skimming the rock's surface. As the water rushes faster, the flow turns into turbulent, roiling whitewater that can overturn your raft.

Turbulence is important in virtually all phenomena involving fluid flow, such as air and gas mixing in an engine, ocean waves breaking on a cliff and air whipping across the surface of a vehicle. However, a comprehensive description of turbulent fluid motion remains one of physics' major unsolved problems.



GRAPHIC COURTESY / **GEORGE HALLER**

MIT visualization of the chaotic tangle underlying turbulence. Area in black box represents a blown-up portion of the fluid showing the self-similarity of the tangle.

Now, in a paper to be published in an upcoming issue of Physical Review Letters, MIT researchers report that they have visualized for the first time a convoluted tangle underlying turbulence. This work may ultimately help engineers design better planes, cars, submarines and engines.

Researchers have long suspected that there's a hidden but coherent structure underlying turbulence's messy complexity, but there has been no objective way of identifying it, said MIT research group leader George Haller, professor of mechanical engineering, who also heads Morgan Stanley's Mathematical Modeling Center in Hungary.

"The fluid mechanics community has not reached a consensus even on an objective definition of a vortex, or whirlpool effect, let alone the definition of structures forming turbulence. The mathematical techniques we have developed give a systematic way to identify the material building blocks of a turbulent flow," Haller said.

To picture the skeleton of turbulence, the MIT researchers analyzed experimental data obtained from co-authors Jori Ruppert-Felsot and Harry Swinney of the University of Texas at Austin. The Texas group used water jets to force water from below into a rotating tank of fluid. They seeded the resulting complicated flow with luminescent buoyant particles. When illuminated with a laser, the miniscule polystyrene spheres were visible as they raced around the vortices and jets.

While the particles looked cool, "most important to our analysis were the particles' velocities, which our collaborators obtained by recording the particles' motion with a high-resolution camera, then using a software tool to figure out which particle moved where in a split second," Haller said. "This gave us a high-quality map of the whole velocity field of the turbulent flow at each time instance."

The technical analysis of the velocity field was carried out by MIT mechanical engineering graduate student Manikandan Mathur, whose work is jointly supervised by Haller and co-author Thomas Peacock, assistant professor of mechanical engineering at MIT.

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NEWS

VAPOR-SENSOR VICTORY

Timothy Swager wins the $500K Lemelson-MIT Prize for his vapor-sensing polymer technology.

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Frank Douglas receives Associated Black Charities' national award.

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The 1970s oil crisis shrank cars and civic confidence.

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HUNTING SEASON

MIT Sloan students build teams and leadership skills by scavenging.

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Douglas receives Black History Maker award

Dr. Frank Douglas, professor of the practice at the Harvard-MIT Division of Health Sciences and Technology and executive director of the MIT Center for Biomedical Innovation in the MIT Schools of Management, Engineering and Science, is one of five recipients of the Associated Black Charities' 2007 Black History Makers Award.

Douglas will receive the award at an April 11 dinner ceremony in New York City.

Douglas, a world-renowned innovator in pharmaceutical research and development, has led the discovery, development and market launch of more than 20 drugs in his 22 years in the pharmaceutical industry.

Frank Douglas

In his current role leading MIT's Center for Biomedical Innovation, Douglas' mission is to transform the discovery, development, manufacture and distribution of cost-effective therapeutics and devices.

Among his many awards are the Heart of the Year Award from the Chicago Heart Association and the Louis B. Russell Memorial Award from the American Heart Association, both for Douglas's development of high blood pressure screening and control programs for black churches in Chicago.

After graduating cum laude from Lehigh University, Douglas earned a Ph.D. in physical chemistry and M.D. from Cornell University.

Douglas's Black History Maker Award is named for Percy L. Julian, who, despite personal and societal hurdles, became an outstanding organic and natural chemist. Julian was the first to synthesize physostigmine and to use soybeans to synthesize human steroids.

The Associated Black Charities is a federation of 14 member agencies who deliver health and human services in New York City. The other 2007 award recipients are Carla Harris, a managing director at Morgan Stanley; David A. Paterson, lieutenant governor of New York; Tony Dungy, head coach of the Indianapolis Colts; and Lovie Smith, head coach of the Chicago Bears.

Swager, of chemistry, wins $500K Lemelson-MIT Prize

Timothy M. Swager, head of the Department of Chemistry and the John D. MacArthur Professor of Chemistry at MIT, is the winner of the $500,000 2007 Lemelson-MIT Prize for inventing sensors that detect vapors of common bomb-making chemicals such as TNT.

The Lemelson-MIT Prize is the most prestigious cash prize for invention in the United States. This year, the prize was slated for a mid-career inventor rising in his or her field.

"The originality, practicality and timeliness of Dr. Swager's inventions made him a stand-out candidate for this year's $500,000 Lemelson-MIT Prize," said Merton Flemings, director of the Lemelson-MIT Program, which has given the award to an accomplished inventor for the past 12 years. "For instance, soldiers and Marines in Iraq are already benefiting from his explosive-detection inventions, and his molecular wire inventions will likely find application in a wide range of healthcare, environmental and security areas."

Timothy M. Swager

Among his many inventions, Swager invented amplifying fluorescent polymers that can attract nitro aromatic molecules, a class of chemicals typically used in explosives. In most molecular sensors, the strength of the emitted signal is proportional to the number of target molecules reaching the sensor. Therefore, they are usually not sensitive enough to detect very small trace amounts of the target substance.

Swager reasoned that if he designed a polymer chain that would carry a signal except when a single target molecule struck the chain, he would have an extraordinarily sensitive detector. Thus, if the target molecule were TNT, a bomb detection device could be constructed from the polymer.

In 2001, Swager licensed his patented polymer technology to Nomadics, now a unit of ICx Technologies, for use in that company's Fido Explosives Detector, so named for its ability to simulate a bomb-sniffing dog.

Currently, American soldiers in Iraq are using Fido devices attached to a robotic platform for deployment to hard-to-reach and dangerous areas and as portable, hand-held monitors to analyze people, clothing and automobiles.

On May 2-5, Swager and Lee Lynd, professor of engineering and adjunct professor of biology at Dartmouth College and the first recipient of the new $100,000 Lemelson-MIT Award for Sustainability, will participate in the first-ever EurekaFest, a multiday celebration of the inventive spirit presented by the Lemelson-MIT Program in partnership with the Museum of Science.

The Lemelson-MIT Award for Sustainability recognizes inventors whose products and processes enhance economic opportunity and community well-being while protecting and restoring the natural environment.

In the United States today, fuel ethanol is derived from corn, which is available in limited quantities and requires substantial amounts of fossil energy to produce. Lynd has identified one-step fermentation of cellulosic biomass into ethanol or other biofuels—a process configuration known as consolidated bioprocessing—as a potentially transformative breakthrough for low-cost processing.

In 2006, with funding from Khosla Ventures and other financiers, Lynd co-founded Mascoma Corp., in Cambridge, Mass. The company develops processes for cost-effectively converting cellulosic biomass, such as grass, wood, wheat and rice straw into ethanol that can be used for fuel.

In his nomination letter for Lynd for the $100,000 Lemelson-MIT Award for Sustainability, renowned venture capitalist Vinod Khosla said he has become a "big believer" in the ability of ethanol to reduce America's dependence on petroleum.

For more information on EurekaFest, visit web.mit.edu/invent/eurekafest.html.

Ellison is Palm Professor of Economics

Professor Glenn Ellison, a leader in the fields of economic theory, industrial organization and financial economics, has been named the inaugural holder of the Gregory K. Palm '70 Professorship in Economics.

The new professorship was endowed by Gregory K. Palm, a 1970 graduate of the MIT economics department and a member of its visiting committee. He graduated from the joint J.D.-M.B.A. program at Harvard and subsequently clerked for Judge Henry Friendly of the 2nd U.S. Circuit Court of Appeals and for Supreme Court Justice Lewis Powell. Palm is currently the general counsel at Goldman Sachs in New York and a member of the firm's management committee.

Ellison, who received his Ph.D. from the MIT economics department in 1992, taught at Harvard for two years before joining the MIT faculty in 1994. He has made fundamental contributions in several subfields of economics. Ellison is internationally recognized for his theoretical analysis of learning in games. He has been particularly influential in identifying how social networks and other institutions that affect communication between market participants affect the speed of learning and the ultimate determination of market equilibrium.

Ellison's contributions in industrial organization include one of the classic studies of cartel behavior, a detailed analysis of the pricing behavior of the 19th-century New York-to-Chicago railroad cartel, as well as several more contemporary studies of pricing policy. In collaboration with his wife, MIT economics senior lecturer Sara Ellison (Ph.D. 1993), he has explored the behavior of Internet shoppers and sellers. This work highlights the role of buyer search and seller obfuscation in Internet markets, and it also demonstrates the importance of tax avoidance as a motive for Internet purchases.

Ellison has also made important contributions in financial economics, where he has studied incentive and agency problems in the mutual fund industry. He has demonstrated that mutual fund managers change the risk profile of their investments in reaction to opportunities for securing a place in the top echelon of fund performers for a given year. Managers at funds that are just outside the top ranks as the year-end approaches take greater risks than comparable managers at funds that are already in the top ranking positions, or than managers at funds that are already virtually assured a low ranking.

Ellison has been an active contributor to the educational mission of the MIT economics department, winning the department's graduate teaching award five times in the last dozen years. He has also served as editor of Econometrica, the premier economics journal for research on economic theory and econometrics.

PHOTO / JAMES POTERBA

Glenn Ellison, left, President Susan Hockfield, Gregory K. Palm, and Provost L. Rafael Reif celebrate Ellison's appointment.

TURBULENCE

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Using involved mathematical tools, Mathur uncovered a convoluted tangle embedded in the flow. "With this approach, we isolated the very source of turbulent mixing, not just its effect on dye or smoke as earlier studies did," said Mathur.

The complexity they found surprised the MIT team. They knew that in turbulent flow, unsteady vortices appear on many scales and interact with each other. What they didn't know was that the complicated, constantly evolving flow patterns are driven by two competing armies of particles constantly being pulled together and pushed apart.

