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TechTalk
SERVING THE MIT COMMUNITY

Protein viewer unveiled

Sasha Brown
News Office

Last week, 200 high school biology students on a field trip to campus became the first to use a new 3-D protein database viewer that was created at MIT and will soon be available to schools nationwide.

The viewer was created by researchers in three different MIT departments, including Professor Graham Walker of biology, who used part of a $1 million Howard Hughes Medical Institute grant to form the HHMI Education Group, a research group dedicated to training science educators and developing tools and curriculum to improve introductory biology courses.

"Proteins are three-dimensional entities and we need to understand them that way," Walker said. But the professional viewers available were "powerful but complicated to use," he said. The ones made for educational purposes were "much more limited in their capabilities," but still difficult to use, he said.

In recent months, members of the HHMI Education Group collaborated to create the new protein database viewer using an educational tool developed several years ago at the MIT Center for Educational

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Fiery debris disk linked to strange new planets

Deborah Halber
News Office Correspondent

IMAGE COURTESY / NASA/JPL-CALTECH/STEWARD OBSERVATORY

This false-color image from three of NASA's Great Observatories provides one example of a star that died in a fiery supernova blast. At the center of this orb, visible only as a tiny turquoise dot, is the leftover corpse of the now-dead star, called a neutron star. The multi-hued shell outside the neutron star is the rest of the original star's scattered remains.

Citing the first direct evidence that the fiery debris of a dying star may swirl around long after the star is obliterated, MIT astrophysicists report in the April 6 issue of Nature that this orbiting disk of debris could also lead to the birth of strange new planets.

This first-of-its-kind observation of a disk of debris around a long-dead star, made with NASA's infrared Spitzer Space Telescope, could be the long-sought missing link behind the existence of the first planets discovered outside our solar system. In 1992, three Earth-sized planets were observed circling an exploded star called a pulsar. The MIT finding confirms what researchers had surmised from indirect evidence: These exotic planets were probably formed out of a dusty debris disk.

"When the planetary system around the pulsar was discovered, people generally agreed that the planets were probably formed from a disk," said lead author Zhongxiang Wang, a postdoctoral fellow with the MIT Kavli Institute for Astrophysics and Space Research.

Yet searches for disks around old pulsars proved fruitless — until now. "Our work, the discovery of such a disk, strongly supports the suggestion that planets form around pulsars from residual disks," Wang said.

"Pulsars emit a tremendous amount of high-energy radiation, yet within this harsh environment, we have a disk that looks a lot like those around young stars where planets are formed," said principal investigator Deepto Chakrabarty, associate professor of physics with the MIT Kavli Institute.

Evidence for fallback

Massive stars more than 10 times the mass of the sun end their lives in supernova explosions. These dying stars collapse under their own weight, flinging material far into space. The incredibly dense remaining core can become a rapidly spinning pulsar, a type of neutron star. A neutron star is the size of a city but with about the same mass as the sun.

Researchers believe that the supernova

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Researchers employ viruses to build tiny batteries

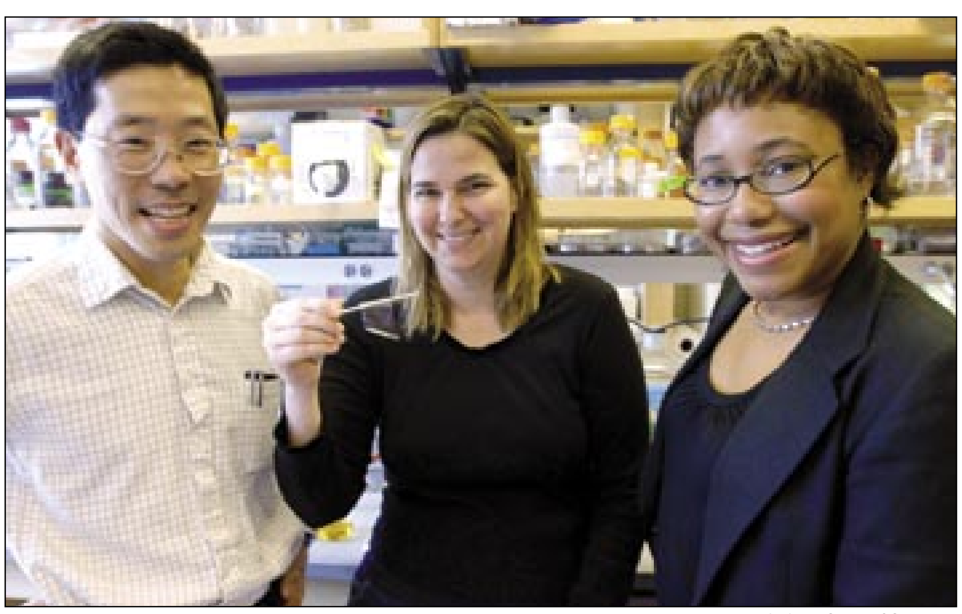

PHOTO / DONNA COVENEY

From left, Professors Yet-Ming Chiang, Angela Belcher and Paula Hammond display a virus-loaded film that can serve as the anode of a battery.

MIT scientists have harnessed the construction talents of tiny viruses to build ultra-small "nanowire" structures for use in very thin lithium-ion batteries.

By manipulating a few genes inside these viruses, the team was able to coax the organisms to grow and self-assemble into a functional electronic device.

The goal of the work, led by MIT Professors Angela Belcher, Paula Hammond and Yet-Ming Chiang, is to create batteries that cram as much electrical energy into as small or lightweight a package as possible. The batteries they hope to build could range from the size of a grain of rice up to the size of existing hearing aid batteries.

Batteries consist of two opposite electrodes — an anode and cathode — separated by an electrolyte. In the current work, the MIT team used an intricate assembly process to create the anode.

Specifically, they manipulated the genes in a laboratory strain of a common virus, making the microbes collect exotic materials — cobalt oxide and gold. And because these viruses are negatively charged, they can be layered between oppositely charged polymers to form thin, flexible sheets.

The result? A dense, virus-loaded film that serves as an anode.

A report on the work was published in the April 6 issue of Science.

Belcher, the Germeshausen Professor of Materials Science and Engineering and Biological Engineering; Chiang, the Kyocera Professor of Materials Science and Engineering (MSE); and Hammond, the Mark A. Hyman Professor of Chemical Engineering (ChE), led a team of five additional researchers.

They are MSE graduate students Ki Tae Nam (the lead author), Dong-Wan Kim, Chung-Yi Chiang and Nonglak Meethong, and ChE postdoctoral associate Pil J. Yoo.

In their research, the MIT team altered the virus's genes so they make protein

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PEOPLE

NEW ASSOCIATE PROVOST

Philip S. Khoury, the Kenan Sahin Dean of the School of Humanities, Arts and Social Sciences, will become associate provost.

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THANKS A MILLION

Associate Professor Catherine L. Drennan has been named a Howard Hughes Medical Institute Professor.

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RESEARCH

QUANTUM LEAP

Physicists announce they have measured a particular subatomic activity for the first time.

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ENERGY TALK

Institute Professor Mildred S. Dresselhaus offers her views on "grand energy challenges."

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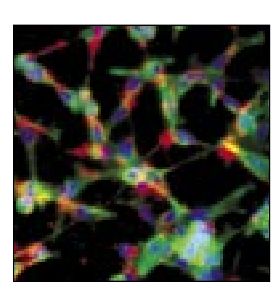

CANCER WEAPON

MIT researchers report on how nanoparticles can be designed to deliver chemotherapy to cancer cells.

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Philip Khoury named associate provost

Sasha Brown
News Office

MIT Provost L. Rafael Reif today announced that Philip S. Khoury, the Kenan Sahin Dean of the School of Humanities, Arts and Social Sciences, will become associate provost of MIT, effective July 1.

Khoury succeeds Professor Alan Brody, who announced earlier this year his intention to step down as associate provost for the arts at the end of the academic year, when he will return to teaching and playwriting as a member of the music and theater arts faculty.

As associate provost, Khoury will oversee and enhance MIT's co-curricular and nonacademic arts programs and will work closely with the senior administration, including the school deans, to develop the financial resources and facilities required to advance the arts at MIT, Reif said in a letter to the MIT community.

In addition to his responsibilities for the arts, Khoury will work to strengthen major interdepartmental educational, research and community-based initiatives, help to develop and implement a strategic plan for MIT's international initiatives, and coordinate MIT's efforts to promote and enhance deeper public discourse on questions of science, technology, society and policy, Reif said.

Philip S. Khoury

"I am delighted that Professor Khoury has agreed to take on these new responsibilities following his exceptional 15-year tenure as dean of humanities, arts and social sciences," Reif said. "Under his leadership as dean, the visibility and stature of MIT's humanities, arts and social sciences programs increased considerably. In conjunction with the school's 50th anniversary, the arts were added to the name of the school, reflecting their growing importance in its scholarly and educational programs."

The provost also noted that under Khoury's leadership, the "school's five doctoral programs — among the best in the nation — were further enhanced, two new graduate programs were established — the master's programs in comparative media studies and in science writing, and the school's international education and research activities grew significantly, especially its East Asian studies faculty and programs."

