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TechTalk

SERVING THE MIT COMMUNITY

Enlisting microbes to solve global problems

Researchers harness bacteria to produce energy, clean up environment

Anne Trafton
News Office

In the search for answers to the planet's biggest challenges, some MIT researchers are turning to its tiniest organisms: bacteria.

The idea of exploiting microbial products is not new: Humans have long enlisted bacteria and yeast to make bread, wine and cheese, and more recently discovered antibiotics that help fight disease. Now, researchers in the growing field of metabolic engineering are trying to manipulate bacteria's unique abilities in order to help generate energy and clean up Earth's atmosphere.

Catherine Drennan

Kristala Jones Prather

Gregory Stephanopoulos

MIT chemical engineer Kristala Jones Prather sees bacteria as diverse and complex "chemical factories" that can potentially build better biofuels as well as biodegradable plastics and textiles.

"We're trying to ask what kinds of things should we be trying to make, and looking for potential routes in nature to make them," says Prather, the Joseph R. Mares (1924) Assistant Professor of Chemical Engineering.

She and Gregory Stephanopoulos, the W.H. Dow Professor of Chemical Engineering at MIT, are trying to create bacteria that make biofuels and other compounds more efficiently, while chemistry professor Catherine Drennan hopes bacteria can one day

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IMAGE / **SHIMAHARA ILLUSTRATION**

Once it is completed in 2010, the new MIT Sloan building (E62, pictured in this artist rendering) should be the greenest building on campus. The six-story structure will incorporate a number of environmentally friendly features including daylighting, chilled beams and radiant ceiling panels.

Turning bricks and mortar green

Deborah Halber
MITEI correspondent

GreeningMIT is an occasional series focusing on the broad efforts to improve energy efficiency on campus.

The limestone and glass walls of MIT's Brain and Cognitive Sciences Complex (BCSC) glint white and silver in the sun. But the complex, also known as Building 46, is really quite green.

The world's largest center for neuroscience research, BCSC opened in 2005. Its high-performance building envelope, gray water reuse, exhaust-fan heat recovery, and daylight-balanced lighting have earned it a coveted ranking by the U.S. Green Building Council (USGBC), making it one of the greenest buildings so far on the MIT campus. And newer buildings under construction could do even better.

Environmental imperatives such as global warming are spurring a renewed interest in sustainable architecture, and MIT is increasingly applying its own architectural and engineering expertise, in areas such as virtual building design and energy-saving technologies, to its own infrastructure, making the Institute an emerging leader in green campus buildings.

"Sustainable buildings pay for themselves. Sustainable buildings please their occupants," says Leon R. Glicksman, professor of building technology and mechanical engineering and co-chair of the Campus Energy Task Force of the MIT Energy Initiative (MITEI). "We are working hard to make them more widespread at MIT and use this as an example to other organizations."

Through use of targeted technology and a system called integrated design, MIT's newest buildings could end up using a third less energy than conventional counterparts do. And because buildings are responsible

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Alternative-energy enthusiast wins Gates scholarship

Alternative-energy enthusiast Orian Welling, a senior in mechanical engineering, has been awarded a full scholarship for graduate study at the University of Cambridge, England, by the Gates Cambridge Trust.

The 24-year-old Wisconsin native heard the news a long way from home: He is currently riding his bicycle from South Africa to England, though he plans a brief visit back to MIT before resuming his trek.

Welling, who is making the trip with his wife, Karen Noiva Welling '08, took a break from cycling to conduct his interview for the Gates scholarship program by phone. He learned that he had been selected a few days later, while he was riding near the border between South Africa and Botswana.

The current trek is actually Welling's second major international pedal-powered journey. He and a friend made an earlier trip from Alaska to Argentina — a 15,000-mile journey that occupied an entire year between his transfer from the University of Wisconsin to MIT — which inspired Welling to create a bike-powered laptop that could be made available to developing countries.

Last year, Welling and five teammates won the MIT IDEAS Competition Yunus Challenge Award for a portable solar cooker intended to withstand the high winds on the plateau of western China. The dish and reflector are formed by Mylar sewn onto a yak-wool canvas base.

Welling's passion for alternative energy was kindled at a young age: His parents long ago founded the Midwest Renewable Energy Fair, and his father managed a solar and wood stove shop. He envisions starting a business dedicated to developing sustainable shipping and transportation technologies. To accomplish this goal, he

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PEOPLE

Faculty named Sloan fellows

Six junior faculty members have been named 2009 Alfred P. Sloan Foundation Research Fellows.

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RESEARCH

Stuck in the middle

Research explains how thin layers of tiny organisms form at sea; could help predict harmful algal blooms.

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NEWS

Piece of cake

'Kitchen Chemistry' class at MIT looks at the science behind chocolate, cookies and more.

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Events at MIT

Today

• "New Opportunities for the Interactions of Mathematics and Other Disciplines." Speaker: Larry Abbott (Columbia University). 5-6 p.m. in 6-120.

• MIT Energy Club Lecture Series: Strategies for Enabling Deep Energy Efficiency in Buildings. Speaker: MIT Energy Efficiency Research Director and MIT Lecturer Harvey Michaels. 6-7 p.m. in 4-153. How do we realize massive-scale efficiency that may reduce the energy use of homes, buildings and communities by 50 percent or more over the next 20 years without sacrificing comfort or function?

• "Is'khathi." Talk by South African photographer and video artist Zanele Muholi. 7-8:30 p.m. in NE30, Broad Institute auditorium.

Thursday, Feb. 26

• "Will China Run Out of Water?" Speaker: Prof. Chunmiao Zheng (University of Alabama). 4-5 p.m. in 48-308.

• The Center for 21st Century Energy Spring 2009 Seminar Series. Speaker: Haijie Chen, on "Deterministic Method on Piston Ring Packs Lubrication." 4:15-5:30 p.m. in 37-212.

• Communications Forum: Popular Culture and the Political Imagination. 5-7 p.m. in E15. Johanna Blakley, deputy director of the Norman Lear Center at USC; David Carr, media and culture writer for the New York Times; and Stephen Duncombe, associate professor at NYU will speak.