The researchers identified a complex network of two types of curves formed by two distinct groups of particles. The first type of curve, which the researchers colored red, attracts other fluid particles. At the same time, the second type, colored blue, repels other fluid particles. Both sets of curves evolve with the flow.

Imagine that the particles visible in the turbulent water are like an army of ants being chased through a bowl of mixed-up red and blue spaghetti. "The ants love red spaghetti and want to stay close to it, but they hate blue spaghetti and won't touch it. And they have to keep running in the bowl under these constraints, stuck in an endless maze forever," said Haller.

The resulting images, which look like dense, tangled masses of blue and red fibers, are snapshots of this stunning, constantly deforming structure. "The chaotic tangle forms the skeleton of turbulence as fluid is simultaneously attracted to, and repelled by, its different components," Haller said.

The MIT researchers call their discovery the "Lagrangian skeleton" of turbulence because their particle-based approach is motivated by the work of 19th-century mathematician Joseph-Louis Lagrange. "Lagrange developed mathematical tools still used today for calculating mechanical and fluid motion," said Peacock.

Among many applications, the new results promise to aid the early detection of clear air turbulence that causes those unexpected jolts in airplanes; they may also help control the spread of oceanic pollution. "Most certainly, they will lead to a better appreciation of ants running in a bowl of spaghetti," said Haller.

This work was supported by the National Science Foundation, the Air Force Office for Scientific Research and the Office of Naval Research.

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Institute admits 1,533 students to the Class of 2011

MIT has admitted 1,533 students from 50 states and 66 countries to the Class of 2011 in an unusual year that saw both an increased number of applicants and an increased freshman class size, with nearly 60 more students admitted than last year. The target size for the incoming freshman class is 1,020—up from 1,005 last year.

The Institute's acceptance rate fell to an all-time low of 12 percent of applicants, who numbered 12,443.

"It was very, very hard to select such a small number of students in such a large and stellar applicant pool," Dean of Admissions Marilee Jones said.

The admissions office is anticipating a yield of 66.5 percent—consistent with last year's yield—which will allow them to admit 10 of the 519 students who have been placed on the waitlist. Forty-eight percent of those now admitted to the Class of 2011 are women and 21 percent are underrepresented minorities. Of students ranked in their high schools, 49 percent are valedictorians and 90 percent are in the top five percent of their class.

Last year, the acceptance rate was nearly 26 percent for women and 10 percent for men. The acceptance rate for all applicants was 13 percent in 2006, with the number of male applicants nearly tripling the number of female applicants. Acceptance rates for the classes of 2008 and 2009 were similar to those in 2006.

MIT does not have quotas for the number of male or female students accepted. The only quotas the admissions office employs are for international students: Foreign students are limited to 8 percent of the incoming class.

When Jones first began working in the admissions office in 1979, the undergraduate population was 17 percent female. That number rose to 39 percent by 1998 when Jones was named dean of admissions. The Class of 2010, which entered last fall, was 45 percent female.

Jones said that MIT continues to recruit women and other groups through a variety of methods, including directly contacting target students who have good standardized test scores. "The problems of the world need to be solved by people who are from many different places and of both genders," she said.

Jones is a member of the Enrollment Management Group, a committee of administrators with ties to undergraduate education. The committee, which is chaired by Dean of Undergraduate Education Daniel Hastings and reports to President Susan Hockfield, recently recommended an increase in the size of the incoming class. Although there was a slight increase in the incoming class size, a large increase will come following the conversion of Ashdown House into an undergraduate residence, since the goal is to keep undergraduate crowding at a minimum.

– Sarah H. Wright

Faculty team will develop initiative on race issues

A core team of faculty representing all five of MIT's schools has been appointed to develop the Institute's new initiative on faculty race issues, Provost L. Rafael Reif announced in a letter to the faculty e-mailed today.

The members of the new core team are Professors Emery N. Brown (science), Paula T. Hammond (engineering), Leslie K. Norford (architecture and planning), Christine Ortiz (engineering), Marcus A. Thompson (humanities, arts, and social sciences) and JoAnne Yates (MIT Sloan).

Christine Ortiz

Paula Hammond

"This new initiative will provide the background necessary to allow us to develop effective mechanisms to strengthen the representation and career experiences of underrepresented minority faculty at MIT. I expect this initiative to bring about real and measurable change at MIT and to make the Institute a leader and a model in minority faculty recruitment and retention," Reif wrote.

As announced in February 2007, the initiative will study how race affects the recruitment, retention, professional opportunities and collegial experiences of underrepresented minority faculty members at MIT, Reif noted.

The core team will "consult closely with the MIT minority faculty, with leaders of the MIT community and with the faculty broadly to define the process and determine the resources required for a comprehensive, rigorous and systematic study of these issues. I have asked the core team to review its recommendations with the minority faculty and with the Council on Faculty Diversity before submitting them to me by the end of this academic year," Reif stated.

The initiative itself will be launched following the consultative process Reif outlined in his letter. Once launched, it will be merged into the committees on minority faculty recruitment and retention established in January 2006.

"We anticipate that the initiative will be similar in scope and in impact—both at MIT and across the nation—to our earlier studies of gender equity in the faculty, which began with the study of women in the School of Science (1999) and went on to include the other four schools in reports released almost exactly five years ago," Reif wrote.

Reif noted that suggestions on the new initiative may be sent to faculty-diversity@mit.edu.

– Sarah H. Wright

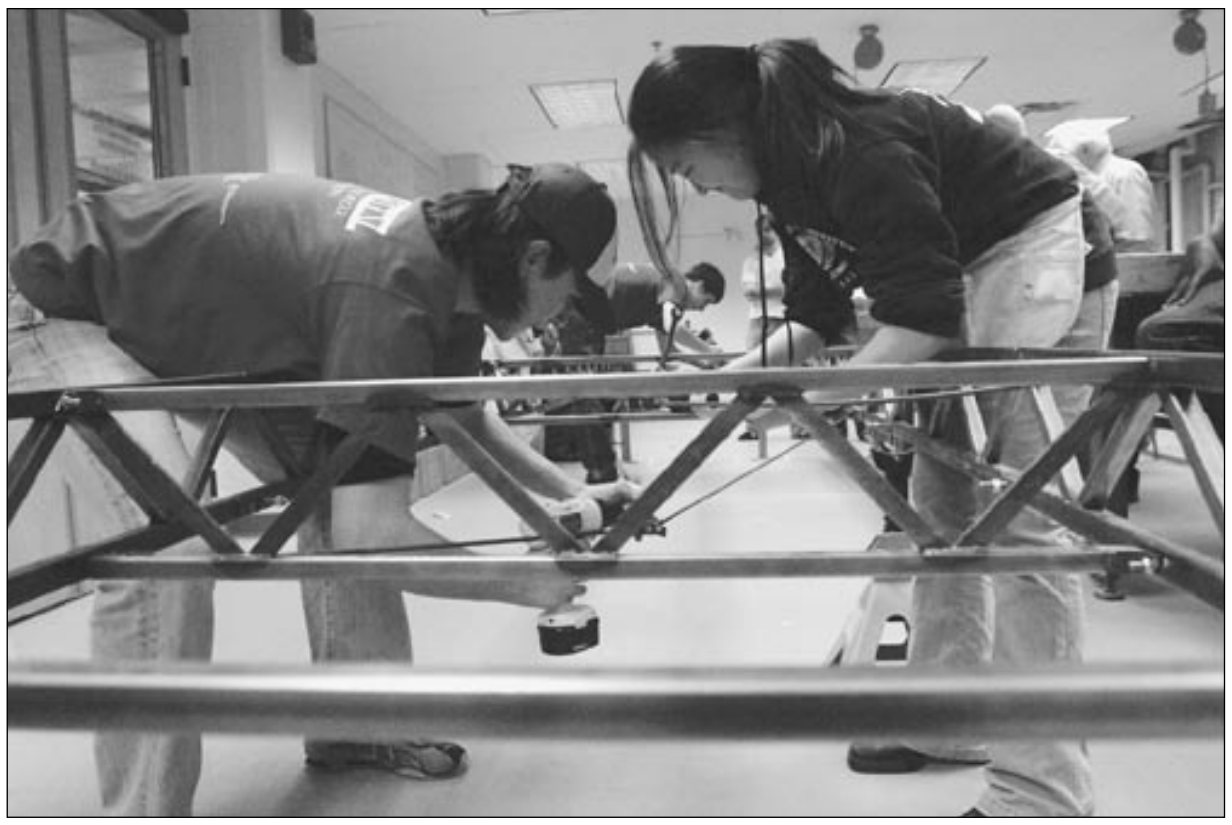


PHOTO / **DONNA COVENEY**

Bridge work

A team of eight undergraduates in civil and environmental engineering won the award for fastest construction and took second place overall in the regional Steel Bridge Competition held March 16-17 at the University of Connecticut, earning a chance to compete at the national competition May 25 and 26 at California State University.

Five people on the MIT team took just under seven minutes to assemble their 32-piece bridge in the competition. Judges scored teams on constructability, usability, stiffness, construction speed, efficiency, economy and looks. Teams transported their bridge prototypes in pieces, assembled them at the competition and then applied a 2,500-pound load. The lowest score won.

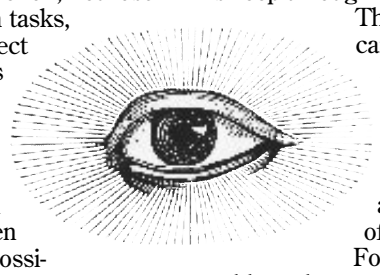
Junior Tracy Takemura, president of the MIT Civil and Environmental Engineering Student Association, said the team "learned a lot about how we can improve upon our bridge. We had overdesigned our lateral strength, so we will be minimizing cross-bracings to decrease overall weight. We can also cut down on builders—to have four total—to cut builder costs."

Team members replicated their high-speed construction at a department celebration of their victory. Shown in the photo above are Takemura, right, and civil engineering sophomore Jose Cano, left. Quinn Vollmert, a junior in civil engineering, is in blue T-shirt at back.

Computer model mimics blink of a human eye

Cathryn M. Delude
McGovern Institute

Computers can usually out-compute the human brain, but there are some tasks, such as visual object recognition, that the brain performs easily yet are very challenging for computers. To explore this phenomenon, neuroscientists have long used rapid categorization tasks, in which subjects indicate whether an object from a specific class (such as an animal) is present or not in the image.