A noted political and social historian of the modern Middle East, with special interests in comparative urban history and politics and in comparative nationalist movements, Khoury joined the history faculty at MIT as an assistant professor in 1981. He became associate dean in 1987, full professor and acting dean in 1990, and dean of the school in 1991.

A fellow of the American Academy of Arts and Sciences and a past president of the Middle East Studies Association, he is a member of the American Association for the Advancement of Science, the American Historical Association and the British Society for Middle Eastern Studies. He currently serves as vice chairman of the board of the American University of Beirut, chairman of the World Peace Foundation, and as a trustee of Trinity College and of the Toynbee Prize Foundation.

Khoury commented, "I have been enormously privileged to serve these many years as dean of SHASS, with its distinguished faculty, outstanding staff and superb undergraduate and graduate students. SHASS has been my home for 25 years and it will always be my first home at MIT. And I am excited about working closely with President Hockfield, Provost Reif and other senior officers to help realize a number of important opportunities for the arts and international research and education at the Institute, and to enhance activities at the intersections of our five schools."

Reif announced that he will begin the process of selecting a new dean of humanities, arts and social sciences soon. He invited comments or thoughts on the position and said letters may be sent to him confidentially at the Office of the Provost, Room 3-208, or via e-mail to hassdeansearch@mit.edu.

Sloan plans live public interview of Comcast CEO

Sarah H. Wright
News Office

Kevin Maney, senior technology writer and columnist for USA Today, will talk business with Comcast CEO Brian Roberts in a live interview to be held on Wednesday, April 19, at 6:30 p.m. in Wong Auditorium. The event is free and open to the public.

The Sloan School of Management organized and is hosting the face-to-face meeting between Maney, author of the critically acclaimed "The Maverick and His Machine: Thomas Watson Sr. and the Making of IBM" (2003), and Roberts, who is credited with transforming a minor Philadelphia cable company into a major media powerhouse.

Maney will interview Roberts on how he got where he is — including how his company expanded to include ownership of the Philadelphia 76ers NBA basketball team as well as the Philadelphia Flyers NHL hockey team — and how he imagines the future for Comcast and the rest of the global media industry.

Under Roberts' leadership, Comcast grew into a Fortune 100 company with 80,000 employees. Roberts is also chairman of the board of directors of the National Cable & Telecommunications Association (NCTA) and previously served as chairman of NCTA from 1995 to 1996, when the landmark deregulatory 1996 Telecommunications Act became law.

Roberts was a founding co-chair of Philadelphia 2000, the nonpartisan host committee for the 2000 Republican National Convention. An All-American in squash, he earned a gold medal with the U.S. squash team in 2005 and silver medals at the 1981, 1985 and 1997 Maccabiah Games in Israel.

Maney is the author of the bestselling "Megamedia Shakeout: The Inside Story of the Leaders and the Losers in the Exploding Communications Industry" (1995).

PHOTO / **DONNA COVENEY**

A clear shot

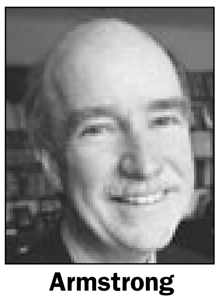
MIT hackers took their show on the road over spring break, nabbing this Civil War-era cannon from Caltech in California and bestowing it with a uniquely MIT signature — a mold of the MIT 'brass rat.' The cannon was in front of the Green Building through Campus Preview Weekend until 30 students and alumni from Caltech drove across the country to retrieve it on Monday, April 10.

Armstrong receives Bingham Medal

Robert Armstrong, Chevron Professor and head of the Department of Chemical Engineering, has been awarded the 2006 Bingham Medal.

The Bingham Medal is awarded by the Society of Rheology, which is devoted to the study of the science of deformation and flow of matter.

Armstrong, whose research interests include rheology as well as polymer molecular theory, polymer fluid mechanics, multiscale process modeling, transport phenomena and applied mathematics, will deliver a lecture and receive the prize at the society's annual meeting in Portland, Maine, in October.



Armstrong

Scolnick Prize winner to talk at McGovern

The McGovern Institute will present the third annual Edward M. Scolnick Prize in Neuroscience to Michael Greenberg, a world leader in molecular neurobiology from Children's Hospital/Harvard Medical School.

The Scolnick Prize provides an important focus for the international neuroscience community by calling attention to the best new approaches to understanding the brain. Greenberg will present a public lecture titled "Signaling Networks that Control Synapse Development and Cognitive Function" from 4 to 5 p.m. on April 25 at the McGovern Institute, located in the Brain and Cognitive Sciences Complex at 43 Vassar St.

Greenberg directs the Program in Neurobiology at the Children's Hospital/Harvard Medical School Department of Neurology. He has made seminal discoveries that have resulted in entirely new avenues of investigation in neural development, the neural response to injury and disease, and the search for new treatments for neurological disorders and brain injuries.

"Dr. Greenberg exemplifies the intersection of basic neuroscience research with areas of clinical importance, which will clearly impact the effort to alleviate the human suffering brought on by brain diseases," said Robert Desimone, director of the McGovern Institute. "Many laboratories worldwide are pursuing new leads based on the discoveries Dr. Greenberg has made."

"I am honored to be selected," said Greenberg. "It is especially meaningful to me because much of my research on signaling mechanisms that control nervous system development was inspired early on by approaches that Dr. Scolnick developed for studying signaling pathways that regulate cell proliferation and cancer development."

The $50,000 prize is named in honor of the former president of Merck Research Laboratories, who held the company's top research post for 17 years. The prize was established through a grant from The Merck Company Foundation to the McGovern Institute for Brain Research.

HOW TO REACH US

News Office
Telephone: 617-253-2700
E-mail: newsoffice@mit.edu
http://web.mit.edu/newsoffice

Office of the Arts
http://web.mit.edu/arts

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Editor
Kathryn O'Neill

Photojournalist
Donna Coveney

Production
Anne Trafton

News Office Staff
Interim Director .... Pamela Dumas Serfes
Senior Communications Officer/
Science Writer .... Denise Brehm
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Nanoscience rising up to meet energy challenge, Dresselhaus says

Deborah Halber
News Office Correspondent

Tiny materials may bring about large-scale advances in a future hydrogen economy, Institute Professor Mildred S. Dresselhaus told audiences Wednesday, April 5, at MIT and at the Technion Israel Institute of Technology.

In a talk, "Addressing Grand Energy Challenges Through Nanoscience," simulcast at both institutions, Dresselhaus related how she became involved in 2003 in making hydrogen a more viable fuel source when she chaired a national study looking at the problem. President Bush's 2003 State of the Union announcement of a hydrogen fuel initiative substantially increased interest in the potential for hydrogen to play a major role in the nation's long-term energy future.

While hydrogen has advantages, it's "not a fuel. You can't mine it. We would have to make nine million tons a year, and eventually, 20 times more than that," Dresselhaus said.

Because hydrogen is currently produced from fossil fuels, scientists would have to find a way to produce it from sustainable sources such as rainfall and ocean water.

"We need to develop the technology to convert hydrogen and water to free hydrogen, but we don't know how to do it cheaply and at a large scale," she said.

To make hydrogen that works as well as gasoline as an automotive fuel or to power the fuel cells that may replace internal combustion engines, researchers are depending on nanotechnology.

"By using new advanced materials now becoming available through nanoscience, scientists can take advantage of quantum phenomena that occur at this scale," said Dresselhaus.

Nanotechnology can help develop efficient, inexpensive catalysts for hydrogen production and storage. Several chemical species contain hydrogen in high concentrations, but the trick is to release hydrogen from its strong chemical bonds to make it usable in a system like a car that needs a steady flow of fuel.

Unfortunately, many promising avenues have drawbacks — nasty by-products or high temperature requirements — but Dresselhaus is confident that these will be eliminated in time. "Each one of these things we know how to do in principle, but we're far from knowing the details," she said.

Dresselhaus said significant change is unlikely to come about through incremental improvements to existing technology. Just as Edison's incandescent light bulb was not born from improving the candle, future technologies are likely to bear little resemblance to today's tried-and-true methods.

The talk was part of a monthly lecture series sponsored by Hibur, an MIT-Hillel-sponsored program started by students last year. The program is designed to create a connection between MIT and the Technion Israel Institute of Technology in Haifa, Israel.

Media Lab hosts workshop on body sensors

Sarah H. Wright
News Office

Experts in wireless sensing and implantable electronics convened at the MIT Media Lab last week for the Body Sensor Network (BSN) 2006 International Workshop, an event highlighting the dramatic changes that computing innovations have made in health care and health monitoring.

The event was a "whirlwind tour through cutting-edge aspects of wearable and pervasive computing, biosensors and implantable systems and medical, clinical and ubiquitous computing applications," said Joseph Paradiso, director of the Media Lab's Responsive Environments Group and co-organizer of the 3-year-old international event.

The BSN workshops, held April 3-5 in Bartos Theater, included presentations and poster sessions covering such topics as wearable and implantable sensors, clinical applications and ways to power these new systems.