Lermusiaux chosen for Doherty Professorship

The MIT Sea Grant College Program has selected Pierre Lermusiaux, associate professor in the Department of Mechanical Engineering's Center for Ocean Engineering, as the recipient of the 2009 Doherty Professorship in Ocean Utilization. He will receive a supplemental award of $25,000 per year for two years.

Lermusiaux's interdisciplinary research focuses on physical ocean dynamics and methods of estimating and assimilating data. His research group creates and utilizes the fundamental mathematical models and computational schemes for ocean prediction, for dynamical diagnostics, optimization and control of autonomous ocean observation systems, and for data assimilation and data-model comparisons. The PhD students in his group develop novel adaptive sampling methodologies, derive new prognostic equations for stochastic ocean fields of large dimensions, incubate the next generation of computational ocean models, and explore fundamental biogeochemical fluid dynamics in straits.

Six junior faculty named Sloan Research Fellows

Six junior MIT faculty, including three from the Department of Physics, have won 2009 Alfred P. Sloan Foundation Research Fellowships, intended to enhance the careers of the very best young faculty members in specified fields of science.

MIT faculty among this year's Sloan Research Fellows are Scott Aaronson of the Department of Electrical Engineering and Computer Science; Pablo Jarillo-Herrero of the Department of Physics; Guido Lorenzoni of the Department of Economics; John McGreevy of the Department of Physics; Ramesh Raskar of the MIT Media Lab; and Robert Simcoe of the Department of Physics.

The fellowships were established in 1955 to provide support and recognition to early career scientists and scholars, often in their first appointments to university faculties, who were endeavoring to set up laboratories and establish their independent research projects with little or no outside support. Financial assistance at this crucial point, even in modest amounts, often pays handsome dividends later to society.

"The Sloan Research Fellowships support the work of exceptional young researchers early in their academic careers, and often at pivotal stages in their work," said Paul L. Joskow, president of the Alfred P. Sloan Foundation and the Elizabeth and James Killian (1926) Professor of Economics and Management at MIT. "I am proud of the Foundation's rich history in providing the resources and flexibility necessary for young researchers to enhance their scholarship, and I look forward to the future achievements of the 2009 Sloan Research Fellows."

MIT tied with Harvard for second place in the list of institutions whose faculty received the most fellowships this year. The University of California at Berkeley had seven fellows.

PHOTO / **JUSTIN KNIGHT**

Distinguished words

Irwin Jacobs MS '57, ScD '59, co-founder and chairman of Qualcomm Incorporated, delivers the inaugural lecture of the School of Engineering Distinguished Lecture Series, which will be a regular opportunity for members of the engineering community at MIT to hear from leaders and pioneers in the engineering disciplines.

News in brief

Kauffman study finds MIT alumni companies generate billions for regional economies

A Kauffman Foundation study released recently demonstrates the critical role universities play not only in fostering innovation and entrepreneurial growth, but in stimulating the much-needed recovery in regional and global economies.

According to the study, "Entrepreneurial Impact: The Role of MIT," which analyzes the economic effect of MIT alumni-founded companies and its entrepreneurial ecosystem, if the active companies founded by MIT graduates formed an independent nation, their revenues would make that nation at least the 17th-largest economy in the world. Within the U.S., these companies currently generate hundreds of billions of dollars and hundreds of thousands of jobs to regional economies, particularly those in Massachusetts and California. Globally, a less conservative estimate of their annual world sales would equal $2 trillion, producing the equivalent of the 11th-largest economy in the world.

"MIT's significant economic impact is of particular interest because it provides an important model for universities interested in helping their students become more effective entrepreneurs," said Lesa Mitchell, a vice president of the Kauffman Foundation.

For more information on this study, see www.kauffman.org/mit.

New faculty task force to examine tenure

A new MIT faculty task force has been formed to examine the process of promotion and tenure at the Institute.

Co-chaired by Chemistry Professor Robert Silbey, former dean of the School of Science, and Thomas Kochan, the George Maverick Bunker Professor of Management at the MIT Sloan School of Management and the incoming chair of the faculty, the new ad hoc committee will review existing policies, procedures, norms and practices that guide promotion and tenure decisions, including the process of considering complaints and grievances.

"MIT is firmly committed to rigorous, comprehensive and fair review for promotion and granting of tenure to faculty," Silbey and Kochan said in a statement. "As an integral part of fair practices in conducting such reviews, the Institute needs to consider seriously any complaints about procedures involved in promotion and tenure and to do so in a manner outlined in MIT's Policies and Procedures."

The task force, created by the Faculty Officers in consultation with Provost L. Rafael Reif, will review promotion practices among the Institute's five schools and consider such issues as mentoring, feedback, fairness and impartiality.

For more information on the faculty task force, see web.mit.edu/newsoffice/2009/faculty-taskforce-0218.html.

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Obituaries

Margaret (Peg) Warner, special assistant to the EVP and treasurer, 67

Margaret (Peg) Warner, special assistant to the executive vice president and treasurer, passed away on Saturday, Feb. 7, at her Lexington home after a courageous battle with cancer. She was 67.

Peg began her career at MIT in 1998 as associate director of the Office of Budget and Financial Planning, responsible for Institute financial planning and budget development, submission and reporting. Appointed as special assistant to the EVP and treasurer in 2007, Peg used her deep knowledge of MIT, particularly of campus/capital-planning activities, to provide invaluable and outstanding service.

Margaret (Peg) Warner

She began her financial career 39 years ago at the Harvard University Smithsonian Astrophysical Observatory, where she was division administrator for the Radio and Geoastronomy Division. In 1984, she joined Raytheon Company, where she served first as business and program manager for several profit centers and later as marketing manager and director of competitive intelligence for Raytheon Service Company. While managing professional, technical and field personnel in the United States and Egypt, Peg also established a computer system to manage finances and logistics for critical air shipment of parts and assemblies to Cairo.

A native Californian, Peg graduated from Stanford University with a BA in French Literature and from Harvard University with an MA in Romance Languages and Literature; she was fluent in French, Italian and Spanish. She received an MBA from Boston University in 1984. A tireless volunteer for the causes in which she believed, Peg served on numerous nonprofit arts, civic and cultural boards in the Boston area, including the Museum of Science (where she served on the Finance Committee), the Massachusetts Cultural Council, the MIT Museum Advisory Board, the Friends of the Public Garden, Light Boston (an organization dedicated to illuminating Boston's historic buildings), Arts in Education "Think Tank", the Harvard University Credit Union and the Five Fields Neighborhood Association in Lexington. She was active in several animal welfare groups around the country including the Charles River Feline Association and the Somerville Alley Cats.