Now, MIT researchers report that a computer model designed to mimic the way the brain processes visual information performs as well as humans do on rapid categorization tasks. The model even tends to make similar errors as humans, possibly because it so closely follows the organization of the brain's visual system.

The work, which appears in the online early edition of the Proceedings of the National Academy of Sciences this week, could lead to better artificial vision systems and augmented sensory prostheses.

"We created a model that takes into account a host of quantitative anatomical and physiological data about the visual cortex and tries to simulate what happens in the first 100 milliseconds or so after we see an object," explained senior author Tomaso Poggio, the Eugene McDermott Professor of Brain and Cognitive Sciences and a member of MIT's McGovern Institute for Brain Research.

"This is the first time a model has been able to reproduce human behavior on that kind of task," said Poggio. His co-authors are Aude Oliva, a cognitive neuroscientist in the MIT Department of Brain and Cognitive Sciences, and Thomas Serre, a postdoctoral associate at the McGovern Institute.

The work supports a long-held hypothesis that rapid categorization happens without any feedback from cognitive or other areas of the brain. In other words, rapid or immediate object recognition occurs in one feed-forward sweep through the ventral stream of the visual cortex.

The results further indicate that the model can help neuroscientists make predictions and drive new experiments to explore brain mechanisms involved in human visual perception, cognition and behavior.

"We have not solved vision yet," Poggio cautioned, "but this model of immediate recognition may provide the skeleton of a theory of vision."

For cognitive neuroscientists, these results add to the convergence of evidence about the feed-forward hypothesis for rapid categorization.

"There could be other mechanisms involved, but this is a big step forward in understanding how humans see," said Oliva. "For me, it's putting light in the black box and gives direction to design new experiments—for instance, to explore perception in clutter."

Earlier this year the Poggio team demonstrated that this biologically inspired computer model can also learn to recognize objects from real-world examples and identify relevant objects in complex scenes (see web.mit.edu/newsoffice/2007/surveillance.html).

This research was supported by grants from the National Institutes of Health, Defense Advanced Research Projects Agency, Office of Naval Research and National Science Foundation.

FELLOWSHIP

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Johnson decided to create a program to help the girls make their own jewelry both for extra income and a sense of accomplishment.

She returned to Sri Lanka in January 2006 to continue work on the project she named "Emerge." She also applied for an importer's license so she could bring the girls' work to the United States for sale.

Whitney-Johnson returns to Sri Lanka in May, but she is proud that Emerge is running independently. She will spend the summer in Guatemala working as an engineering intern for the Appropriate Infrastructure Development Group before returning to MIT for her senior year.

She hopes to host an MIT seminar on how to design living spaces for the girls: "There is a huge need in Sri Lanka for homes for these mothers." She is anxious to get more students interested in public service work, something that has profoundly affected her MIT experience.

"I'm really excited about coming back, not only because I love MIT but also (because) I can't wait to get more students involved," she said.

Pulsing light quiets overactive neurons

Anne Trafton
News Office

Scientists at the MIT Media Lab have invented a way to reversibly silence brain cells using pulses of yellow light, offering the prospect of controlling the haywire neuron activity that occurs in diseases such as epilepsy and Parkinson's disease.

Such diseases often must be treated by removing neurons that fire incorrectly. The new MIT research could lead to the development of optical brain prosthetics to control neurons, eliminating the need for irreversible surgery.

"In the future, controlling the activity patterns of neurons may enable very specific treatments for neurological and psychiatric diseases, with few or no side effects," said Edward Boyden, assistant professor in the Program in Media Arts and Sciences and leader of the Media Lab's new Neuroengineering and Neuromedia Group.

Boyden and Media Lab research affiliate Xue Han published their results in the March 21 issue of the online journal PLOS One.

The work takes advantage of a gene called halorhodopsin found in a bacterium that grows in extremely salty water, such as the Great Salt Lake in Utah. In the bacterium, Natronomas pharaonis, the gene codes for a protein that serves as a light-activated chloride pump, which helps the bacterium make energy.

When neurons are engineered to express the halorhodopsin gene, the researchers can inhibit their activity by shining yellow light on them. Light activates the chloride pumps, which drive chloride ions into the neurons, lowering their voltage and silencing their firing.

That inhibitory effect may be extremely useful in dealing with diseases caused by out-of-control neuron firing, said Boyden. "In such diseases, inhibition is more direct than excitation, because you can shut down neural circuits that are behaving erratically," he said.

Many epilepsy patients have implanted electrodes that periodically give their brains an electric jolt, acting as a defibrillator to shut down overactive neurons. This new research opens up the possibility of an optical implant that could do the same thing, using light instead of electricity. The Media Lab neuroengineering group plans to start studying such devices in transgenic mice this year.

The group also plans to use the new method to study neural circuits. Last year, Boyden devised a technique to stimulate neurons by shining blue light on them, so with blue and yellow light the researchers can now exert exquisite control over the stimulation and inhibition of individual neurons.

Learning more about the neural circuits involved in epilepsy could help scientists develop devices that can predict when a seizure is about to occur, allowing treatment (either shock or light) to be administered only when necessary, Boyden said.

The technique also offers a way to study other brain diseases, as well as normal brain circuitry, offering insight into which brain regions and neurons contribute to specific behaviors or pathological states, Boyden said.

The halorhodopsin gene was originally discovered in the 1980s, but Boyden didn't think its full potential had been explored. The protein expressed by the gene turned out to have exactly the right characteristics to make it useful in neuron inhibition.

"Often if you are patient and think carefully about what you want to do, you can find a molecule that is very close to what you want, and with a little bit of luck it will turn out to work," Boyden said.

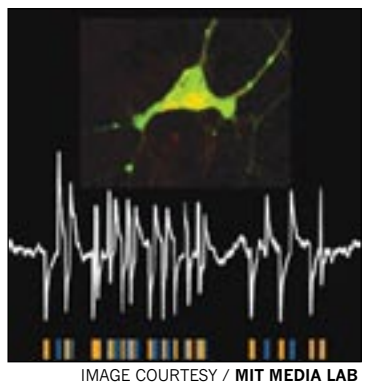

IMAGE COURTESY / **MIT MEDIA LAB**

This voltage trace of a single neuron shows pulses of blue light stimulating the neuron, yellow light inhibits it.

The halorhodopsin work is one of the first projects from the Media Lab Neuroengineering and Neuromedia Group, which was formed about six months ago to enhance the Media Lab's study of the brain-body relationship.

"The Media Lab has always been interested in studying the interface between people and the world," Boyden said, "but now people are getting interested in the interface between bodies and brains in the world."

The research was funded by an anonymous donor, the MIT Media Lab and the Helen Hay Whitney Foundation.

PHOTO / **DONNA COVENEY**

Edward Boyden, assistant professor in the MIT Media Lab, uses light to silence brain cells, which could block abnormal neuron activity in diseases like epilepsy and Parkinson's.

Child's play shows cause and effect

Deborah Halber
News Office Correspondent

It's not child's play to Laura E. Schulz, assistant professor of brain and cognitive sciences at MIT, to figure out what child's play is all about.

Schulz spoke March 21 at an MIT Museum Soap Box event, "Twisting the Lion's Tail: Exploratory Play and Children's Causal Learning."

Soap Box is a series of salon-style, early-evening conversations with scientists and engineers in the news, a public forum for debate about ideas and issues in science and technology.

The theory of cause and effect is fundamental to our understanding of the world. However, despite almost universal agreement that children learn about cause and effect through exploratory play, little is known about how children's play might support accurate causal learning, Schulz said.

"One of the deep mysteries of cognitive science is how we predict the future and how we explain the past and intervene in the present," she said. Causal reasoning even pervades our emotional lives when we speculate about why someone has a certain expression on her face or why a friend or colleague said what he did.

Causation in a nutshell: If you change this, all else being equal, something else changes. From earliest infancy and across all species, action and effect are correlated. Anyone who owns a pet knows that an animal quickly learns that opening a certain food container means dinner is on the way.

Statistical evidence is one factor that contributes to our rich beliefs about the universe. Our prior experiences and beliefs

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Page 6

ATTENTION

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Top to bottom

Brain signals related to the knowledge we have acquired about the world are called top-down. Signals related to incoming sensory information are called bottom-up.

"Loud, flashy things like fire alarms automatically grab our attention," Miller said. "By contrast, we choose to pay attention to certain things we think are important. We found two different modes of brain operation related to each, and they seem to originate in different parts of the brain. Further, automatic versus willful modes of attention seem to rely on two different frequency channels in the brain, suggesting that the brain might communicate in different frequency bands to take advantage of the type of internal network best suited for the task at hand."

ADD involves being overly sensitive to the automatic attention-grabbers and less able to willfully sustain attention. "Our work suggests that we should target different parts of the brain to try to fix different types of attention deficits," Miller said.

To address the fact that neural activity from the prefrontal and sensory cortices had never been directly compared, Miller and co-author Timothy J. Buschman, an MIT graduate student in the Department of Brain and Cognitive Sciences, conducted a series of experiments in which monkeys were engaged in different kinds of tasks. The researchers looked at activity in two areas of the brains simultaneously—the prefrontal cortex, also called the brain's executive because it is in charge of voluntary behavior, and the sensory cortex, which integrates sensory information coming from various parts of the body.

The monkeys had to pick out rectangles of certain colors and orientations on a video screen. Some of the rectangles popped out at them like the anaconda in the forest; others they had to search for.

The results support the idea that when something pops out at us, the visual part of our brain directs our eyes toward the stimulus. When we look for something, the prefrontal cortex is doing the driving.

"Taken together, these data suggest two modes of operation: When a stimulus pops out, a bottom-up, fast target selection occurs first in the posterior visual cortex; while in search mode, a top-down, longer latency target selection is reflected first in the prefrontal cortex," Miller said. "To our knowledge, these are the first direct demonstrations that these areas may have different contributions to these different modes of attention."

This work is supported by the RIKEN-MIT Neuroscience Research Center and the National Institute of Neurological Disorders and Stroke.