Paradiso noted in his introduction to the proceedings, "We hope this workshop becomes a Rosetta Stone that keeps us all communicating to build out the future of physiological interfaces between people and computation."

Postdoctoral associate Rana el Kaliouby, graduate student Alea Teeters and Professor Rosalind Picard of media arts and sciences, all of the MIT Media Lab, led the session on clinical applications with a moving presentation on how a small video camera might be used as a "social-emotional prosthetic" to help people with autism spectrum disorders learn to identify and decode facial expressions.

John Wyatt, professor of electrical engineering and computer science, described his work in developing a retinal implant for the blind. His paper describes how an implant containing a 10-micron-thick microelectrode array could restore a "useful level of vision" to patients suffering from macular degeneration.

Other presenters on clinical applications showed how sensors applied to the arm can assess the abilities and progress of people recovering from strokes; how a pervasive body sensor network could monitor postoperative recovery; and how a wireless sensor system might aid in treating dyskinesia, the involuntary writhing movements associated with Parkinson's disease.

Wearable sensors, many of which look like they're straight out of gadget-casting for Xenon, Girl of the Future, promise profound and potentially life-saving changes in health care.

BSN presenters offered examples from around the world, including HealthGear,

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PHOTO / **DONNA COVENEY**

Professor of biology Graham Walker watches two Holliston High School students — Hannah Cohen, left, and Kristen Mirageas — explore the PDBViewer in the TEAL classroom in the basement of the Stata Center on Friday, March 31.

PDB VIEWER

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Computing Initiatives for the MIT physics department. That tool, the Technology Enhanced Active Learning Simulation Environment (TEALsim), was designed by Andrew McKinney, Phillip Bailey and Michael Danziger. It uses computer graphics to simulate physics problems, making them easier for students to visualize and understand, said Professor John Belcher of physics.

If TEALsim worked for physics, the team thought it might also work for biology.

Using the TEALsim architecture, Walker and his research team joined forces with Danziger and Ivica Ceraj of Information Systems and Technology (IS&T) to create the PDBViewer, which has much of the power of the professional viewers, but is both easy to use and visually appealing. They plan to introduce it into several MIT courses next year.

The PDBViewer was unveiled to the MIT community in the basement of the Stata Center on Wednesday, March 29. On March 30 and 31, students from eight area high schools came for a science field trip, which Walker's group has run annually since 2003 during the MIT spring break. High school students tour labs, attend lectures and participate in lab work led by graduate students.

Last year, the students attended a lab using an older protein viewer. Their teachers remembered the problems they had with that program and this year they praised the new PDBViewer. "This is such a gorgeous program," said Mary Aguirre, a biology teacher at Hudson High, who was jumping up and down with excitement. "It gives you such an amazing visual of what is going on."

Working in pairs, the high school students spent an hour on a tutorial program, first looking at the structure of the protein hemoglobin. By clicking the mouse, they could rotate the hemoglobin molecule, move it up and down, and zoom in on specific areas. They were able to quickly answer questions about the shape and structure of hemoglobin.

Although they worked steadily, few students raised their hands with questions — a huge change from last year, said Melissa Kosinski-Collins, a postdoctoral associate in Walker's lab. "Last year there had to be two graduate students per table," she said.

Electric power expert offers perspective on critical infrastructure

Ask most Americans where their electricity comes from and they'll say, "From the wall." They don't tend to think about the country's energy infrastructure or how a hurricane or terrorist attack could disrupt it.

The Electric Power Research Institute (EPRI) is thinking about these things. The institute was created after a massive 1965 blackout in the northeastern United States revealed the vulnerability of the nation's electric grid. EPRI, not a government agency and not an arm of the utilities, develops technical solutions to industry issues as an objective outsider that raises its own funding.

Theodore U. Marston, EPRI senior vice president and chief technology officer, spoke Thursday, April 6, as part of the Perspectives on Critical Infrastructure Systems series co-sponsored by MIT's Center for Technology, Policy and Industrial Development and the Engineering Systems Division.

Hurricanes, terrorists and hackers all have something in common: They are potential disruptors of a critical national resource.

The EPRI is reviewing all 103 U.S. nuclear power facilities for their vulnerability to natural and man-made threats, and eventually it will conduct risk analysis of the terrorist vulnerability of 17 sectors, including liquefied natural gas, subways, water supplies, dams and the power grid. The EPRI will advise the Department of Homeland Security on where to allocate funds to best protect these facilities.

Surprisingly, the institute has found that "nuclear plants have a low terrorist risk," he said, because of the nature of their design and the fact that few nuclear plants are in heavily populated areas. A rarely considered but potentially serious scenario is that of an avian flu epidemic, Marston said. Because symptoms don't appear for 24 hours, an individual could infect an entire crew, leaving a dearth of personnel to run a plant.

EPRI also tallied the lessons learned from the Gulf Coast following Hurricanes Katrina and Rita, when high winds took down utilities' walls and blew asbestos from their thermal insulation "everywhere," Marston said.

For fuller text, visit http://web.mit.edu/newsoffice/2006/electricity.html.

— *Deborah Halber*

Nanoparticles combat cancer

Ultra-small particles loaded with medicine — and aimed with the precision of a rifle — are offering a promising new way to strike at cancer, according to researchers working at MIT and Brigham and Women's Hospital.

In a paper published in the Monday April 10, online edition of the Proceedings of the National Academy of Sciences, the team reports a way to custom design nanoparticles so they home in on dangerous cancer cells, then enter the cells to deliver lethal doses of chemotherapy. Normal, healthy cells remain unscathed.

The team conducted experiments first on cells growing in laboratory dishes, and then on mice bearing human prostate tumors. The tumors shrank dramatically, and all of the treated mice survived the study; the untreated control animals did not.

"A single injection of our nanoparticles completely eradicated the tumors in five of the seven treated animals, and the remaining animals also had significant tumor reduction, compared to the controls," said Dr. Omid C. Farokhzad, an assistant professor at Brigham and Women's Hospital and Harvard Medical School.

Farokhzad and MIT Institute Professor Robert Langer led the team of eight researchers. (Farokhzad was formerly a research fellow in Langer's lab.)

The scientists said further testing is needed. Although all the parts and pieces of their new system are known to be safe, the system itself must yet be proven safe and effective in humans. This means thorough testing must be done in larger animals, and eventually in humans.

"We're most interested in developing a system that ends up in the clinic helping patients," Farokhzad said. To make that happen, he added, "we brought in cancer specialists and urologists to collaborate with us."

Further, he said, from an engineering perspective, "we wanted to develop a broadly applicable system, one that other investigators can alter for their own purposes."

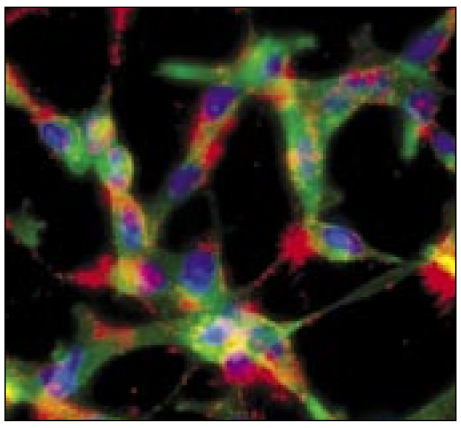

PHOTO / COURTESY BENJAMIN A. TEPLY

This image shows prostate cancer cells that have taken up fluorescently labeled nanoparticles (shown in red). The cells' nuclei and cytoskeletons are stained blue and green, respectively.

For example, Langer said, researchers "can put different things inside, or other things on the outside, of the nanoparticles. In fact, this technology could be applied to almost any disease" by re-engineering the nanoparticles' properties. The nanoparticles work like a bus that can safely carry different passengers to different destinations.

In the study, Farokhzad, Langer and colleagues tailor-made tiny sponge-like nanoparticles laced with the drug docetaxel. The particles are specifically designed to dissolve in a cell's internal fluids, releasing the anti-cancer drug either rapidly or slowly, depending on what is needed. These nanoparticles were purposely made from materials that are familiar and approved for medical applications by the U.S. Food and Drug Administration. Thus all of the ingredients are known to be safe.

Also, to make sure only the correct cells are hit, the nanoparticles are "decorated" on the outside with targeting molecules called aptamers, tiny chunks of genetic material. Like homing devices, the aptamers specifically recognize the surface molecules on cancer cells, while avoiding normal cells. In other words, the bus is driven to the correct depot.

In addition, the nanoparticles also display polyethylene glycol molecules, which keep them from being rapidly destroyed by macrophages, cells that guard against foreign substances entering the body.

The team chose nanoparticles as drug-delivery vehicles because they are so small that living cells readily swallow them when they arrive at the cell's surface. Langer said that particles larger than 200 nanometers are less likely to get through a cell's membrane. A nanometer is one-billionth of a meter.

The Farokhzad-Langer team created particles that are about 150 nanometers in size: a thousand sitting side by side might equal the width of a human hair.