Friends fondly remember Peg's whimsical, off-beat sense of humor; her voracious love of all things edible, especially sweets; her interesting tales of MIT, Harvard and California; and, of course, her delightful stories about and love for her three cats, Thomas, Lucy and Ida. Peg enjoyed gardening, hiking, horseback riding, traveling and spending time in her log cabin in the New Hampshire woods. She loved to attend theater, dance, and music concerts and especially enjoyed having lunch with friends and colleagues around the Institute.

"Peg was a very truly special person and friend," said Vice President for Finance Israel Ruiz. "Everyone in the MIT community that got to meet Peg knows that, beyond her passion for budgets and watching MIT's financial 'bottom line,' she had a myriad of wonderful interests and talents.

"Personally, I always looked forward to having an enriching end-of-the-day conversation with her. She embraced me and counseled me since my first day at MIT and always made sure to look after me from a distance," Ruiz added. "Despite my great sorrow at her passing away, I find comfort in remembering our shared moments and great memories of our many years working together with shared passion for MIT."

She will be fondly remembered for her delightful spirit, her sincerity and her loyalty to her many friends at MIT. She will be tremendously missed by all.

A memorial service celebrating Peg's life will be held at 3:30 p.m. on Tuesday, March 24, in the MIT Chapel, followed by a reception.

Alan Jay Simmons, former Lincoln Laboratory group leader, 84

Alan Jay Simmons SM '48, who worked at MIT's Lincoln Laboratory for more than 15 years, died peacefully on Monday, Feb. 9, of complications from Parkinson's disease. He was 84.

Alan Jay Simmons

Simmons began his connection with MIT in the late 1940s, when he received his SM in electrical engineering and computer science. In 1971, Simmons began working at MIT's Lincoln Laboratory, eventually becoming one of the lab's group leaders. Besides working as a manager and administrator, he continued his work solving engineering problems related to satellite antenna systems for defense communications.

In 1976, two satellites that Simmons worked on at Lincoln Lab, LES 8 and 9, were launched into geosynchronous orbit, where they remain today still functioning.

In 1987, Simmons retired from full-time work at Lincoln Lab and began consulting. In 1991, he was named a life fellow of the Institute of Electrical and Electronics Engineers (IEEE). Throughout his career, he also published more than a dozen scientific papers and was a frequent speaker at professional meetings here and abroad.

A memorial was held on Saturday, Feb. 14, in Sandwich, Mass.

Awards&Honors

Six receive Martin Luther King Jr. leadership awards

Six members of the MIT community have received Dr. Martin Luther King Jr. Leadership Awards for 2009 in recognition of service that reflects the late civil rights leader's ideals and vision.

In presenting the awards on Feb. 5 during the 35th Annual Dr. Martin Luther King Jr. Breakfast Celebration, MIT Chancellor Phillip L. Clay reflected on the meaning of the word "leadership."

"Those who are anointed as our leaders are first our servants," he said. "Dr. King, in several of his sermons, underscored that point. Leadership is not purchased … but it is earned through service."

The 2009 leadership recipients are divided into three groups: faculty, staff and students. Staff award recipients comprise Barry Reckley, MIT Sloan School of Management assistant director in minority recruitment and retention; and Deborah Liverman, assistant director in the Global Education and Career Development Center. Christine Ortiz, associate professor in the Department of Materials Science and Engineering, and John Essigmann, toxicology and chemistry professor, won the faculty awards, while the student awards went to seniors Aisha Bobb-Semple and Jason Forte.

A royal honor for TLO's Nelsen

Lita Nelsen, director of the Technology Licensing Office at MIT, has been named a Member of the Most Excellent Order of the British Empire for her work in innovation and technology transfer in the United Kingdom.

Nelsen was cited for her talents as an internationally recognized authority in technology licensing and technology transfer, and for contributing significantly to the development of a network of trained Technology Licensing Offices in the United Kingdom.

In 2002, Nelsen co-founded Praxis Courses Ltd., a nonprofit U.K. technology transfer program, with Professor David Secher, then director of research services at Cambridge University. Praxis has played a key role in shifting the culture of U.K. universities toward commercialization.

The Most Excellent Order of the British Empire was founded in 1917 and honors civilians and service personnel for public service or other distinctions. It is widely used by the queen to honor non-British subjects who have given outstanding service to the United Kingdom.

Lita Nelsen

DeLong wins ASM award

The 2009 American Society for Microbiology (ASM) D.C. White Research and Mentoring Award has been awarded to Edward F. DeLong, professor in the Department of Civil and Environmental Engineering and Department of Biological Engineering.

DeLong was cited as one of the first marine microbiologists to apply novel molecular genetic methods to address fundamental ecological questions. The award will be presented in May during the 109th General Meeting of the ASM in Philadelphia.

Edward DeLong

Ketterle wins award for lifetime achievements

Wolfgang Ketterle, a professor in the Department of Physics, has been elected the recipient of a Humboldt Research Award after having been nominated by the German scientist Theodor W. Hänsch. The award is conferred in recognition of lifetime achievements in research. In addition, the awardee is invited to carry out research projects of his own choice in cooperation with specialist colleagues in Germany.

Buchanan wins Benjamin Siegel prize

The 2008/2009 Benjamin Siegel prize — offered to the MIT student submitting the best written work on issues in science, technology and society — has been awarded to graduate student Nicholas Buchanan, in the Program in Science, Technology, and Society, for his paper "Narrating Nature: Scientific Legality, Indigeneity, and Environmental Authority."

MIT to increase financial aid to middle-income families

MIT has set tuition and fees for 2009-2010 and has budgeted an additional $7.6 million for financial aid enhancements, including an expansion in aid to middle-income families that will ensure even more students have access to an affordable education.

While tuition and fees will increase 3.8 percent to $37,782, the smallest increase in eight years, the total undergraduate financial aid budget will rise more than 10 percent to $81.6 million. That marks the 10th straight year in which MIT's financial aid enhancements have outpaced rising tuition. This year, understanding that college costs can also present challenges for middle-income families, MIT's financial aid budget includes an additional $1.4 million to help families earning more than $75,000 a year.