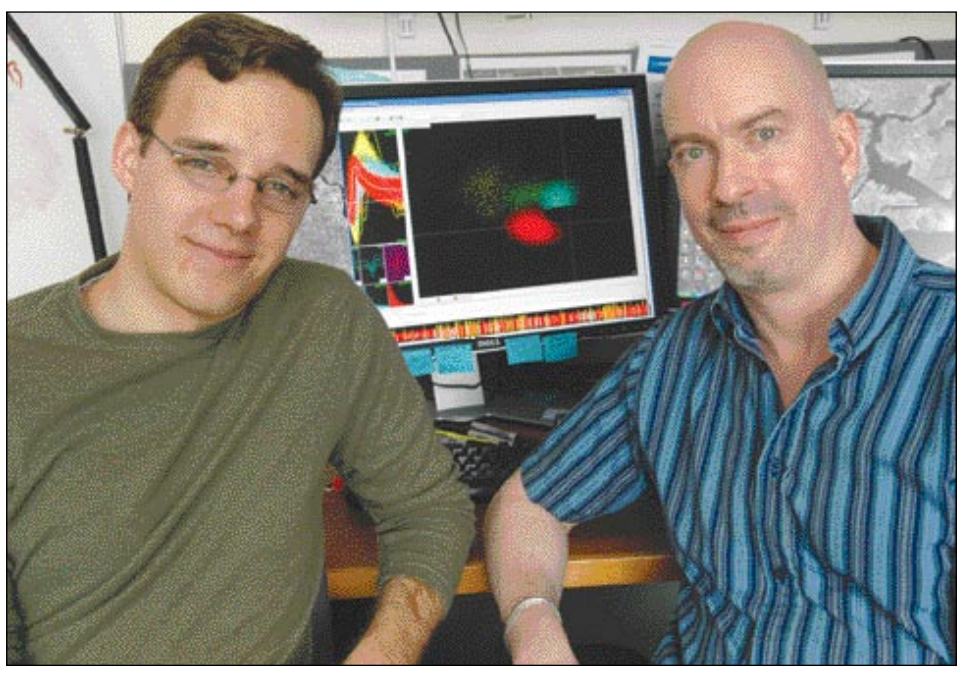

PHOTO / **DONNA COVENEY**

MIT graduate student Timothy J. Buschman, left, and Professor Earl Miller of the Department of Brain and Cognitive Sciences have found concrete evidence that two radically different brain regions play different roles in the different modes of attention.

Infectious diseases to be first focus of Singapore-MIT Alliance for Research and Technology (SMART)

Elizabeth Thomson
News Office

Infectious diseases will be the focus of the first research group through the proposed Singapore-MIT Alliance for Research and Technology (SMART) Center, as announced by the Singaporean National Research Foundation (NRF), which will sponsor the center.

This research group "aims to develop an integrated, cutting-edge research program to study pathogen-host interactions of infectious diseases," as described in a fact sheet released by Singapore's Research, Innovation and Enterprise Council.

"It will focus on infectious diseases of importance to Singapore, Asia and the world. These diseases are respiratory syncytial virus, influenza, tuberculosis and malaria."

MIT Professor Jianzhu Chen of the Department of Biology will lead the group, which will comprise eight MIT faculty members and 17 researchers from universities, industry and institutes in Singapore.

"This research activity, along with the future programs of SMART, will strengthen and expand ongoing educational and research collaborations between MIT and Singapore," said Subra Suresh, Ford Professor of Engineering at MIT and MIT team leader for SMART.

SMART will serve as an intellectual hub for interactions between MIT and global researchers in Singapore at the frontiers of science and technology. SMART is the first of several world-class centers planned by the NRF in the international Campus for Research Excellence and Technological Enterprise.

MIT has worked with Singapore for eight years through the Singapore-MIT Alliance. Plans for MIT and Singapore to formalize SMART are expected to be completed in the next several months.

Lack of fuel may limit U.S. nuclear power expansion

Limited supplies of fuel for nuclear power plants may thwart the renewed and growing interest in nuclear energy in the United States and other nations, says an MIT expert on the industry.

Over the past 20 years, safety concerns dampened all aspects of development of nuclear energy: No new reactors were ordered and there was investment neither in new uranium mines nor in building facilities to produce fuel for existing reactors. Instead, the industry lived off commercial and government inventories, which are now nearly gone. Worldwide, uranium production meets only about 65 percent of current reactor requirements.

That shortage of uranium and of processing facilities worldwide leaves a gap between the potential increase in demand for nuclear energy and the ability to supply fuel for it, said Thomas Neff, a research affiliate at MIT's Center for International Studies.

"Just as large numbers of new reactors are being planned, we are only starting to emerge from 20 years of underinvestment in the production capacity for the nuclear fuel to operate them. There has been a nuclear industry myopia; they didn't take a long-term view," Neff said. For example, only a few years ago uranium inventories were being sold at $10 per pound; the current price is $85 per pound.

Neff has been giving a series of talks at industry meetings and investment conferences around the world about the nature of the fuel supply problem and its implications for the so-called "nuclear renaissance," pointing out both the sharply rising cost of nuclear fuel and the lack of capacity to produce it.

Currently, much of the uranium used by the United States is coming from mines in such countries as Australia, Canada, Namibia and, most recently, Kazakhstan. Small amounts are mined in the western United States, but the United States is largely reliant on overseas supplies. The United States also relies on Russia for half its fuel, under a "swords to ploughshares" deal that Neff originated in 1991. This deal is converting about 20,000 Russian nuclear

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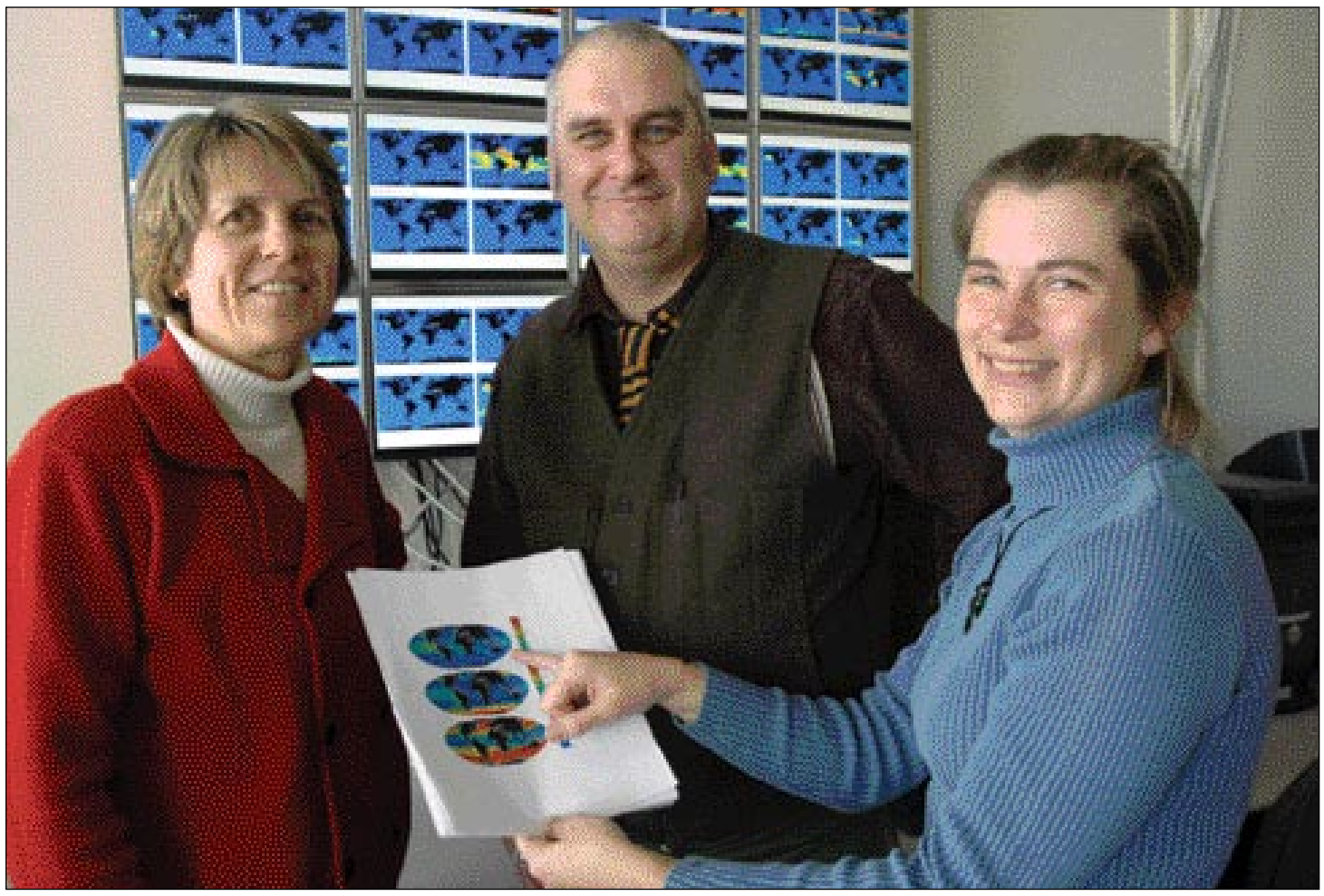

PHOTO / **DONNA COVENEY**

MIT Professor Penny Chisholm, left, and research scientists Mick Follows and Stephanie Dutkiewicz have created an ocean model in which the populations of 'sown' microbes precisely mimic real-world patterns of the same organisms.

Ocean model captures diversity of underwater forests

Simulation comprises 10 years of evolution into five days of computing

Denise Brehm
Civil and Environmental Engineering

Scientists at MIT have created an ocean model so realistic that the virtual forests of diverse microscopic plants they "sowed" have grown in population patterns that precisely mimic their real-world counterparts.

This model of the ocean is the first to reflect the vast diversity of the invisible forests living in our oceans—tiny, single-celled green plants that dominate the ocean and produce half the oxygen we breathe on Earth. And it does so in a way that is consistent with the way real-world ecosystems evolve according to the principles of natural selection.

Scientists use models such as this one to better understand the oceans' biological and chemical cycles and their role in regulating atmospheric carbon dioxide, an important greenhouse gas.