Additional authors of the new paper are Jianjun Cheng, a former postdoctoral fellow with Langer now at the University of Illinois; Benjamin A. Teply of Brigham and Women's Hospital (BWH) and Harvard; Ines Sherifi, also at BWH and Harvard; Sangyong Jon, a former postdoctoral fellow with Langer now at the Gwangju Institute of Science and Technology in South Korea; Dr. Philip W. Kantoff of the Dana Farber Cancer Institute; and Dr. Jerome P. Richie of BWH and Harvard.

The research was supported, in part, by a grant from the National Cancer Institute (NCI) through the Harvard-MIT Center of Cancer Nanotechnology Excellence. The Harvard-MIT center is one of eight national Centers of Cancer Nanotechnology Excellence established recently by the NCI.

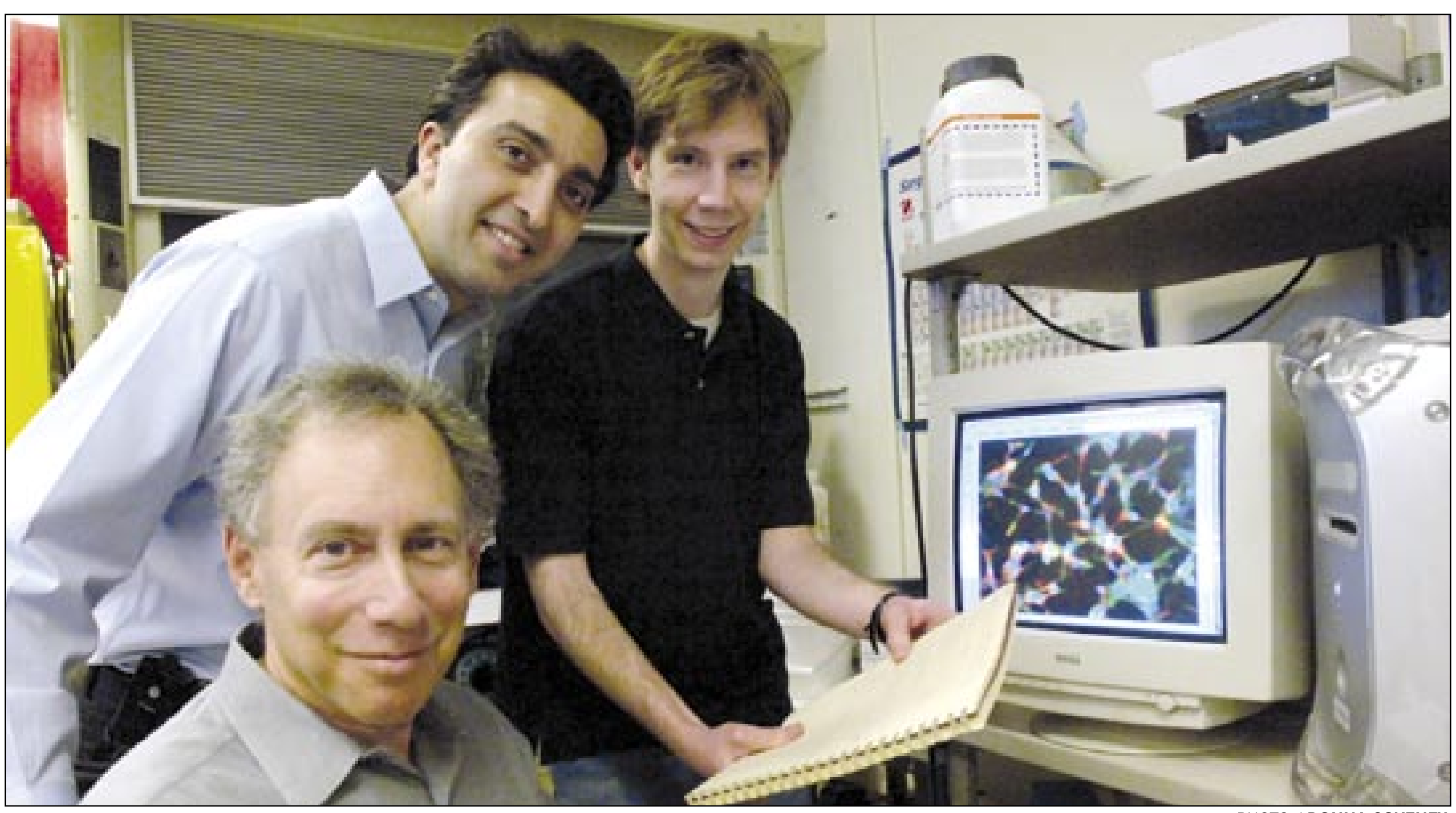

PHOTO / DONNA COVENEY

MIT Institute Professor Robert Langer, seated, joins Dr. Omid C. Farokhzad and researcher Benjamin A. Teply beside a monitor displaying an image of nanoparticles on Friday, March 31. The three are part of a team of researchers that showed nanoparticles could be custom designed to get inside cancer cells and release lethal doses of chemotherapeutic drugs to eradicate tumors.

VIRUS

Continued from Page 1

coats that collect molecules of cobalt oxide, plus gold. The viruses then align themselves on the polymer surface to form ultra-thin wires. Each virus, and thus the wire, is only 6 nanometers (6 billionths of a meter) in diameter, and 880 nanometers in length.

"We can make them in larger diameters," Belcher said, "but they are all 880 nanometers in length," which matches the length of the individual virus particles. And, "once we've altered the genes of the virus to grow the electrode material, we can easily clone millions of identical copies of the virus to use in assembling our batteries.

"For the metal oxide we chose cobalt oxide because it has very good specific capacity, which will produce batteries with high energy density," meaning it can store two or three times more energy for its size and weight compared to previously used battery electrode materials. And adding the gold further increased the wires' energy density, she added.

Equally important, the reactions needed to create nanowires occur at normal room temperatures and pressures, so there is no need for expensive pressure-cooking technology to get the job done.

The work is important, too, because energy density is a vital quality in batteries. A lack of energy density — meaning the amount of charge a battery of a given size can usefully carry — is what has hampered development of electric cars, since existing batteries are generally too heavy and too weak to compete with gasoline as an energy source. Still, battery technology is gradually being improved and may someday even become competitive as the price of oil escalates.

"The nanoscale materials we've made supply two to three times the electrical energy for their mass or volume, compared to previous materials," the team reported.

The researchers' work was spurred by "growing evidence that 'nanostructured' materials can improve the electrochemical properties of lithium-ion batteries," compared to more conventional batteries based on older technologies, the team wrote in Science.

But to create new battery materials, Belcher noted, special control is needed so just the right amounts of the exotic materials end up exactly where they belong. Cobalt oxide "has shown excellent electrochemical cycling properties, and is thus under consideration as an electrode for advanced lithium-ion batteries."

In earlier research, Belcher and colleagues learned they could exploit the abilities of microbes to recognize the correct molecules and assemble them where they belong.

A new means of inducing this order comes from self-assembly, a tool that is commonly used now in Hammond's lab. "By harnessing the electrostatic nature of the assembly process with the functional properties of the virus, we can create highly ordered composite thin films combining the function of the virus and polymer systems," Hammond said.

This work was funded by the Army Research Office Institute of Collaborative Biotechnologies, the Institute of Soldier Nanotechnologies and the David and Lucille Packard Foundation.

PLANET

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explosion blows away most of the star and any existing local planets, but that some small amount of debris ends up falling back toward what had been the core of the star, now the neutron star. "Nobody really knows how much of that material will fall back, but there should be some," said Pappalardo Postdoctoral Fellow David Kaplan of physics. "Up until now, people had searched for some evidence of this in the universe, but had not found anything direct."

When Wang, Chakrabarty and Kaplan used the Spitzer Space Telescope to look at a young X-ray pulsar 13,000 light years away in the constellation Cassiopeia, they saw a cold disk of material glowing around it in infrared light. This, they said, is the so-called "fallback disk," material that has not escaped from the supernova explosion that occurred about 100,000 years ago.

"Our work provides the first direct evidence for such a scenario, because the debris disk we detected was likely formed from the fallback material," Wang said.

Birth of strange planets

The research provides a missing link that would help explain a new, exotic type of planetary system that forms around pulsars.

Like most of the objects in space, the material that falls back toward the pulsar will keep rotating. If it rotates fast enough, it will end up forming a disk in orbit around the pulsar.

The disk is unlike anything in our solar system. Our sun, the planets in our solar system and most of the other stars and planets we know formed out of the same mix of materials: mostly hydrogen, some helium and tiny amounts of other elements such as oxygen and carbon.

However, a massive star is a nuclear furnace that converts hydrogen into all of the other elements. And the supernova explosion itself can provide more nuclear tricks. So the material that makes up the disk, instead of being mostly hydrogen, could be mostly iron, nickel or cobalt, and will likely contain all sorts of other interesting elements. What's more, the disk is constantly bathed in the X-ray light of the pulsar, creating an extremely harsh environment.