The latest initiatives build on MIT's long tradition of ensuring that it remains affordable to talented students from a full range of economic backgrounds. The Institute's student population is already among the most economically diverse of America's top-ranked universities, partly as a result of MIT's commitment to "need-blind" admissions and to meeting the full need of all undergraduates it admits. Moreover, MIT doubled its undergraduate financial aid budget between 2001 and 2008.

"In these tough financial times, MIT recognizes that students and their families need our help more than ever. That's why we are pleased to be able to not only maintain our commitment to need-based aid but to be able to allot more funds to financial aid overall," said Dean for Undergraduate Education Daniel Hastings.

"We want all students to be able to afford to attend and not worry about finances," Hastings added, "so they can get the maximum educational benefit from their time at MIT."

Community Giving at MIT: now more than ever

Local nonprofits that we care about need financial help now more than ever. Please join generous MIT employees and retirees in supporting Community Giving at MIT, the easiest and most effective way to make your charitable contribution.

Donate to the MIT Community Service Fund, the United Way of Massachusetts Bay & Merrimack Valley, or your favorite local charity through payroll deduction, check, credit card or securities by Feb. 27, the official close of the campaign.

Every gift, modest or large, counts and is appreciated. Donate online at web.mit.edu/community-giving or request a donation packet from the Community Services Office (617-253-7914 or community-giving@mit.edu).

WIN AN IPHONE!

Don't forget, the first-ever Sustainability at MIT Photo Contest is going on through March 31, so there's still time to submit your photos. Show us what you see and what your aspirations are as MIT launches its greeningMIT campaign to help the Institute walk the talk on energy and the environment.

The grand-prize winner will receive an iPhone and have his or her winning entry published on the MIT home page and in MIT's official newspaper, Tech Talk. Prizes will also be awarded to the first- and second-place finishers.

For complete rules, including how to enter, please visit web.mit.edu/newsoffice/2009/photo-contest-rules.html.

Putting heads (and computers) together to solve global problems

Anne Trafton
News Office

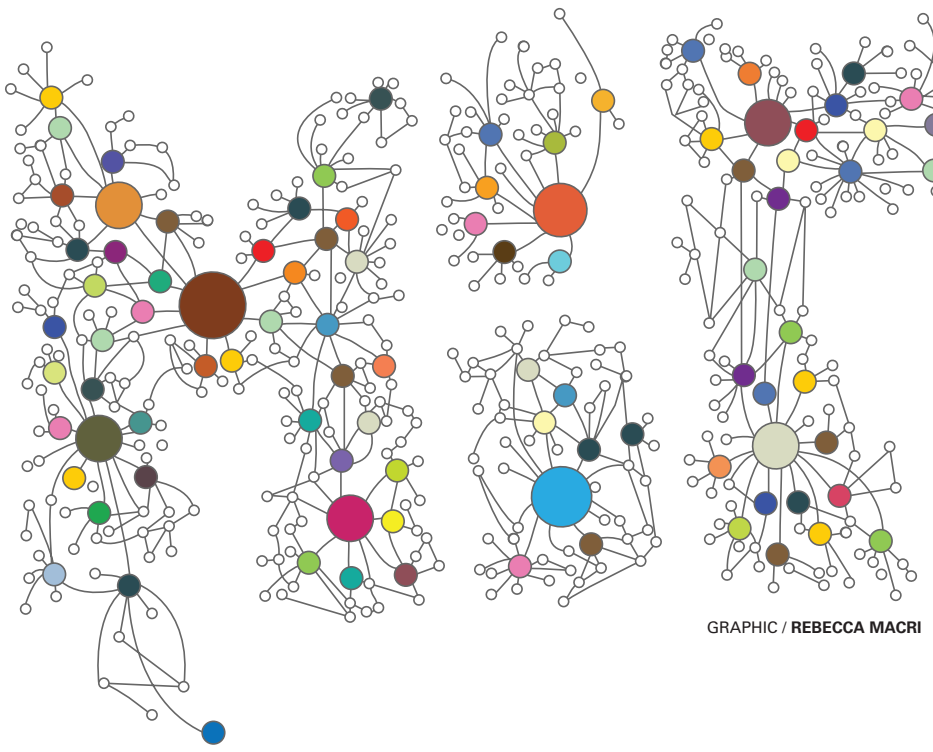
Imagine if the planet's collective brainpower and computing power could be brought together to tackle some of the world's toughest problems, including global climate change and cancer.

It may sound like science fiction, but researchers at MIT's Center for Collective Intelligence (CCI) are trying to make it reality.

Popular applications such as Wikipedia, Linux and YouTube already take advantage of collective intelligence — the harnessing of human knowledge and intelligence that allows groups of people to act together in ways that seem to be intelligent. But those applications only scratch the surface of what is possible with collective intelligence, says Thomas Malone, director of the CCI and professor at the MIT Sloan School of Management.

He envisions that pooled brainpower, enabled by computing advances, could allow doctors to make better cancer diagnoses and help experts and others brainstorm solutions to climate change.

The CCI's goal is nothing less than figuring out "how can people and computers be connected so that collectively they act more intelligently than any person, group or computer has ever done before," says Malone. "That's a kind of intelligence that's never existed on the planet before."



GRAPHIC / **REBECCA MACRI**

Beyond YouTube

One ambitious CCI project aims to tackle one of the most pressing and complicated issues now facing the world: global climate change.

"If ever a problem required the best intelligence from our whole species and all of our computer power, many people would say this is it," says Malone. "Certainly people are working on the problem in various ways, but so far the results leave a lot to be desired."

Global climate change involves so many variables — pollution, transportation, economics, etc. — that it's impossible for any one expert to have all of the solutions, or even understand all of the issues.

In one part of the Climate Collaboratorium project, led by Mark Klein, CCI principal research associate, the center is developing an online deliberation tool that allows experts in a wide range of fields to get together to share ideas.

Unlike existing online discussion forums, the Climate Collaboratorium requires users to catalog their contributions and connect them to points that have already been made. Such "argument maps" help eliminate the repetitive, unhelpful comments and tangents that render most online discussion forums unhelpful.