The output of the new model, the brainchild of oceanographer Mick Follows, has been tested against real-world patterns of a particular species of phytoplankton, called prochlorococcus, which dominates the plant life of some ocean regions.

Follows and co-authors report this work, part of the MIT Earth System Initiative's new Darwin Project, in the March 30 issue of Science. The Darwin Project is a new cross-disciplinary research project at MIT connecting systems biology, microbial ecology, global biogeochemical cycles and climate.

"The guiding principle of our model is that its ecosystems are allowed to self-organize as in the natural world," said Follows, a principal research scientist in MIT's Department of Earth, Atmospheric and Planetary Sciences (EAPS), lead author on the paper and creator of the model. "The fact that the phytoplankton that emerge in our model are analogous to the real phytoplankton gives us confidence

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B12

Continued from Page 1

teaching laboratory, "completes a piece of our understanding of a process very fundamental to life," said Graham Walker, MIT professor of biology and senior author of a paper on the work that appeared in the March 23 issue of Nature.

Vitamin B12 is produced by soil microbes that live in symbiotic relationships with plant roots. During the 1980s, an undergraduate research course taught by Walker resulted in a novel method for identifying mutant strains of a soil microbe that could not form a symbiotic relationship with a plant.

Walker's team has now found that one such mutant has a defective form of an enzyme known as BluB that leaves it unable to synthesize B12.

BluB catalyzes the formation of the B12 fragment known as DMB, which joins with another fragment, produced by a separate pathway, to form the vitamin. One of several possible reasons why it took so long to identify BluB is that some bacteria lacking the enzyme can form DMB through an alternate pathway, Walker said.

One of the most unusual aspects of BluB-catalyzed synthesis is its cannibalization of a cofactor derived from another vitamin, B2. During the reaction, the B2 cofactor is split into more than two fragments, one of which becomes DMB.

Normally, the B2-derived cofactor would assist in a reaction by temporarily holding electrons and then giving them away. Such cofactors are not consumed in the reaction.

Cannibalization of a cofactor has very rarely been observed before in vitamin synthesis or any type of biosynthetic pathway, says Michiko Taga, an MIT postdoctoral fellow in Walker's lab and lead co-author of the Nature paper.

"There are almost no other examples where the cofactor is used as a substrate," she said.

One early clue to BluB's function was that a gene related to it is located near several other genes involved in B12 synthesis in a different bacterium. Still, the researchers were not convinced that one enzyme could perform all of the complicated chemistry needed to produce DMB.

"It looked like a number of things had to happen in order to make the DMB," said Walker. "We originally thought that BluB might be just one of several enzymes involved in DMB synthesis."

Therefore, it came as a surprise when Taga isolated the BluB protein and showed that it could make DMB all by itself.

Nicholas Larsen, lead co-author and a former college classmate of Taga's now at Harvard Medical School, did a crystallographic analysis of the protein after Taga told him about her research over coffee one day. The protein structure he developed clearly shows the "pocket" of BluB where the DMB synthesis reaction takes place.

Still to be explored is the question of why soil bacteria synthesize B12 at all, Walker said. Soil microorganisms don't require B12 to survive, and the plants they attach themselves to don't need it either, so he speculates that synthesizing B12 may enable the bacteria to withstand "challenges" made by the plants during the formation of the symbiotic relationship.

More than 30 genes are involved in vitamin B12 synthesis, and "that's a lot to carry around if you don't need to make it," Walker said.

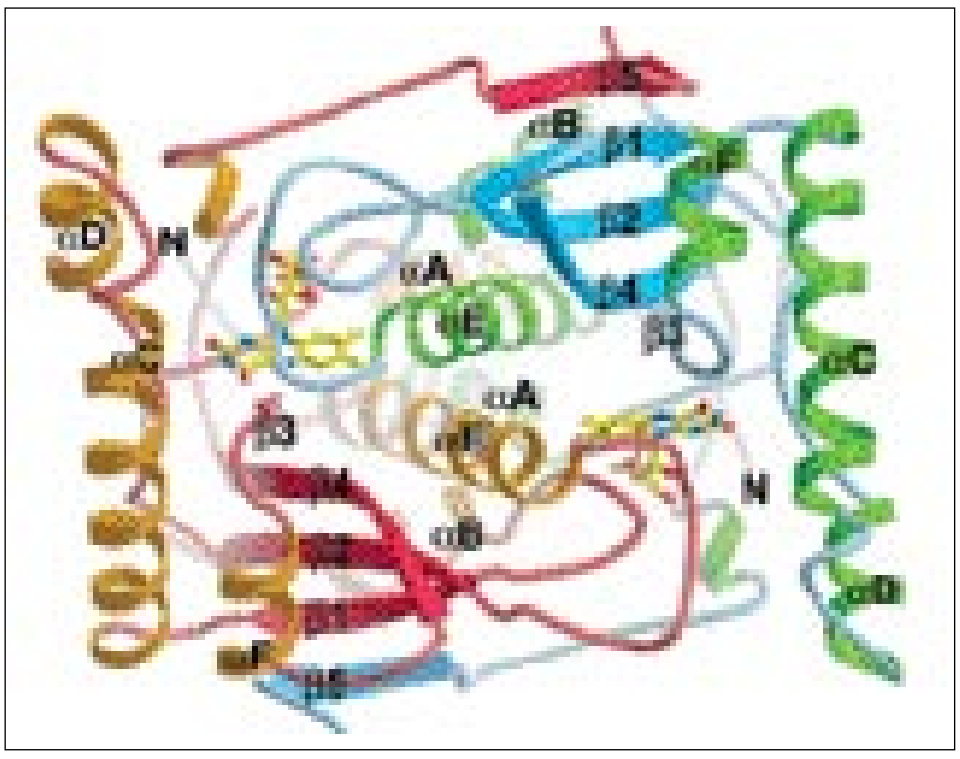

IMAGE COURTESY / **GRAHAM WALKER LABORATORY**

This is a ribbon diagram of the enzyme BluB, which MIT researchers have shown catalyzes the formation of DMB, a fragment of vitamin B12. The stick drawings (in yellow, red and blue) represent cofactors that the enzyme cannibalizes to form DMB.

The full implications of the new research will probably not be known for some years, which is often the case with basic research, Walker said. "I've been in many other situations in research where we did something very basic and did not immediately realize the importance of it, and subsequently the implications were found to be much more broad-reaching," he said.

Other authors on the paper are Annaleise Howard-Jones, a postdoctoral fellow at Harvard Medical School, and Christopher Walsh, professor of biological chemistry and molecular pharmacology at Harvard Medical School.

The research was funded by the National Institutes of Health and the Jane Coffin Childs Memorial Fund for Medical Research.

Faculty discuss improving teaching, undergraduate experience

Deborah Halber
News Office Correspondent

Teaching was the focus of the March 21 faculty meeting, where the faculty continued its discussion of the recommendations of the MIT Task Force on the Undergraduate Educational Commons.

If approved, the changes to MIT's undergraduate curriculum will be the most far-reaching of the past half-century.

Among other recommendations, the task force called for a series of actions that task force members believe would improve the quality of undergraduate education at MIT.

Charles H. Stewart, department head and professor of political science, and Dean for Undergraduate Research J. Kim Vandiver outlined ways that faculty could become more engaging as teachers and more involved in mentoring students. They spoke about the need to double the number of faculty that currently advise first-year students and discussed changing the requirement for students to earn two separate undergraduate degrees versus two majors.

Other items that "excited faculty interest" when the task force was developing its recommendations included creating a reading period before finals; redefining orientation for incoming students to include more faculty involvement; and the need to improve maintenance of existing teaching spaces and develop new ones to accommodate the increased hands-on learning and other recommendations contained in the report.

There are currently 66 faculty members who advise first-year students, serving around half of the incoming class. The faculty discussed whether students need more of a mentoring relationship with their advisors than a guidance counselor relationship. Faculty discussed whether advising should be considered when salary reviews come up, to create incentives for faculty to add advising to their already busy schedules.

"We realized we had great teaching at MIT. We also want to continually improve," Vandiver said. He outlined a proposal to change an approach in which lectures were reserved for material that gave students the "big picture and got students excited" and "provided a framework" for the rest of the knowledge being presented in the class.

Recitations, Vandiver said, could become more geared toward helping students understand and practice the material under the tutelage of an expert. "We experts tend to forget what the novice finds difficult," he said.

The faculty heard discussion of a proposal to change the Division of Biological Engineering to the Department of Biological Engineering. Thomas L. Magnanti, dean of the School of Engineering, said that a five-year review of the division, which was presented in spring 2006, recommended that the division eventually receive departmental status. The proposal will be voted on at a future meeting.

Stewart read a resolution on the death of Stephen M. Meyer, political science professor, expert in national security issues and passionate advocate of global biodiversity, who died of cancer Dec. 10 at age 54. "As a scholar and courageous human being, Steve was one of the best," Stewart said. "Let the faculty of MIT record its profound sense of loss and sympathy to his family."

The faculty held a moment of silence in Meyer's memory.

Iceland's leaders meet at MIT on energy

The president of Iceland, Olafur Ragnar Grimsson, will be at MIT today to discuss geothermal energy, climate change and other energy topics with MIT professors.

Grimsson will meet with Professor Ernest Moniz, co-director of MIT's Energy Initiative; Professor Jefferson Tester of chemical engineering, lead author of a recent MIT report on geothermal energy; and Professor Ronald Prinn of earth, atmospheric and planetary sciences, one of the lead authors of a recent Intergovernmental Panel on Climate Change report.

"Iceland sets a high standard for other countries to follow in achieving sustainable, carbon-free energy," Tester said. "For example, we can learn much from the technology they are now developing in their new initiative to produce hydrogen from high-temperature geothermal fluids for transportation applications."

During his visit to MIT, Grimsson will also meet with MIT's Icelandic community (three professors and six graduate students) and with Chancellor Phillip Clay.

"We are pleased to host President Grimsson and his colleagues to share what we are doing in energy and technology research. We appreciate his understanding of the important role national leadership plays in motivating and supporting the research required to make breakthroughs in energy," said Clay.

The visit will help to strengthen already existing ties between MIT and Iceland. The Iceland Consortium of Industry and Commerce recently became part of MIT's Industrial Liaison Program and hopes to learn more about MIT's educational and research activities.