In most solar systems, the star at the center collapses out of a cloud of gas. The remains of that cloud form a big disk around the star that eventually makes planets. "So, by analogy, the disk of debris that we see could eventually form some planets," Kaplan said. "However, those planets would be constantly hit with X-rays, so anything on them would have a very tough time."

This work also may help answer questions about how black holes form. Some theories suggest that black holes form due to fallback. For instance, if the debris from the exploded star isn't rotating fast enough, it could fall until it hits the pulsar. Then, what had been a neutron star will become too massive and collapse quickly into a black hole. The observations should help to decide whether this is possible.

NASA's Jet Propulsion Laboratory manages the Spitzer Space Telescope Mission. This work is supported by NASA.

Chemist discovers secret behind nature's medicines

Cathryn Delude
News Office Correspondent


PHOTO / DONNA COVENEY
Some crystallography sleuthing by Associate Professor Catherine L. Drennan of chemistry has uncovered the secret behind some naturally produced medicinal compounds. Drennan was also recently named a Howard Hughes Medical Institute Professor.

MIT scientists have just learned another lesson from nature.

After years of wondering how organisms managed to create self-medications such as anti-fungal agents, chemists have discovered the simple secret.

Scientists already knew that a particular enzyme was able to coax a reaction out of stubborn chemical concoctions to generate a large family of medically valuable compounds called halogenated natural products. The question was, how do they do it?

Chemists would love to have that enzyme's capability so they could efficiently reproduce, or slightly re-engineer, those products, which include antibiotics, antitumor agents, and fungicides.

Thanks to MIT chemistry Associate Professor Catherine L. Drennan's recent crystallography sleuthing, the secret to the enzyme's enviable prowess has come to light, and it appears almost anti-climatic. It's simply a matter of the size of one of its parts.

"If an enzyme is a gun that fires to cause a reaction, then we wanted to know the mechanism that pulls the trigger," Drennan said. "In chemistry, we often have to look at 'molecules in, molecules out.' With halogenated natural products, though, we couldn't figure out how it happened, because the chemicals are so nonreactive. Now that we have the enzyme's structure and figured out how it works, it makes sense. But it's not what we would have predicted."

To make halogenated natural products, enzymes catalyze the transformation of a totally unreactive part of a molecule, in this case a methyl group. They break specific chemical bonds and then replace a hydrogen atom with a halide, one of the elements from the column of the periodic table containing chlorine, bromine and iodine. In the lab, that's a very challenging task, but nature accomplishes it almost nonchalantly. The trick involves using a turbo-charged enzyme containing iron.

A clue to how these enzymes operate emerged from a 2005 study by Christopher T. Walsh of Harvard Medical School, Drennan's collaborator and co-author of the study published in the March 16 issue of Nature. Looking at the SyrB2 enzyme that the microorganism *Pseudomonas syringae* uses to produce the antifungal agent syringomycin, he discovered it had a single iron atom in the protein's active site, the part responsible for the chemical reaction.

Drennan and her graduate student Leah C. Blasiak, who was first author of the study, crystallized SyrB2 and then used X-ray crystallography to discover the physical structure of the protein. The X-rays scatter off the crystal, creating patterns that can be reconstructed as a three-dimensional model for study.

Normally, iron-containing enzymes have three amino acids that hold the iron in the active site. In this enzyme, however, one of the typical amino acids was substituted with a much shorter one.

That smaller substitute leaves more room in the active site — enough space for the halide, in this case a chloride ion, to casually slip inside and bind to the iron, without the grand theatrics chemists had anticipated. After the iron and the chloride bind, the protein closes down around the active site, effectively pulling the trigger on the gun.

"We were surprised," Drennan said. "The change in activity required for an enzyme to be capable of catalyzing a halogenation reaction is so radical that people thought there must be a really elaborate difference in their structures. But it's just a smaller amino acid change in the active site. Things are usually not this simple, but there's an elegant beauty in this simplicity," and it may be what gives other enzymes the prowess required for making other medicinally valuable halogenated natural products, too.

The research was partially funded by the National Institutes of Health.

Drennan named million-dollar HHMI professor

Catherine L. Drennan, an associate professor in the Department of Chemistry, has been named a Howard Hughes Medical Institute Professor. The $1 million award honors top research scientists who are also great teachers.

Drennan is one of 20 new HHMI professors who, "through their teaching and mentoring, are striving to ignite the scientific spark in a new generation of students," according to HHMI.

HHMI does not tell the professors what to do or how to approach science education. Rather, it provides them with the resources to turn their own creativity loose in their undergraduate classrooms. For example, some may design programs to attract more women and minorities to science. Others might turn large introductory science courses into engaging, hands-on learning experiences.

"The scientists whom we have selected are true pioneers — not only in their research, but in their creative approaches and dedication to teaching," said Thomas R. Cech, HHMI president. "We are hopeful that their educational experiments will energize undergraduate science education throughout the nation."

HHMI awarded $20 million to the first group of its professors in 2002. MIT Professor of Biology Graham Walker received one of the 2002 awards.

— *Elizabeth Thomson*

Physicists get to heart of antimatter

Deborah Halber
News Office Correspondent

Like Jekyll and Hyde, some subatomic particles are able to act as both matter and their antimatter counterparts. Known as mixing, this process has been known to quantum physicists for 50 years. Now it has been measured for the first time by an international collaboration involving MIT scientists.

The work could lead to a better understanding of the early universe, when these particles were present in great abundance.

The achievement was announced yesterday by Ivan Furic (MIT Ph.D. 2004), now at the University of Chicago, representing the Collider Detector at Fermilab (CDF) collaboration at the Fermi National Accelerator Laboratory.

The CDF team specifically reported rapid-fire transitions between matter and antimatter of a subatomic particle called the B_S (pronounced "B sub s") meson. They found that this particle oscillates between matter and antimatter states at a mind-boggling 3 trillion times per second.

The B_S itself is composed of other subatomic particles: a heavy "bottom quark" bound to a "strange anti-quark."

Christoph Paus, associate professor of physics (and Furic's thesis advisor at MIT), represents MIT in the CDF collaboration, a team of 700 physicists from 61 institutions and 13 countries. Paus, a member of MIT's Laboratory for Nuclear Science, led the data analysis effort involving 80 scientists from 27 institutions.

The result was announced just one month after the data-taking was completed at the CDF, the world's highest-energy particle accelerator.

"The rapid matter-antimatter oscillations, 3 trillion times per second, give us a glimpse at the development of the early universe and might help us understand why there is so little antimatter in it right now," Paus said.

The researchers' goals are to discover the identity and properties of the particles that make up the universe and to understand the forces and interactions between those particles. Over the past 20 years, many experiments worldwide have been part of a program to make high-precision measurements of the behavior of matter and antimatter.

Scientists hope that by assembling a large number of precise measurements involving the exotic behavior of these particles, they can begin to understand why these particles exist, how they interact with one another and what role they played in the development of the early universe.

Although none of these particles exists in nature today, they were present in great abundance in the early universe. Scientists can only study these particles now at large particle accelerators.

Within the high-energy physics community, the new measurement will immediately be interpreted within different theoretical models. The fact that it confirms the 25-year-old existing theory, the Standard Model of Particle Physics, "means that nature has not yet revealed its secret for why matter, and not antimatter, dominates the universe," Paus said, "although this result will refute some theories based on even faster oscillations.

"As an experimentalist, the pleasure of ruling out new theories is second only to ruling out the existing one," Paus said. "This measurement is not the end of the story. It opens new venues to pursue the quest for nature's best-kept secrets."

CDF is supported by the DOE, the NSF and international funding agencies.

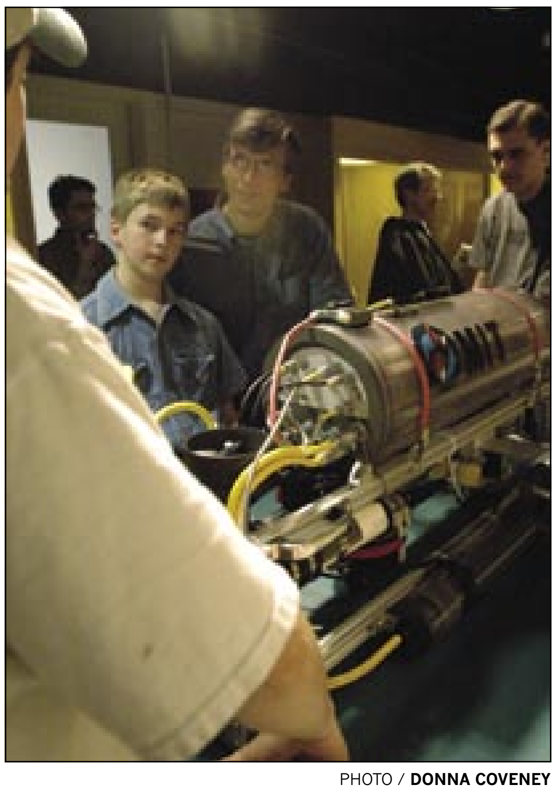
PHOTO / DONNA COVENEY

Show and tell

John Hutchinski, with his father Pete behind him, listens as a member of Project Orca talks about underwater autonomous robot submarines at the open house held in the Edgerton Center for Campus Preview Weekend last Friday afternoon, April 7.