The researchers are also connecting their deliberation tool with computer-based climate models, so users' suggestions about different parts of the problem can be more easily combined and tested.

Klein, who initially developed online deliberation tools to help engineers share ideas about projects they're working on, believes such tools could one day prove useful in tackling other large, complex problems, such as poverty or terrorism.

"Because these are such big problems, it's essentially impossible for any one person or small group to be cognizant of all of the issues, ideas and trade-offs," Klein says.

The CCI has also proposed a project to consolidate patient data, clinical practices and medical research into a worldwide network. The network could use that information to precisely pinpoint the type of cancer and predict the treatment best suited to individual patients, depending on the tumor characteristics.

Wisdom of the crowds

CCI researchers are also exploring collective prediction, building on the success of popular Internet sites where people can buy and sell predictions about the outcome of elections, sporting events, etc. Such web sites, based on the collective wisdom of their users, have proven remarkably accurate, says Malone.

The MIT team plans to expand on that concept by bringing computers into the mix and programming them to make predictions, along with humans. This maximizes collective intelligence by taking advantage of the strengths of each group: Computers are good at predicting things based on historical data, and people are good at predicting how an unexpected event will throw things off.

In an early version of this system, the CCI is developing a model to predict what plays are most likely to be called next in a football game, depending on the game situation and the team's historical tendencies. The same approach may someday be useful for predicting the actions of a business competitor or a military enemy.

While developing these projects, the CCI is also taking a scientific look at ways to measure collective intelligence, similar to the way a psychologist measures an individual person's IQ. This research could allow them to figure out ways to improve intelligence, possibly by adding or subtracting members of the group, or using different processes.

"These early examples we're seeing around us today are not the end of the story," says Malone. "They're just the beginning."

Chronic infection may add to developing-world deaths

MIT study points to hidden threat stalking many diarrhea patients

David Chandler
News Office

Worldwide, nearly 2 million people per year die from diarrhea, the vast majority of them in poor countries in Africa and Asia. The disease accounts for 18 percent of all deaths among children — and yet is almost always preventable with proper treatment. Now, new research from MIT indicates that underlying, low-level undiagnosed infection may greatly add to the severity of a number of these cases. This realization could lead to changes in health-care strategies to address the problem.

The findings, reported by MIT Professor of Biological Engineering and Comparative Medicine David Schauer, show that these undiagnosed gastrointestinal infections increase the severity of and delay recovery from acute diarrhea, and the analysis provides a model that could allow public health officials to evaluate new preventive strategies or therapeutic treatments.

The work grew out of the increasing recognition of the relationship between persistent, chronic infections many people carry and the outcomes of later infection.

"It seemed likely that persistent enteric infection with bacterial agents would also elicit immune responses that could have similar effects. However, this had not been previously studied," Schauer says. "We wanted to provide proof of principle and begin to define the mechanism for such an interaction."

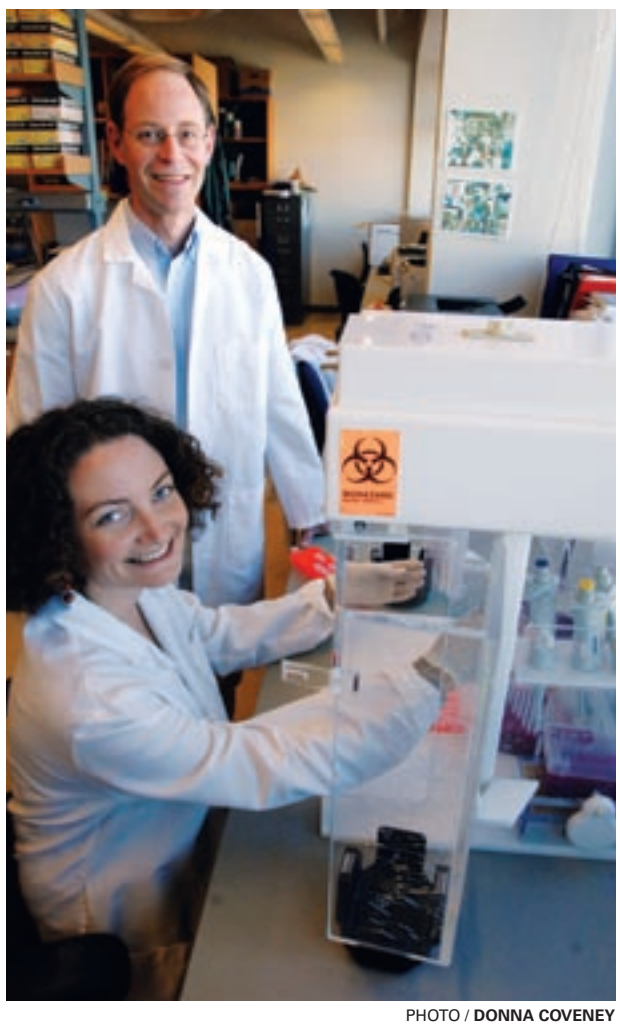


PHOTO / **DONNA COVENEY**

Professor of Biological Engineering and Comparative Medicine David Schauer and postdoctoral student Megan McBee do work on the effects of underlying infections on deaths caused by diarrhea.

To study the possible effects of these chronic infections, Schauer and his team used laboratory mice infected first with a strain of bacteria that causes a chronic condition but produces no symptoms, and then with a second infectious agent that causes acute diarrhea. They found that even though the underlying chronic infection did not cause disease on its own, it did make the acute infection much worse than in a control group that was only exposed to the second agent.

Schauer and his team say as far as they know this is the first time, for any kind of disease, that an underlying "subclinical" infection has been shown to make a later bacterial infection more severe. And in the case of diarrhea, this may play a significant role, since about 50 percent of the world population carries a chronic infection with Helicobacter pylori, which causes stomach-lining inflammation but usually no clinical symptoms, and which is closely related to the initial infectious agent used in the mouse experiments.

"It may be that an individual's infection status with these or other agents is important in determining outcome of infection, immune-mediated disease or even immunization," Schauer says.

The work may also be significant in terms of understanding the results of much clinical research using rodent models. Infections similar to the chronic H. pylori "are now known to be widespread in many rodent facilities, and infection with these Helicobacter species does not cause clinical disease, except in certain genetically engineered lines of mice," Schauer says, so "it is important to be aware of infection status with these agents when conducting research with laboratory rodents."