Through the consortium, Icelandic companies will be invited to access the ILP programs in order to learn about MIT's educational and research activities. There are various grounds for profitable collaborations, especially in the field of energy, as Iceland is renowned for its renewable energy sources.

Svafa Grönfeldt, the president of Reykjavik University, is accompanying Grimsson.

Grimsson, who is in his second four-year term as Iceland's president, has a Ph.D. in political science.

SOAP BOX

Continued from Page 4

affect how we interpret the evidence we see with our own eyes or hear about from scientists. But how do children form their conclusions about how the world works?

Schulz designs experiments that seek to determine how children think and learn about cause and effect and the role of play in this process. She has collected data from more than 600 preschoolers at play to try to figure out, for instance, how a 4-year-old tries to get a puppet to pop out of a box with two knobs when it's unclear what combination of knob-pressing will achieve the desired effect.

Schulz is continually amazed at how much knowledge of how things work—not only mechanically, but also socially and culturally—children pick up in early childhood. "Everything you need to know about the world you really did know before kindergarten," she said.

Schulz noted that child's play is messy—not just because of paint and juice, but because it can look random and unfocused. The trick is to design experiments that isolate the variables, she said.

Schulz believes that evidence of how children learn through play could one day lead to a new respect for how abstract and sophisticated kids' early learning is much more than what computers are capable of. "It would be nice if people who worked with children got as much respect as people who work with computers."

EVOLUTION

Continued from Page 5

in the value of our approach."

One of Follows' collaborators, Penny Chisholm, the Lee and Geraldine Martin Professor of Civil and Environmental Engineering and Biology and director of the Earth Systems Initiative, has made prochlorococcus her focus of study for 20 years. Stephanie Dutkiewicz, a research scientist in EAPS, and Scott Grant, a graduate student at the University of Hawaii, who was an MIT physics undergraduate during this project, collaborated with Chisholm and Follows on the new model.

Chisholm believes that because previous ocean models did not convey the diversity of phytoplankton, they did not well represent the systems they modeled. The new model remedies that.

"Now we are finally modeling the ocean systems in a way that is consistent with how biologists think of them—water filled with millions of diverse microbes that wax and wane in relative abundance through interactions with each other, and the environment, as dictated by natural selection," said Chisholm.

Indeed the guiding principle of the new model is natural selection. It simulates the physical and chemical characteristics of the oceans, but adds to the virtual soup about 100 random types of phytoplankton. The model randomly generates the single-celled plants, which differ primarily in their size, and in their sensitivity to light, temperature and nutrient availability, then allows the ocean to self-select those most fit for survival in any particular area.

What emerged after the model completed its 10-year virtual evolution—which took four to five days on a cluster of parallel computers—is a phytoplankton community with members that are characteristic of observed phytoplankton communities, including plants similar to prochlorococcus that are extremely abundant in the warm mid-latitude Atlantic and Pacific oceans.

Chisholm said this is the first major change in the way scientists approach ocean models in many years. She believes it will serve to break down disciplinary barriers between the physical and biological ocean sciences.

The Paradigm Consortium of the National Ocean Partnership Program, the National Science Foundation, the Department of Energy, the Gordon and Betty Moore Foundation, and the MIT Global Habitat Longevity Award provided funding for the research.

Chisholm, Follows and Dutkiewicz plan to use this new type of model to look in more detail at what shapes the habitats of the phytoplankton and to link this to other, larger scientific issues about oceans, the plants and creatures living in them and global climate.

"This is just the beginning," said Chisholm. "Now we can begin to ask the model questions and test hypotheses about the role of oceanic microbes in global processes. This will help guide decisions about responsible use of the oceans in this era of global change."

CLASSIFIEDS

Tech Talk runs classified ads in the first issue of each month. Members of the MIT community may submit one classified ad per month. 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.

HOUSING

Lexington, 2-family house for sale. Small yard. Close to T. Near Route 2 & 128. $389,900. Call 617-694-5950.

2BR, 1.5BA townhouse w/loft; Hollis Crossing, Nashua, NH. Back deck overlooks creek & ducks. Convenient to Haystack Observatory. $202,000. Contact Bill at wredmond@draper.com, 617-258-2657 or 781-849-8632.

Saugus—Bright & sunny 1BR apt., first floor, off-street parking, washer/dryer h/u in basement, on bus line (#430) to Malden Station, $750/mo, no utilities. 617-253-8144.

Cambridge—Partially furnished 2BR, bed frames, bureaus, large closets; LR w/ bookcases, TV, coffee table; large kitchen w/ fridge, micro, table, some kitchen equip. Laundry, encl. yard, bicycle. Walk to Kendall Sq., MIT, supermarket, Galleria, Red Line, Green Line, bus to Harvard Sq. $1625. No fee, no pets, no sec. deposit.

Somerville: 2BR apt, 2nd&3rd fl., offstrt prk - 2 cars, hdwd flrs, mod kitchen, porch, skylights, min. to MBTA/Davis Sq, $1450/mo. 617-201-4732, dekow@psfc.mit.edu or 74h.home.comcast.net . Avail. 5/1.

Belmont—Large elegant 4BR, hdwd floors, dishwasher, disposal, two baths (whirlpool tub), washer, dryer. Parking. Convenient public transportation. Exc. schools. $3,500/month unfurnished. $3,800/month furnished. Avail. June 1. Lease. Call 617-489-2403 or e-mail stewart@wi.mit.edu.

VACATION

Lakeside cottage on Broad Bay of Ossipee Lake, NH. Private beach & dock. Avail. 8/18-8/25. $695. Contact Arthur at 978-372-1152.

Point Sebago Resort, ME: 2 BR/2BA house w/ large open living/dining/kitchen area. Located within resort near golf course. Renters have access to all resort activities. See www.pointsebago.com/ for resort amenities. $1,200/week, weekends available. Contact Ann at airforce@mit.edu.

Brewster, MA. June, July Aug weeks avail. Sweet house on lake, 15 min to ocean beaches. Sleeps 6, abuts conservation forest. Private beach, piano, fireplace, screened porch, separate studio/bedroom in the woods. $1,200/week. Andy, 617-876-6257.

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Summer rental - Falmouth. 2BR, 2BA, Cape on cozy cul-de-sac off Shore St. Short walk to Main St. & Surf Drive beach. 2-week min. $1500/wk. No pets/smoking. Call Nick at 3-1664.

Cottage, Lake Maranacook, ME. Crystal clear 7 mi. lake, fishing, canoe, rowboat. 2BR, bath, kitchen, 260 ft. sandy pvt. beach. $825/wk. Photos & ref. at MIT. 6/30-7/7 or 7/14-7/21. Call Tom at 508-376-4336.

We can't use our time-share week in the Berkshires this week. Can you? June 17-24. Oak 'n' Spruce resort, South Lee, MA. Sleeps 4. $500. 413-584-0123.

Martha's Vineyard, Oak Bluffs. 2 BR/1.5BA; wraparound deck, outdoor shower, barbecue, sunny, open interior. Near lagoon, tennis & bike trails. $550-975/week. Nina at ninad@mit.edu or view web site: home.comcast.net/~ndomenico/marthasvineyard/index.htm.

Ocean front summer cabin, Mount Desert Island, ME: 2BR/1BA w/living/kitchen area; picture windows, deck overlooking water; stairway to beach. Mins from Acadia National Park, Bar Harbor. $1,000/week June-Sept. Steve at 253-5757 or chorover@mit.edu.

FOR SALE

Retired toolmaker selling machine tools & accessories—micrometers, indicators, measuring tools, verniers, squares, taps, end mills & more. Call George for further details, 781-684-0701.

AKC registered golden retriever pups; champ. stock; hips, eyes & heart of parents & several generations cleared; excellent w/ children; boxy head; colors light to golden; ready mid-April. Contact 617-332-8251 or rgunder@mit.edu.

Books for sale: "Handbook of Image & Video Processing," ed. Al Bovik, Academic Press, 2000, $75. "The Biomedical Engineering Handbook," Volume I, Volume II. Second Edition, 2000, CRC Press, IEEE Press, 2000. $50 for 2-volume set. Contact bmasters@mit.edu.

DR 6 chrs $500, ktch 4 chrs $350, 2 gsneck chrs $275, bureau $150, patio set 4 chrs, sofa table or dresser $75, bench $60. Call Susan at 781-223-7721.

Black/glass dining set w/ 4 leather chairs, $80. Sharper Image Ionic Breeze Quadra Air Purifiers, one-$40, two-$70. Toshiba DVD player $35. Folding sofa/sleeper, $20. 617-484-0308.

Amateur xcver: FT-100 Mobile w/ detachable head. All bands. Exc. cond, used very little. Comes w/ original boxes, manual, mic, matching automatic antenna tuner, Yaesu FC-20. Comet duplexer CF-706 for VHF, ready to hook up power & antenna. Asking $785, split shipping. Contact 781-893-3377 or k1cei@arrl.net.

VEHICLES

$2,500 - 1994 Volvo 850. 136K, power windows/locks, sunroof, leather seats, cruise. Need to sell, buying larger family car. Priced below Kelly Blue Book Value. Call x8-5445.

2002 Mercedes CLK320 Coupe. 16K, silver, excellent condition, one owner, always garaged. $22,900. Contact Ken 978-250-1387.

2001 Audi TT Coupe, $19,888, 6,948 mi, 5-speed manual quattro stability control, gray pearl out w/ gray leather in. Always garaged, exc. cond. A/C, Bose sound 6-CD, htd seats, hi-prf 17-in wheels/tires plus winter 16-in wheels/tires. Htchbk, folding rear split seat. E-mail ralston@ll.mit.edu. Lexington 781-981-7803.

1989 Jeep Wrangler. Red w/ tan interior, 31 inch wheels, 4 inch lift kit. Great condition. Needs some work. $3,000/best offer. E-mail Kevin at csash@mit.edu or call 617-913-4722.

MISCELLANEOUS

Typist wanted to work on book in mathematical physics. Proficiency in LaTeX required. Pay rate of $5 per completed typed page. Contact N. Prakash at 617-492-8797.

PHOTO / **DONNA COVENEY**

Meg Jacobs of the MIT history section makes a point during a recent colloquium about the 1970s oil crisis.