Wellness Week message: Sleep and eat

Sasha Brown
News Office

Wellness Week kicked off the morning of April 10 with a host of events focusing on mental health, fitness and nutrition that will end Sunday, just in time for the Boston Marathon on April 17.

"It seemed like the perfect time to focus on this," said Yao-Chung King, chairman of the Undergraduate Association's Committee on Student Life, the organizing group. "It is just after spring break and right before everything gets really crazy."

Although there have been similar events in the past, this is the first one to be almost entirely organized and run by students, said King. He and the other committee members raised more than $15,000 from sponsors on campus and off.

On Monday, an early morning yoga class on Kresge Oval was immediately followed by a push-up and sit-up contest. Later, a fitness fair in the Zesiger Center highlighted MIT's many club and varsity sports, as well as physical education classes available for students.

"These events really all support one another," said King. Students can go from a cooking class to a fitness activity and then to a very relaxing activity like the four-hour "Nap Zone," which invited students to nap on beds in the Student Center. Some events focus on body image and self-esteem, such as Tuesday night's "Stand Up Stand Out" event, sponsored by the Panhellenic Association.

On Thursday, a chef will give a healthy cooking demonstration in front of the Student Center, creating meals with food that can be purchased on campus. "We wanted to make this as accessible as possible," said King.

A mini-triathlon, the "Iron Nerd," will pit competitors against one another as they swim four laps, wheel around "dorm row" on roller blades, bikes and roller skates ("creativity is encouraged," King said), then finish with a mile-long run around campus. The Iron Nerd starts Saturday at 11 a.m. For a complete list of events, see the web site at http://web.mit.edu/ejang/www.

PHOTO / **DONNA COVENEY**

Wellness Week started off Monday, April 10, with push-ups on Kresge Oval featuring senior Zack Eisenstat, junior Chris Cabral and freshman Mark Norsworthy.

Conference explores work that crosses disciplines

Sarah H. Wright
News Office

Graduate students in architecture, engineering and political science will invite cross-disciplinary discussions of cutting-edge research projects at a two-day conference to be held on Friday, April 14, and Saturday, April 15, at MIT.

The conference, titled "*research in progress," is hosted by the Department of Architecture and organized by graduate students Jennifer Ferng, in history, theory and criticism of architecture (HTC), and Michael Baker, in electrical engineering and computer science (EECS). The event is free and open to the public.

"Often graduate study requires that we focus on one particular area in great depth. 'Research in progress' is an opportunity for me to contribute to a forum where cultural, political or even ethical dimensions of any research can be explored," said Baker.

"Approaching material from different points of view, as in this type of collaboration, can be extremely productive," Ferng said.

Yung-Ho Chang, head of architecture, will open "*research in progress" on Friday evening in the Advanced Visualization Theater, Room 3-133.

Discussion sessions on Saturday will be held in Room 10-105. These will include "Scientists and Diplomats (and the Architects Who Love Them)" and "Second Nature: Interventions in the Environment."

Most presenters are already involved in interdisciplinary work and will use the conference to invite even wider discussion.

As Lucia Allais, HTC doctoral student, noted, "Interdisciplinarity is a very healthy habit. It forces a certain rigor; you have to clean up your use of jargon; you have to be doubly sure of every assertion if you are to be taken seriously outside your discipline."

Allais will present her research on the temporary U.N. headquarters built in Paris in 1951 and destroyed in 1960.

Nick Buchanan, doctoral student in science, technology and society, will present part of his dissertation project, a study of the costly, elaborate failure by the federal government to "civilize" the Klamath Indians and force them to abandon hunting for farming. (The Klamath reservation was established in southern Oregon in 1864.)

Beaudry Kock, master's candidate in civil and environmental engineering, studies collaborative decision-making as it applies to contemporary water resource conflicts in the American West.

"I skip across disciplines every day in my research, and I'm seeking to make new links to new fields and practitioners all the time," he said.

OBITUARIES

Ernest Rabinowicz

Ernest Rabinowicz, professor emeritus of mechanical engineering, died April 3. He was 79.

Rabinowicz worked at MIT for 43 years before retiring in 1993. He was known for his work in tribology, the study of the design, friction and wear of interacting surfaces such as bearings. In 1998, he received the Tribology Gold Medal Award from the Institution of Mechanical Engineers in England.

His seminal book "Friction and Wear of Materials" has been widely cited. He is also the co-author of "Physical Measurement and Analysis," which he wrote with Nathan H. Cook, his longtime friend and colleague. Rabinowicz also co-authored "Introduction to the Mechanics of Solids."

A graduate of Cambridge University with a Ph.D. in physical chemistry, he also worked as a consultant to a wide range of companies during his MIT career, traveled internationally as an expert witness, and spent a sabbatical at the Haifa Technion in Israel.

He is survived by his wife, Ina (Feldman) Rabinowicz; three daughters, Deena Dugan of Silver Spring, Md., Judith Raymond of Stamford, Conn., and Laura Rabinowicz of Chicago, Ill.; two sisters, Hedda Boxer of London and Ilse Saltzman of Israel; a brother, Norman Rabinowicz of Colorado; and seven grandchildren.

Donations may be made to the Alzheimer's Association, 311 Arsenal St., Watertown, MA 02472, or Combined Jewish Philanthropies of Greater Boston, 126 High St., Boston, MA 02110.

Michael Tsan Ty

Michael Tsan Ty, a 28-year-old neurologist who earned his medical degree at the MIT-Harvard Division of Health Sciences and Technology, died April 3 when scaffolding crushed his car on Boylston Street in Boston.

While at the Division of Health Sciences and Technology (HST), Ty spent 18 months working in the laboratory of Mriganka Sur, head of the Department of Brain and Cognitive Sciences.

"He was very kind, very skilled and very creative," Sur said.

Ty, a native of Atherton, Calif., majored in neuroscience at Johns Hopkins University, where he graduated Phi Beta Kappa in 1999. After earning his medical degree from HST in 2004, he became a clinical fellow in neurology at Massachusetts General Hospital and at Brigham & Women's Hospital.

In Ty's M.D. thesis research at MIT, "he combined materials science and micropatterning with neuroscience in a very clever way," to create a fixed substrate for growing brain cells in culture, Sur said. He applied that technique to a study of how the strength of neuronal connections, or synapses, varies depending on how many neighbors a neuron has.

Ty, who lived in Roslindale, is survived by his wife, Robin; his parents, George P. and Bonnie Tsan Ty; a sister, Monica; and many friends and colleagues.

A private memorial service is planned.

NEWS YOU CAN USE

Study abroad

An information session for students interested in studying abroad will be held April 20 from 3 to 5 p.m. in Room 1-277. Two information sessions on foreign scholarships will be held April 24 from 4 to 5:30 p.m. in Room 3-133 and April 25 from 3:30 to 5 p.m. in Room 4-163.

For more information, contact studyabroad@mit.edu or foreign-scholarship-advice@mit.edu.

SENSOR

Continued from Page 3

a real-time wearable system that monitors blood oxygen during sleep; "smart" clothes, such as the MyHeart instrumented shirt, a close-fitting sleeveless T with electrodes embedded in the fabric; and the EKG shirt, a prototype for a sensing T-shirt that measures an EKG signal through circuitry that has been embroidered on it with conductive yarn.

Smart clothes can be bulky. Eric Wade, a graduate student in mechanical engineering, and H. Harry Asada, the Ford Professor of Mechanical Engineering, presented a paper on simplifying routing among connectors and integrating systems that use conductive fabrics, which are made of nylon and polyester with a silver, nickel or aluminum coating.

For fuller text, visit http://web.mit.edu/newsoffice/2006/media-sensors.html.

CLASSIFIED ADS

Members of the MIT community may submit one classified ad each issue. Ads can be resubmitted, but not two weeks in a row. 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

Somerville, near Red Line T-stop: guest room/B&B in our home for one person or a couple. Use of kitchen, parking, laundry, piano. $75/night. MIT rate. Call 617-629-0048.

Paris-Marais. Spacious, sunny, fully furnished & equipped 2BR apartment. Five months minimum $2100/month. 617-247-2922.

VEHICLES

2003 Mini Cooper, premium silk green metallic , 17.4K, dual-pane panoramic sunroof, 16" alloy wheels, AC, AM/FM CD, always garaged. $18,900. Call John at 781-862-8973.

FOR SALE

Girls bicycle, made by Jetter, Reactor & Manufacturing, double hand breaks, adjustable reflectors, lug frame, high ten tubing. Great bike, great buy! Asking $30. Call 781-893-3377 or e-mail k1cei@comcast.net.

Boston Symphony — 1 ticket. Fri Apr 28 @1:30. 1st balcony, right. $31. Program: Schubert, Henze, & Brahms. Conductor: Frank Peter Zimmermann. Call 508-877-9518 after 6.

VACATION

Cottage on pristine Lake Maranacook, Maine. Photos and ref. avail. at MIT. 2BR, 270 ft. sand beach. Time in June, July, Aug. $750/wk. Tom King, 508-376-4336.