A report on the research was published last November in the journal Infection and Immunity, and was highlighted in December in Microbe magazine, both from the American Society for Microbiology. The work was carried out by Schauer and his students Megan E. McBee and Patricia Z. Zheng in the Department of Biological Engineering, and Arlin B. Rogers and James G. Fox in the Division of Comparative Medicine, all at MIT. The work was supported by a U.S. Public Health Service grant.

MICROBES: Using bacteria for energy

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help soak up pollutants such as carbon monoxide and carbon dioxide from the Earth's atmosphere.

'Chemical factories'

Found in nearly every habitat on Earth, bacteria are chemical powerhouses. Some synthesize compounds useful to humans, such as biofuels, plastics and drugs, while others break down atmospheric pollutants. Most rely on carbon compounds as an energy source, but species differ widely in their exact metabolic processes.

Metabolic engineers are learning to take advantage of those processes, and one area of intense focus is biofuel production. At MIT, Prather is developing bacteria that can manufacture fuels such as butanol and pentanol from agricultural byproducts, and Stephanopoulos is trying to make better microbial producers of biofuels by improving their tolerance to the toxicity of the feedstocks they ferment and products they make.

The recent spike in oil prices and growing greenhouse-gas emissions have catalyzed the push to find better pathways to produce biofuels and other chemicals such as bioplastics. "You see a visible boost when you have a crisis linked to energy problems," says Stephanopoulos.

Manufacturing plastics and textiles using bacteria can be far less energy intensive than traditional industrial processes, because most industrial chemical reactions require high temperatures and pressures (which require a great deal of energy to create). Bacteria, on the other hand, normally thrive at around 30 degrees Celsius and at atmospheric pressure.

Metabolic engineering involves not only creating new products but also developing more-efficient ways of making existing compounds. Recently, Prather's laboratory reported a new way to synthesize glucaric acid, a compound with multiple uses, ranging from the synthesis of nylons to water treatment, by combining genes from plants, yeast and bacteria.

Prather is also working on bacteria that transform glucose and other simple starting materials into compounds that can be used to make biodegradable plastics such as PHA (polyhydroxyalkanoate). In Stephanopoulos' laboratory, researchers are developing new ways to produce biodiesel, plus other compounds, including the amino acid tyrosine, a building block for drugs and food additives, biopolymers and hyaluronic acid, a natural joint lubricant that can be used to treat arthritis.

Both labs collaborate in a project to engineer the isoprenoid pathway in yeast and bacteria, which is responsible for the biosynthesis of many important pharmaceutical compounds. The two labs are investigating methods to make different compounds with higher activity as well as improving productivity.

Microbes express a huge range of metabolic pathways, offering great opportunities but also challenges. "Biology has a lot of diversity that's untapped and undiscovered, but the flip side is that it's hard to engineer in precise ways," says Prather. "Nature has evolved to do what it does, and to get it to do something different is a nontrivial task."

Bacterial clean-up crew

Drennan is also looking to bacteria, but with a different goal in mind. Instead of using bacteria to build things, she's studying how they break things down — specifically, carbon dioxide, carbon monoxide and other atmospheric pollutants.

Her microbes, found in a range of habitats including freshwater hot springs, absorb carbon dioxide and/or carbon monoxide and use them to produce energy. Such microbes remove an estimated one billion tons of carbon monoxide from Earth and its lower atmosphere every year.

"These bacteria are responsible for removing a lot of CO and CO_2 from the environment," says Drennan, who is a Howard Hughes Medical Institute investigator. "Can we use this chemistry to do the same thing?"

To answer that question, Drennan and her students are using X-ray crystallography to decipher the structures of the metal-protein enzymes involved in the reactions, which they believe will allow them to figure out how the enzymes work. That understanding could lead to development of catalysts to lower carbon monoxide levels.

"If you're going to borrow ideas from nature, the first step is to understand how nature works," she says.