Seventies oil crisis was a 'perfect storm' for United States

Deborah Halber
News Office Correspondent

During the energy crisis of the 1970s, many people believed that fully loaded tankers lingered just offshore, waiting for oil prices to go up.

It was an era in American history, said Meg Jacobs, Class of 1947 Career Development Associate Professor, when a number of political, global and social events came together to create a perfect storm.

Jacobs spoke at a Science, Technology and Society colloquium March 19. A political historian, Jacobs said she is writing a book on the energy crisis because it provides a good example of how chaos can erupt when there is a disconnect between what citizens expect and how government reacts.

For anyone who owned a car in 1973, it's hard to forget the long lines at pumps, the "sold out" and "no gas today" signs, the rationing and the gas station attendants who carried guns for self-protection.

What caused the crisis was the Organization of Arab Petroleum Exporting Countries' (OAPEC, which was the Arab members of OPEC plus Egypt and Syria) embargo on shipping petroleum to nations that supported Israel in the Yom Kippur War between Israel, Syria and Egypt.

About the same time, OAPEC members agreed to use their leverage over the price-setting mechanism for oil to quadruple world oil prices, after attempts at negotiation with the major oil companies failed.

The problem worsened, Jacobs said, because most people didn't believe the crisis was real. "They believed it was a conspiracy perpetrated by big oil to reap high profits, and they also blamed government," she said.

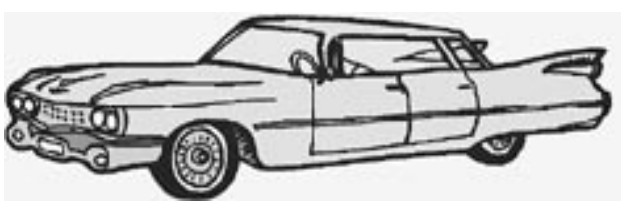
Americans were not prepared for an energy shortage. They drove cars like the 1959 Cadillac Coupe de Ville—a 5,000-pound "living room on wheels"—and took the presence of cheap and abundant energy for granted. The Department of Energy didn't exist yet because energy issues were not on most people's mental radar screens.

Democrats in Congress blamed big oil and demanded that government come to the rescue. The Nixon administration was reluctant to "overreact," as Office of Management and Budget Director Roy L. Ash put it in a White House memo, but, unknown to most Americans, the administration allowed imported oil to trickle in to boost supply.

The full-blown crisis—schools and offices shut down to save on heating oil, laid-off factory workers, a truckers' strike to protest a national maximum 55 mph speed limit—provides a "lesson from the past on the difficulty of winning support for solutions," Jacobs said.

The energy crisis did lead to some positive, although unintentional, results: a greater interest in renewable energy, a conservation movement and corporate average fuel economy (CAFE) standards that downsized existing automobile categories and made the Volkswagen Rabbit more popular than gas-guzzlers.

"What does the energy crisis teach us? That it's hard for meaningful change when few think there is a problem," Jacobs said. The challenge today, as much as it was then, is to "create a market and momentum for new ways of thinking about energy."



'Hunt' leads the pack during SIP

Kathryn M. O'Neill
MIT Leadership Center

The negotiations taking place in the windswept East Campus courtyard were tense and going badly. As the Sharks considered trading keys with the Dolphins to unlock the box in the courtyard, suspicions were running high.

"You guys are vicious," one Dolphin said.

"We got cheated already," a Shark complained.

The Dolphins had opened just five of the 10 boxes needed to win "The Hunt," a new Sloan Innovation Period (SIP) course held on Wednesday, March 21. The Sharks already had nine items, one item from each box they'd opened during the three-hour scavenger hunt that called for seven-member teams to follow picture clues, barter for scarce keys and solve a rebus puzzle as a final competitive challenge.

The Dolphins felt the tide turning against them. "If you want to kick us while we're down, there's some sand here," said John Clingan (M.B.A. '08), his team's lead negotiator.

In the end, keys were swapped and everyone got a little bit closer to winning the scavenger hunt. At the same time, students gained some first-hand experience in team-building, problem-solving and negotiating under pressure—which was the overarching goal of the new SIP activity.

SIP, an annual week of workshops and leadership training, offers a break in routine for M.B.A. students halfway through each semester at the MIT Sloan School of Management. This year's courses, held March 19-23, included "The Hunt" as well as "Design-Inspired Innovation," "What's Your Leadership Style?" and "The Future of Work."

"The Hunt" attracted a capacity enrollment of 70 students. "It just sounded interesting and a little bit more active," said Shivani Garg (M.B.A. '08) about why he signed up. "I think everyone is kind of excited about it."

The Sharks emerged victorious. Although only the third team to return to Wong Auditorium with an item retrieved from each box, the Sharks made it to first place by succeeding in the second task in the game—solving a rebus riddle using the items.

Members of the Sharks credited their success to their cooperative spirit. "We shared information freely" and worked hard on developing goodwill, said Dong Kim (M.B.A. '08).

Wait a minute, the Sharks were the nice ones? They weren't vicious?

In the discussion that followed the game, led by Jonathan Lehrich, associate director of the MIT Leadership Center, students revealed that many teams had felt deceived. But the "lies" turned out to be innocent misunderstandings. One student, for example, had been so close to a box it was simply incredible to others that he hadn't seen it.

"Time and competition reduce trust quickly," Lehrich said.

"The Hunt" was organized and presented by the MIT Leadership Center. Run by Noah Schneiderman (C.P. 2002), president of NRS Consulting, it's often used as a team-building exercise within companies. The dynamics are a little different when there is an existing hierarchy, Schneiderman said.

"If you have a team and the CEO is on the team or the head of a department is on the team, you know that team is going to lose," he said. Why? The boss tends to go it alone without tapping into the strengths of others.

The MIT Sloan students came into the game on a more-or-less equal footing, but there were still team members who fell into line behind more dominant types.

Perhaps in the end, the cooperative spirit wasn't all the Sharks had going for them. Teammates also said that everyone took on leadership roles, and they communicated well with each other. "Everyone's strengths came out," said Ryan McDonald (M.B.A. '08).

PHOTO / **DAN COURTER**

Edmund Aziabor MBA '07 negotiates with Saadiq Rodgers-King (M.B.A. '08) during a tense stand-off in 'The Hunt.'

PHOTO / **DAN COURTER**

Teammates spot their next location.

FUEL

Continued from Page 5

weapons to fuel for U.S. nuclear power plants, but it ends in 2013, leaving a substantial supply gap for the United States.

Further, China, India and even Russia have plans for massive deployments of nuclear power and are trying to lock up supplies from countries on which the United States has traditionally relied. As a result, the United States could be the "last one to buy, and it could pay the highest prices, if it can get uranium at all," Neff said. "The take-home message is that if we're going to increase use of nuclear power, we need massive new investments in capacity to mine uranium and facilities to process it."

> *We need massive new investments in capacity to mine uranium and facilities to process it.*
>
> **Thomas Neff**

Mined uranium comes in several forms, or isotopes. For starting a nuclear chain reaction in a reactor, the only important isotope is uranium-235, which accounts for just seven out of 1,000 atoms in the mined product. To fuel a nuclear reactor, the concentration of uranium-235 has to be increased to 40 to 50 out of 1,000 atoms. This is done by separating isotopes in an enrichment plant to achieve the higher concentration.

As Neff points out, reactor operators could increase the amount of fuel made from a given amount of natural uranium by buying more enrichment services to recover more uranium-235 atoms. Current enrichment capacity is enough to recover only about four out of seven uranium-235 atoms. Limited uranium supplies could be stretched if industry could recover five or six of these atoms, but there is not enough processing capacity worldwide to do so.

Susskind receives Global Environment Award

Teresa Hill
Laboratory for Energy and the Environment

Lawrence E. Susskind, the Ford Professor of Urban Studies and Environmental Studies in the Department of Urban Studies and Planning (DUSP), has received this year's International Association for Impact Assessment (IAIA) Global Environment Award. The award will be conferred in Seoul, South Korea, at the IAIA's annual meeting in June 2007. The conference theme is "Power, Poverty and Sustainability."

This year marks the seventh time that the Global Environment Award has been given. Previous winners include Maurice Strong, Jan Pronk, Mostafa Tolba, Margot Wallstrom, Gus Speth and Wangari Maathai.

Thanking the organization for the award, Susskind said, "IAIA has been an important force for change. I'm honored by their recognition. Impact assessment is used around the world to promote better environmental decision-making, and assessments are an important means of achieving greater transparency and increased public engagement."

Susskind was selected for the honor because of his "outstanding, sustained and unique contributions to the field," according to IAIA materials. Award committee chair Jean-Roger Mercier notes in particular Susskind's founding of the Consensus Building Institute (CBI), which has assisted in the resolution of hundreds of seemingly intractable environmental disputes. CBI is currently involved with a wide range of resource management disputes including the mediation of Bedouin land claims in Israel, air quality management in Mexico City and strategies for resolving facility-siting disputes in Korea.

Susskind has been at MIT for 35 years and currently serves as director of the Environmental Policy and Planning Group in DUSP; he has also been chair of the department. He was extensively involved with the Mexico City project led by Professor Mario Molina and coordinated by LFEE and the Alliance for Global Sustainability. He is the author or co-author of 15 books.