Martha's Vineyard, Oak Bluffs - 2 BR/1.5 BA; wraparound deck, outdoor shower, barbecue, sunny open interior. Near lagoon, tennis & bike trails. $550-1000/wk. E-mail Nina at ninad@mit.edu or view web site: http://home.comcast.net/~ndomenico/marthasvineyard/index.htm.

Wellfleet: Wonderful 1920 farmhouse on acre: 3 BR, 2 BA, jacuzzi, outdoor shower, washer/dryer, fireplace, near ponds and ocean beaches. $1350-$1750/wk. Contact alcohen@mit.edu.

STUDENT EMPLOYMENT

Positions for students with work-study eligibility

Charter public high school, City on a Hill, seeks tutors to prepare its sophomores for upcoming math & English MCAS tests. Tutoring sessions held 10 Saturday mornings from late January until May. Tutors work w/ students in 2-on-1 setting. Paid training session given to all tutors. City on a Hill staff will prepare currriculum for tutorials and be available to help tutors every step of the way. Contact Michael Larsson 617-262-9838 x211 mlarsson@cityonahill.org. $16/hr.

You will work 1-on-1 on math/literacy skills w/ a student at the Cambridge High Schoool Extension Program who has previously failed the MCAS exam. Payment for 3-15 hours of tutoring & 1-5 hrs of planning per week. Compensation higher for returning students. Two to four days a week (MTWR) for two, four or six hour shifts between 9 am and 3:30 pm. $16/hr. Starts asap. Visit www.readingmd.org for more information. Contact mdestler@cpsd.us.

MISCELLANEOUS

Writing your thesis? Submitting a paper to a journal? Experienced MIT-affiliated editor can fix grammar, improve style, and enhance the clarity of your document. Flexible rates. E-mail to wordplayer06@yahoo.com.

$4.25 million donated to support humanities

Sarah H. Wright
News Office

The School of Humanities, Arts and Social Sciences has received a $4.25 million gift from an alumnus donor and spouse who wish to remain anonymous.

The gift will establish a $3 million endowment for a Contemporary French Studies Fund and will support the Hyperstudio and Comparative Media Studies Program through $1.25 million in expendable gifts over the next five years.

In announcing the gift, Philip S. Khoury, the Kenan Sahin Dean of Humanities, Arts and Social Sciences, said, "This generous gift will have an enormous impact on the humanities at MIT. It will support the continuing creative initiatives of our French faculty and provide critical core funding for our innovative Hyperstudio and Comparative Media Studies Program."

The new Contemporary French Studies Fund will make it possible for French program faculty to develop new courses and ambitious programming, host visiting professors and writers, organize conferences and foster student cultural exchanges. It will also support the continuing development of such existing projects as Cultura, a web-based tool designed to build cross-cultural understanding between American and French students.

The gifts to support the Hyperstudio and Comparative Media Studies Program will help humanities faculty and students develop cross-disciplinary curriculum and research projects in which they use and study media technologies.

Led and administered by the foreign languages and literatures section, the Hyperstudio houses a wide range of interactive media content and projects developed for the classroom across disciplines that include foreign languages and literatures, literature, music, comparative media studies and history. This rich content is fueled by a technology that facilitates the collaborative sharing of media among faculty and students.

Comparative media studies is a multidisciplinary program at MIT examining media technologies and their cultural, social, aesthetic, political, ethical, legal and economic implications. The program offers a master's degree and undergraduate major (now the largest humanities major at MIT). Its faculty and students are engaged in a range of research projects, partnering with foundations and industry in areas that include media literacy, the development of education technologies and media convergence.

Architect Holl builds on themes

Robin H. Ray
News Office Correspondent

Award-winning architect Stephen Holl shared some of the themes running through his building designs, including "porosity," a concept given concrete illustration in Simmons Hall, in his April 4 campus lecture.

His design for the residence hall, sometimes familiarly called the "Space Waffle," sought to open up that area of campus to the neighboring community of Cambridgeport on one side and the Charles River on the other. The exterior walls of the building are dotted with hundreds of tiny, square windows. Holl seemed gratified that the residents had adopted and adapted the space to their needs by selectively lighting up windows to make a smiley face, for example.

Holl organized his presentation in Room 10-250 around five themes—fragments, porosity, insertions, precincts and fusion—that have informed his work over the past two decades. His projects display diversity—museums, churches, housing complexes and commercial buildings—and manifest his commitment to a sustainable, environmentally sensitive architecture.

His most ambitious porous project is a massive housing development under construction in Beijing, which seeks to break up the grim monotony of the high-rise apartment complexes. The eight towers of Holl's project vary in height and are connected by sweeping walkways. Their lower levels provide space for the necessities of urban China: laundromats, noodle shops, a cinema. It is the largest geothermal residential project in history.

Under the theme he calls "fragments," Holl showed a number of projects that attempt to rein in the ragged sprawl of contemporary urban development. He designed low-cost, densely packed housing complexes in Phoenix, Ariz., and Nanjing, China, that bracket and protect the natural space and use gray-water recycling and garden roofs to conserve resources.

Finally, Holl discussed "fusion," a notion best exemplified by the water-treatment plant he designed for New Haven, Conn., that has turned out to be a prized setting for weddings.

PHOTO / JOHANNA TORKKOLA

MIT alumna Pia Lindman performs with the robot Domo at the Luxe Gallery in New York City. Her solo show, 'Pia Lindman: Embodiments,' opens at the MIT Museum's Compton Gallery on April 18.

Artist explores human-robot interaction

Lauren Maurand
Office of the Arts

Alumna Pia Lindman, who has received acclaim for her performance and video artwork exploring human gesture, has a new solo show in the MIT Museum's Compton Gallery: She will become a human imitating machines that imitate human gestures.

"Pia Lindman: Embodiments," opens on Tuesday, April 18, with a reception in the gallery from 5:30 to 7:30 p.m. The exhibit includes drawings, videos and video documentation of her recent studies of humans interacting with robots.

Lindman will perform "The MIT Project," a series of embodiments of the interactions between human beings and robots built at the Humanoid Robotics Group at Computer Science and Artificial Intelligence Laboratory (CSAIL), at approximately 6 p.m. on April 18. The MIT piece was conceived during her 2005-2006 fellowship at MIT's Center for Advanced Visual Studies (CAVS). She is artist-in-residence at CSAIL.

Lindman's work highlights the intricate possibilities of human expression through gesture. It also probes the gulf between humans and machines while witnessing what happens when the two merge.

When she began working at CSAIL last summer, Lindman observed that there is always "something emotional in the relationship" between a researcher and his or her subject — even if that subject is a robot.

Lindman's plans include further exploration of the border between the human and non-human: She hopes to work with biomechatronics, where mechanical limbs provide biological sensory input to the human body to which they are connected. She is also interested in primates.

Lindman earned her master of science in visual studies from MIT in 1999 as a Fulbright Scholar and served last year as a lecturer in the Visual Arts Program.

"Pia Lindman: Embodiments" is on view in the MIT Museum's Compton Gallery through June 30. Admission is free. For more information, call x3-4444.

Religious integration possible for Europe's Muslims, Grand Mufti says in talk

Sasha Brown
News Office

Assimilation is possible for the roughly 30 million or more Muslims currently living in Europe, according to Mustafa Ceric, Grand Mufti of the Republic of Bosnia and Herzegovina, the highest official of religious law in that country.

"Europe has never been a continent of one faith," Ceric told the audience gathered in Room 54-100 for his April 4 talk titled, "European Muslim Identity in the New Millennium." The responsibility for assimilation lies with both the European Muslim minority and the European majority, he said.

Ceric proposed that a third option be added to the traditional Islamic concept that one either lives in an Islamic country or in a state of war fighting to keep the values of Islam alive: "Europe is neither a house of Islam or war. Europe is the house of contrast, peace and reconciliation," he said.

"An understanding of Europe is very important for Muslims," said Ceric, who said Muslims should try to embrace this third option, and that many Europeans need to eliminate their prejudice against Islam.

"I worry about the future of Muslims in Europe especially after recent events in Denmark," said Ceric, referring to the editorial cartoons depicting the Prophet Mohammed in a negative light that appeared in a Danish newspaper and set off a series of violent protests around the world. The cartoons were "meant to hurt," Ceric said. They "left a bitter feeling."

Condemning the recent terrorist attacks against the United States, England and Spain, Ceric said that "Muslims around the world have been shocked (by the attacks)." He encouraged Muslims in Europe to be proactive.

"The East believes Islam is the answer and the West believes Islam is the problem ... both are using and misusing Islam," Ceric said. He encouraged Muslims to live by the principle that "Islam is about the West and the East," he said.

"I am very optimistic," Ceric said. "I believe in the new generation of Muslims."

His visit was sponsored by the Center for International Studies, the Muslim Students Association and the Technology and Culture Forum at MIT.