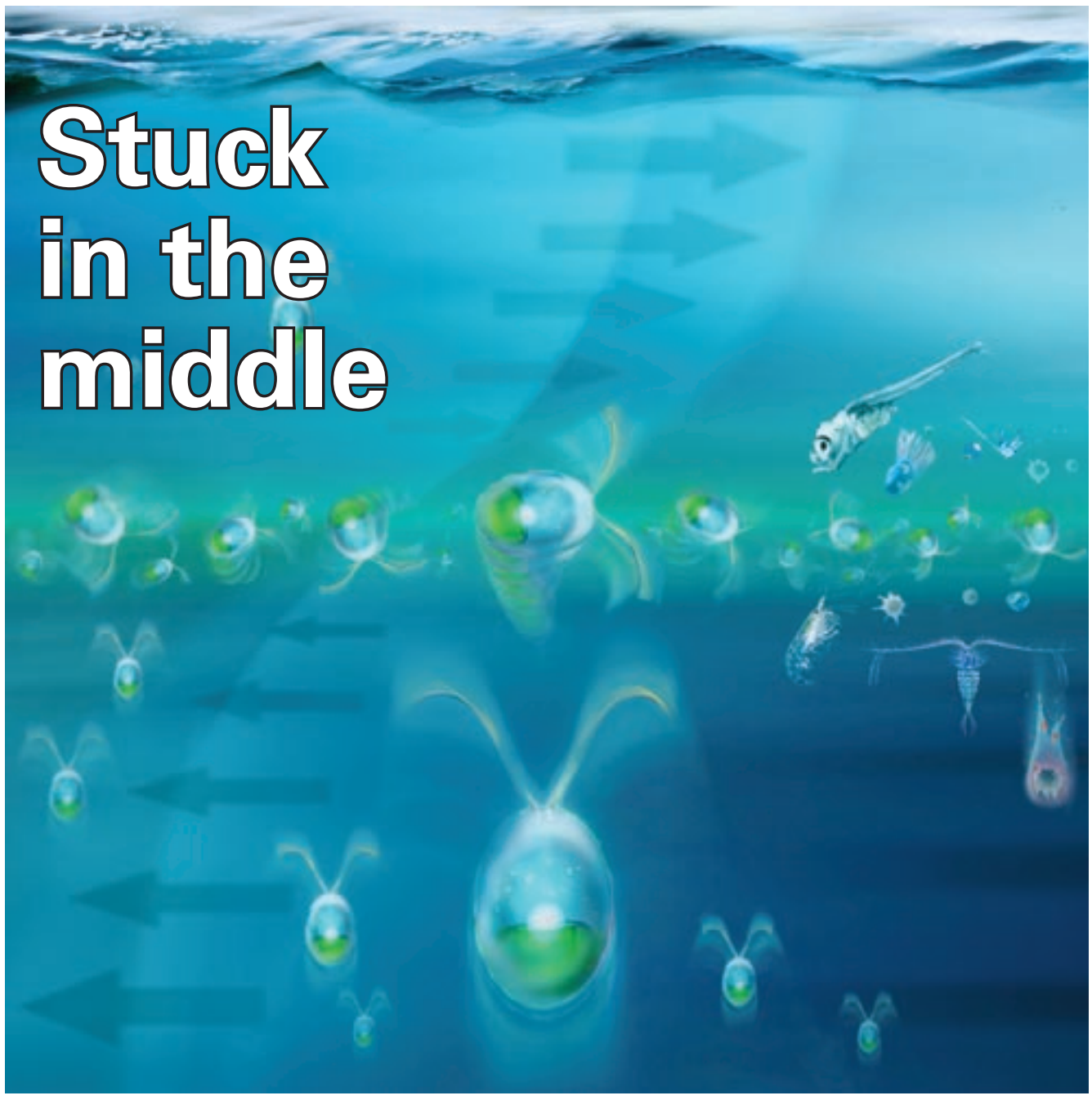

IMAGE / **GLYNN GORICK; WILLIAM DURHAM AND ROMAN STOCKER**

Researchers discovered that thin layers of phytoplankton form where strong variations in flow velocity cause the cells to overturn. These flow conditions form a watery trap: Phytoplankton can swim in but not out.

MIT research explains how thin layers of tiny organisms form at sea; work could help predict harmful algal blooms like red tide

Denise Brehm
Civil and Environmental Engineering

Not far beneath the ocean's surface, tiny phytoplankton swimming upward in a daily commute toward morning light sometimes encounter the watery equivalent of Rod Serling's Twilight Zone: a sharp variation in marine currents that traps billions of these single-celled organisms and sends them tumbling until a shift in wind or tide alters the currents and sets them free.

Scientists are aware of these thin layers of single-celled creatures and their enormous ecological ramifications, but until now, they knew little about the mechanisms responsible for their formation.

The explanation by researchers in MIT's Department of Civil and Environmental Engineering of how these common, startlingly dense layers of photosynthetic phytoplankton form, moves the scientific community a step closer to being able to predict harmful algal blooms, a well-known example of which is red tide. The work also opens new perspectives on other phenomena, like predatory feeding by larger organisms at these ecological hotspots.

"Phytoplankton are incredibly small. You would have to stack about 10 back to back to equal the width of a single human hair," said PhD student William Durham, co-author on a paper that appeared in the Feb. 20 issue of Science. "But despite their small size, they play an outsized role in the environment: they form the base of the marine food web and cumulatively produce half the world's oxygen. Many species can swim, but this fact is often neglected by researchers because phytoplankton are slow compared to ocean currents. However, we have shown that their motility can play a crucial role by concentrating them into dense assemblages, known as thin layers."

In the Science paper, Durham, Professor Roman Stocker and University of Arizona physics Professor John Kessler explain how adjacent layers of water moving at different speeds produce a "shear" flow that traps the phytoplankton as they swim into it. These layers form in the top 50 meters of the ocean and can be anywhere from a few centimeters to a couple of meters thick, span several kilometers horizontally and last hours, days or weeks.

"Our research pinpoints a mechanism for the formation of these thin layers of phytoplankton, which are analogous to watering holes in a savanna — localized areas of concentrated resources that draw a wide range of organisms and thus play a disproportionate role in the ecological landscape," said Stocker, the Doherty Assistant Professor of Ocean Utilization at MIT.

Because motile phytoplankton have different morphologies and swimming abilities, one species may be able to swim through a layer of shear that will capture another. This means that each species could be trapped in a different level of shear, creating a sort of oceanic layered-cake effect, a boon for zooplankton or young fish that feed on specific species.

And when a toxic species of phytoplankton gets trapped in a thin layer, that layer can spawn a harmful algal bloom — an explosion in the population of toxic phytoplankton that sickens or kills the larger animals that ingest the cells. Harmful algal blooms are a major source of social and economic concern, particularly near coastal areas, because they are becoming more frequent and cause billions of dollars in annual losses to fishing and recreational industries worldwide.

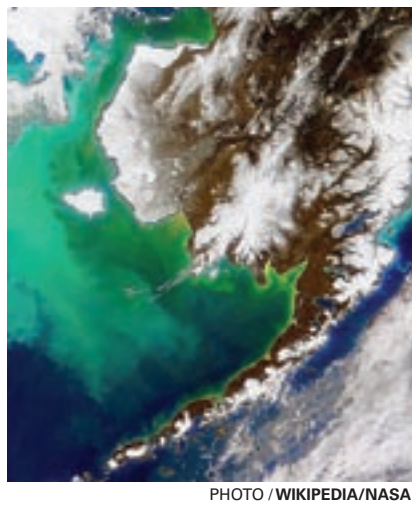

PHOTO / **WIKIPEDIA/NASA**

A satellite image showing a coccolithophore bloom in the Bering Sea.

In a perspective piece accompanying the paper in Science, scientist Daniel Grünbaum of the University of Washington writes: "The authors demonstrate a sort of Peter Principle for algae migrating in shear: cells swim up until they reach their level of instability. At this critical shear level, cells can swim in, but they cannot swim out. The resulting aggregation, in what is arguably an unfavorable microenvironment, may have widespread consequences, as harmful blooms of toxic algae often take the form of thin layers."

Using video-microscopy, Durham and Stocker were able to track the movements of individual cells as they become trapped in the layers of shear. They also modeled the movements of the swimming cells mathematically and proved that they cannot escape these layers. Once trapped, they're at the mercy of the flow and must wait for the shear to decrease before they can swim out and exit the Twilight Zone.