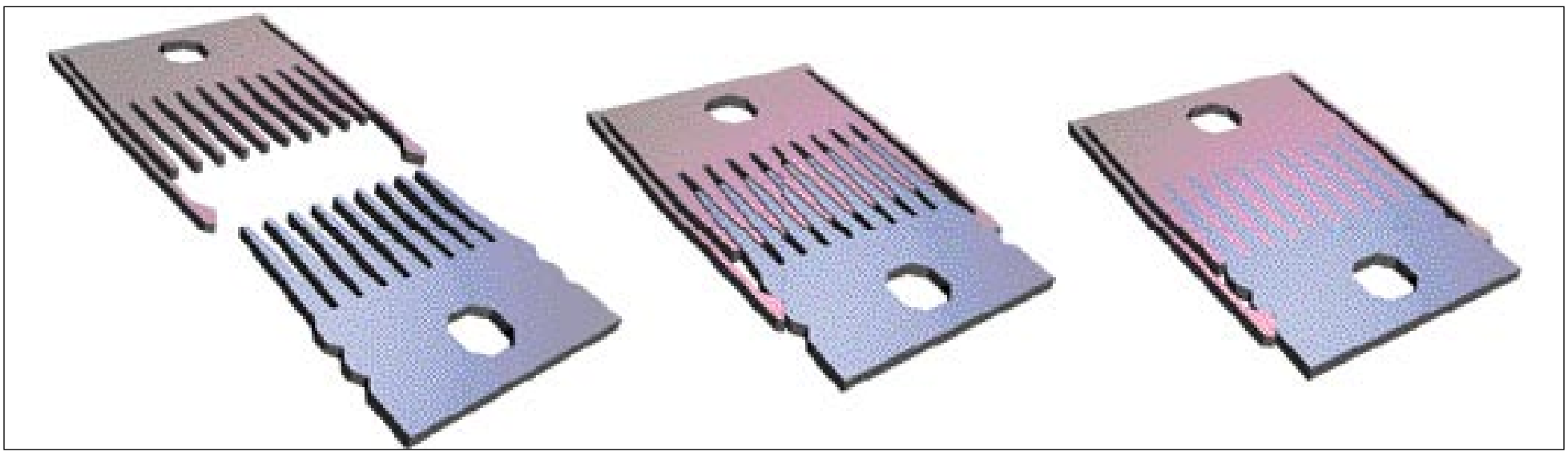


IMAGE COURTESY / **ELLIOT HUI**

Researchers at HST have developed a device that allows them to control the distance between cells. The cells are placed on combs, which can be fully separated (left), locked together with combs in contact (middle) or slightly separated (right).

HST device draws cells close–but not too close–together

Elizabeth Dougherty
Harvard-MIT Division of Health Sciences and Technology

In a popular children's game, participants stand as close as possible without touching. But on a microscopic level, coaxing cells to be very, very close without actually touching one another has been among the most frustrating challenges for cell biologists.

Now MIT researchers led by Sangeeta Bhatia, associate professor of electrical engineering and computer science at the Harvard-MIT Division of Health Sciences and Technology (HST) and Brigham and Women's Hospital, have solved the problem with a novel device. The work promises to allow researchers to perform cellular experiments that were previously impossible.

Bhatia and HST postdoctoral associate Elliot Hui describe the device in the March 27 issue of the Proceedings of the National Academy of Science. Hui is first author of the paper.

The new device, a microelectromechanical system (MEMS), allows biologists to physically arrange cells to be either touching, close but not touching, or completely separated from one another. Further, they can change that configuration at will. And the device works without the use of tools such as the microscopes or robotic control arms typically required by MEMS devices.

Because cells communicate via signals transmitted both through the touching of cell membranes and through soluble molecules that flow between separated cells, biologists need to vary the spacing of cells to study their interactions. Also, since some signals induce a cell to change its internal programming, it is important for biologists to be able to rearrange cells over time to learn which signals spur change and which don't.

In the past, researchers erected chemical "moats" around cells in an attempt to keep them close but separate. Over time, however, cells invariably bridge the divide. "They are very good at crossing the moat," said Bhatia, who performed several such experiments in graduate school.

Bhatia and Hui's first thoughts about how to solve this cellular space and time problem involved another children's game: plastic puzzles with squares that slide around on a grid. They wondered if they could put different cells on each square and then move them around.

This idea quickly evolved into an elegant tool designed expressly for biologists.

The device involves two separate comb-shaped pieces coated with living cells. These two pieces can click into place at two settings: One allows cells on the edges of the combs to touch, the other maintains a gap of 80 micrometers, or about four cell widths. The assembly is geared so that switching between these two settings involves a movement of two millimeters, an amount controllable by the human hand. Hui selected 80 micrometers as the gap setting because at shorter distances, cells sometimes migrate across the gap and end up touching. At wider distances, some soluble signals drop off.

Bhatia and Hui have used the new device to study liver cells. The two found that to get liver cells to express specific liver functions, they needed to touch supporting stromal cells for 18 hours. For the liver cells to survive and continue to act as liver cells, they don't have to keep touching these stromal cells, but they do need to stay close.

The finding will allow Bhatia and Hui to examine more deeply which surface molecules trigger liver cell differentiation and which soluble molecules maintain it.

Such information will help the team devise different approaches to engineering liver therapeutics by helping them understand exactly which signals are needed to support specific liver cell functions. Instead of building an entire liver from scratch, Bhatia wants to isolate the key cell type, "the business end of the organ," and get it to work without replicating the entire cellular environment that supports it. "If you can get away with it, you want to get rid of the supporting cells," she says.

This simple device will also be useful for exploring a host of other cellular interactions. Most prominently, the device could be very useful in exploring embryonic development, during which the local cellular environment dictates development of major organs over time, and cancer, in which supporting cells are thought to play a role in tumor formation.

The research was supported by the National Science Foundation, the National Institutes of Health and the David and Lucile Packard Foundation. Hui was supported by a Ruth L. Kirschstein National Research Service Award.

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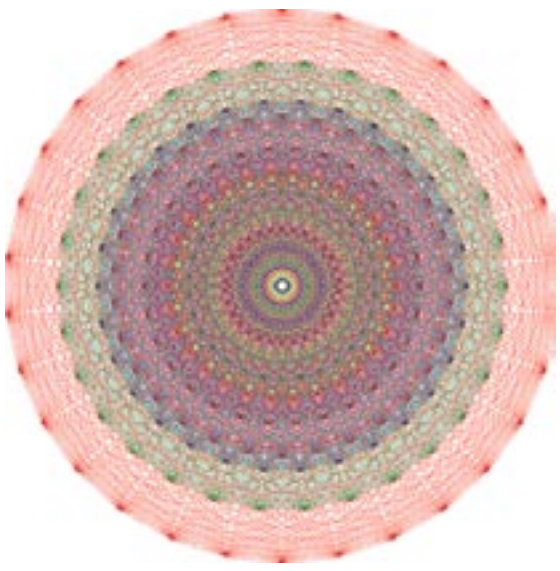
Congress commends E_8 math team



GRAPHIC / **JOHN SEMBRIDGE**

This graphic, based on a drawing by Peter McMullen, shows one visualization of the E_8 group recently mapped by mathematicians.

A major mathematical feat by a team of 18 scientists, including two from MIT, has received a commendation from Congress, one week after the work made international headlines after being unveiled at MIT.

On Tuesday, March 27, Rep. Jerry McNerney (D-Calif.) read a statement to Congress about the work, which involved mapping one of the largest and most complicated structures in mathematics. If written out on paper, the calculation describing this structure, known as E_8, would cover an area the size of Manhattan.

The work is important because it could lead to new discoveries in mathematics, physics and other fields. In addition, the innovative large-scale computing that was key to the work likely spells the future for how longstanding math problems will be solved in the 21st century.

On March 19 MIT's David Vogan, a professor in the Department of Mathematics and member of the research team, unveiled the team's results in a talk at MIT to a standing-room-only crowd. (See web.mit.edu/newsoffice/2007/e8.html.) Vogan's MIT colleague on the E_8 team is Dan Ciubotaru, the CLE Moore Instructor in the Department of Mathematics.

In his statement, which will be included in the Congressional Record, McNerney concluded: "The participants are to be commended for their work that has expanded the limits of human knowledge and brings hitherto unknown beauty and power to grace our human condition."

McNerney, who has a Ph.D. in mathematics, represents the district that is home to the American Institute of Mathematics (AIM). The E_8 project was funded by the National Science Foundation through AIM.

—Elizabeth Thomson

Natural polyester makes new sutures stronger, safer

Anne Trafton
News Office

With the help of a new type of suture based on MIT research, patients who get stitches may never need to have them removed.

A biopolymer suture cleared last month by the FDA is made of materials that the human body produces naturally, so they can be safely absorbed once the wound is healed. They are also 30 percent stronger than sutures now used and very flexible, making them easier for surgeons to work with.

The sutures were developed by Tepha, a Cambridge company that hopes to use the same material to produce an array of absorbable medical devices, including stents, surgical meshes and possibly a heart valve scaffold, says Simon Williams, CEO of Tepha and a former MIT postdoctoral associate.

Williams said he envisions that the new sutures will be used for abdominal closures, which are prone to re-opening, and to stitch tendons and ligaments.

Developed using a method created at MIT, the absorbable sutures are the first made from material produced by genetically modified bacteria.

About 20 years ago, researchers in the laboratory of MIT biology professor Anthony Sinskey started swapping genes between different bacteria, hoping to achieve industrial production of desirable natural compounds synthesized by those bacteria.

The researchers focused their "biopolymer engineering" efforts on a group of genes that code for enzymes in a pathway that produces polyesters. Those polyesters can be broken down into metabolites naturally produced by humans, so they cause no harm when absorbed.

Once the genes were identified, they could be transferred into a strain of industrial E. coli that can produce large quantities of the strong, flexible polymer.

The FDA cleared the biopolymer sutures on Feb. 8, and Williams said Tepha plans to start marketing them soon, in partnership with another company.

"Not only is it technically and in an engineering sense a tremendous victory, but it's also a victory for society because this leads to new medical devices that can help people in new and novel ways," said Sinskey, who is one of the founders of Tepha and sits on its board of directors.

The new suture is the first of what the researchers hope will be many medical devices made from the natural polyesters.

Tepha is now working on developing other medical devices, such as surgical meshes, multifilament fibers and stents. Ultimately, the researchers hope to develop an artificial scaffold that could be used to grow heart valves after being implanted in a patient, which would spare children with heart valve defects from undergoing repeated surgeries.

Tests of the device in animals have shown promise.

"We've been able to show we can produce a valve scaffold that functions better and can grow with the animal," Williams said.

Tepha, founded six years ago, is a spin-off of Metabolix, a company the researchers founded in 1992 to market bioplastics and biopolymer packaging materials.

Other current and former MIT researchers who helped develop the recombinant DNA methods used to create the biopolymer are JoAnne Stubbe, Novartis Professor of Chemistry and professor of biology, former postdoctoral associate Oliver Peoples and the late Professor Emeritus Satoru Masamune.

Original work at MIT on this technique was funded by the National Institutes of Health.