MIT EVENT HIGHLIGHTS APRIL 12-16

Science/Technology · Performance · Architecture/Planning · Humanities · Music · Exhibit · Reading · Special Interest · Business/Money · Film · Sports · Featured Event

PHOTO / ALISON HAMMER

Personal space

Six photographs by MIT students are on view through Saturday, May 6, at the Photographic Resource Center's 2006 Annual Students' Exhibition in Boston. This photograph is by Alison Hammer, a graduate student in architecture. For more information, visit www.bu.edu/prc/.

WEDNESDAY April 12

"Power-Sharing or Partition? History's Lessons for Keeping the Peace in Bosnia" Talk by Alan Kuperman of the University of Texas at Austin. Noon. Room E38-615. 253-7529.

Advanced Music Performance Concert Graduate student Mary Farbood on the harpsichord. Noon. MIT Chapel. 253-2826.

Advanced Music Performance Concert Graduate student Lindy Blackburn on the piano. Chopin's Four Ballades. 5 p.m. Killian Hall. 253-2826.

THURSDAY April 13

MIT Writers Series Talk by Robert Adamson. 7 p.m. Room 32-141. 253-7894.

Chicks Make Flicks "Stay Until Tomorrow," directed by Laura Colella. 7 p.m. Room 6-120. 253-8844.

FRIDAY April 14

"Anime, Art and World Politics" Panel presentation. 2-4 p.m. Room 32-155. 253-4771.

Research in Progress 2006 Interdisciplinary workshops to foster and support collaboration among MIT graduate students from various departments and fields of study. April 14 and 15. Opening Reception. 4:30-6:30 p.m. Room 7-431.

Advanced Music Performance Concert Graduate student Pavitra Kumar on the piano. 5 p.m. Killian Hall. 253-2826.

"Rocking the World: Women in Science" MIT Dance Theater Ensemble presents original dance theater work, featuring choreography by Edisa Weeks and interactive technology by Liubo Borissov. April 14 and 15. 8 p.m. Kresge Little Theater. 253-4720.

SATURDAY April 15

Bengali New Year's Barbecue Noon-4 p.m. Kresge barbecue pits.

"The Violent Commodification of Desire" Panel presentation on anime fans and the creative destruction of online piracy. 2-4 p.m. Room 32-155.

Research in Progress 2006 Symposium featuring presentations by graduate students. 9 a.m.-4:15 p.m. Room 10-105.

SUNDAY April 16

International Folk Dancing Every Sunday. 8-11 p.m. Student Center, 2nd floor. 253-FOLK.

Chantey Sing Bringing maritime history alive, local chantey singers perform a variety of historic songs that celebrate the sea and the hard work that went into exploring it. 1-4 p.m. MIT Museum.

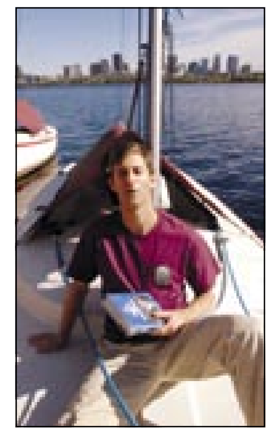

PHOTO / DONNA COVENEY

David Kessler, who works at MIT's Sloan School of Management, helped launch a series of sea chantey sings. There is one Sunday afternoon.

Go Online! For complete events listings, see the MIT Events Calendar at: http://events.mit.edu.

Go Online! Office of the Arts website at: http://web.mit.edu/arts/office.

EDITOR'S CHOICE

"KEEPING THE PEACE IN BOSNIA" — *Apr. 12*

Talk by Alan Kuperman on "Power Sharing or Partition? History's Lessons for Keeping the Peace in Bosnia."

Room E38-615

Noon

"PALESTINE/ ISRAEL" — *Apr. 13*

Talk by Ali Abunimah on "Palestine/Israel: Peace or Apartheid?"

Room 10-250

7 p.m.

"BLOGGER'S WAR" — *Apr. 15*

Movie screening and discussion of how Iranian expatriates fight for freedom of speech.

Room 4-237

5:30 p.m.

Big advance for tiny particles

Anne Trafton
News Office

MIT chemical engineers have devised an elegant new method for creating complex polymeric microparticles that could have applications in a variety of fields, from drug delivery in medicine to the creation of building blocks for the photonic materials that carry light. The particles can also add texture to skin creams and color to inks.

The new synthesis method gives researchers an extraordinary degree of control over the shape and chemical properties of the microparticles, which range in size from about 1 millionth of a meter to a millimeter.

"We have precise control over shape and an ability to create patterned chemical regions, that is rather unprecedented," said Assistant Professor Patrick Doyle of chemical engineering, one of the authors of a report appearing in the online edition of Nature Materials on April 9.

Doyle says he hopes other researchers will adopt his team's new technique of continuous flow lithography (CFL), which allows for faster, easier production of microparticles of diverse shape, size and chemical composition.

CFL builds on the well-known technique of photolithography, but its novelty lies in the fact that it is performed in a laminar (not turbulent) flowing stream as opposed to the traditionally used stationary film. Wherever pulses of ultraviolet light strike the flowing stream of small building blocks, or oligomers, a reaction is set off that forms a solid polymeric particle in a process known as photopolymerization.

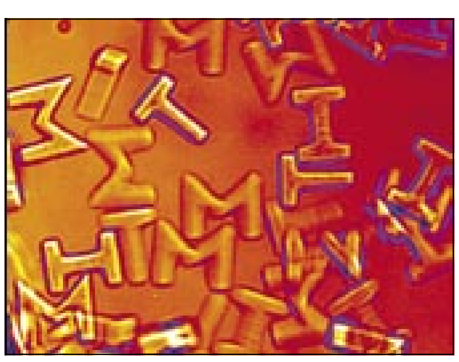

IMAGE / DANIEL PREGIBON

MIT chemical engineers created these microparticles, which are 60 microns high.

The method makes use of microfluidics — tiny fluid-filled channels with cross-sections typically smaller than a strand of hair. Until now, microfluidic methods have been limited to producing spheres, discs or cylinders.

However, with CFL, the particles can be configured into just about any projected 2D shape the researchers want by using a transparency mask to define the shape of a beam of ultraviolet light and focusing it with a microscope. As liquid flows through a microfluidic device, where the synthesis occurs, the shape is repeatedly imprinted onto the oligomer stream, at a rate of about 100,000 particles per hour with the current simple design.

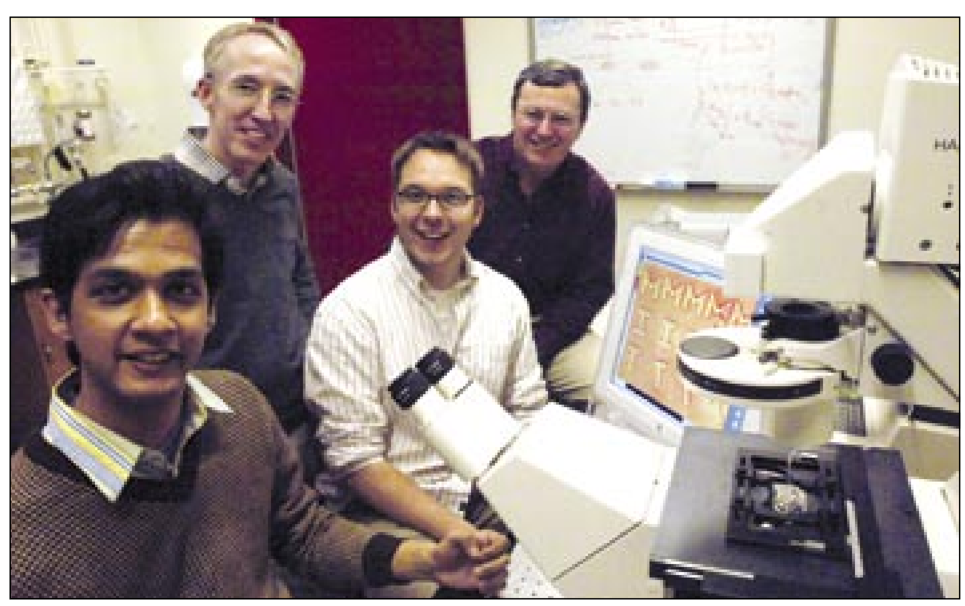

PHOTO / DONNA COVENEY

Graduate student Dhananjay Dendukuri, Professor Patrick Doyle, graduate student Daniel Pregibon and Professor Alan Hatton developed a new method for creating microparticles, shown on the monitor to the right.

"From an engineering point of view, converting a batch process (photolithography) to a continuous process may have significant advantage when we consider scaling up the technique," said graduate student Dhananjay Dendukuri, lead author on the paper.

The researchers can also create particles with different chemical properties in different locations.

Potential medical applications for such particles include drug delivery and performing diagnostic tests, such as testing blood for the presence of certain antibodies or other proteins. Graduate student Daniel Pregibon, one of the authors, said he is interested in creating ring-shaped particles, or "cell cages," that would trap cells for high throughput single cell studies.

Other authors on the paper are Alan Hatton, Ralph Landau Professor of Chemical Engineering Practice, and senior physics major Jesse Collins.

The research was supported by a National Science Foundation grant.