This research was supported by grants from the National Science Foundation and the MIT Earth Systems Initiative.

PHOTO / **DONNA COVENEY**

Senior Angie Chiang, foreground, and junior Taylor Williamson finish up a chemistry experiment — making 'Death by Chocolate' cookies — during Patricia Christie's 'Kitchen Chemistry' course.

Cooking up a new approach to chemistry

Anne Trafton
News Office

It's Tuesday afternoon, and the smell of chocolate wafts from a lounge kitchen through the hallways of MIT's Building 24.

Inside the sixth-floor kitchen, students are busy measuring flour, melting chocolate and beating eggs. But they're not just trying to satisfy a sweet tooth — they're doing science.

This is "Kitchen Chemistry," a course in which students learn principles of food chemistry through experiments involving chocolate chip cookies, hot sauce, chili, coffee and ice cream, among other tasty treats.

Patricia Christie, a lecturer in MIT's Experimental Study Group, has been teaching "Kitchen Chemistry" every spring since 2000.

"I'm a chemist who likes to cook," she says. "In this class, we apply chemical principles to food to get students to think about food in a different way."

Students learn why certain recipes call for baking soda and others require baking powder, and why chopping an onion makes you cry. And this is undoubtedly the only chemistry class at MIT in which the students get to eat their experiments.

> *The fun thing is they don't even realize they're learning about chemistry. But they're learning a lot.*
>
> **Patricia Christie**
> **lecturer, 'Kitchen Chemistry' instructor**

"That's the biggest perk," says junior Jenna Houston, a chemical engineering major.

"My roommate has already put in a request" for some of the "Death by Chocolate" cookies the class whipped up during a recent session, said Houston's baking partner, Sarah Cooper-Davis, a senior mechanical engineering major.

The course is limited to 18 students, and is so popular that it fills up within minutes of the opening of class registration. Another 30 students were waitlisted this year.

The class is part of the Experimental Study Group, an alternative academic program at MIT that offers small, hands-on seminars for all undergraduates, as well as a small group-learning program in the freshman core subjects.

In the case of the Kitchen Chemistry class, the hands-on approach gives students a chance to figure out culinary mysteries such as why you need to add vinegar to milk when baking scones (the batter needs an acid to combine with baking soda, a base, to produce carbon dioxide that causes the dough to rise).

"The fun thing is they don't even realize they're learning about chemistry," says Christie, "but they're learning a lot."

To see a video interview with Christie, and the baking in action, visit http://web.mit.edu/newsoffice/2009/kitchen-chemistry-0220.html.

News in brief

Library book sale Feb. 26

MIT Libraries' book sale will be held from 10 a.m.-3 p.m. on Feb. 26 in the Bush Room, 10-105.

The sale offers a selection of material including architecture, art, chemistry, children's books, engineering, fiction, history, linguistics, math, movies, music and physics. Proceeds will benefit the Libraries' Preservation Fund.

The sale is open to the MIT community only; dealers and their representatives by appointment only.

For more information, contact the MIT Libraries' Gifts Office at 617-253-5693 or gifts-lib@mit.edu.

'Mind-Body Month' offers self-care, stress relief tips

With economic issues constantly in the news and other seasonal stresses taking their toll, MIT's "Mind-Body Month" — being held now through March — aims to enhance community members' well being, health and relaxation.

"Stressful times require deliberate measures, and we'll present some of the most effective stress-reduction skills," said Susanna Barry, a program manager in MIT Medical's Center for Health Promotion and Wellness. "Participants will come away with concrete tools to manage their stress and tap into their natural relaxation response."

Some of the events currently scheduled as part of Mind-Body Month include meditation classes, sleep and mindful-eating workshops, chair massages, yoga and more.

Most workshops are free of charge, but some (including the chair massage) do require a fee. Workshops can be scheduled to be held in your area, at lunchtime or otherwise.

For more information on Mind-Body Month, visit http://medweb.mit.edu/about/news/article/mind-body-090126.html, or contact Susanna Barry at 617-253-1316 or bars@med.mit.edu.

The program is co-sponsored by MIT Medical, the Department of Physical Education, Athletics and Recreation (DAPER), the Board of Chaplains, Student Life Programs, the Student Activities Office and lgbt@MIT.

Big ideas

In unusual coincidence, MIT philosophers release eight books

Stephanie Schorow
News Office

It's unusual for philosophers to publish many books these days, which is why the publication of eight books by eight of the 12 MIT philosophy faculty in the span of a year marks a noteworthy chapter for the Institute's philosophy section.

"Philosophers, especially analytic philosophers, tend to publish articles rather than books," says Richard Holton, professor and head of the philosophy section in the Department of Linguistics and Philosophy. So, he says, it is very unusual to have so many philosophy books — both published and upcoming — from MIT at one time.

The themes of the eight books differ widely — ranging from the philosophy of Fellini to free will to the epistemology of pornography — but "they are all careful, analytic works," says Holton. "In that sense they are all very much MIT products, and they have all benefited from much discussion in the department here. They show how very diverse topics can benefit from what is recognizably the same approach. It is a feature of philosophy that, unlike most disciplines nowadays, we remain generalists."

Holton's own book, "Willing, Wanting, Waiting," will be published in July by the Oxford University Press. The other books by philosophy faculty are: "Our Knowledge of the Internal World," by Professor Robert Stalnaker (Oxford University Press, September 2008); "Normativity," by Professor Emerita Judith Jarvis Thomson (Open Court, December 2008); "Cinematic Mythmaking: Philosophy in Film," by Professor Irving Singer (MIT Press, September 2008); "Thoughts: Papers on Mind, Meaning, and Modality" by Professor Stephen Yablo (Oxford University Press, January 2009); "Sexual Solipsism: Philosophical Essays on Pornography and Objectification," by Professor Rae Langton (Oxford University Press, January 2009); "Disjunctivism: Contemporary Readings," by Professor Alex Byrne and graduate student Heather Logue (MIT Press, March 2009); "On Myself and Other Less Important Subjects," by Associate Professor Caspar Hare (Princeton University Press, September 2009).

Holton cautions against reading too much into the timing: "I wish there were some intriguing explanation, but I think it's basically coincidence."

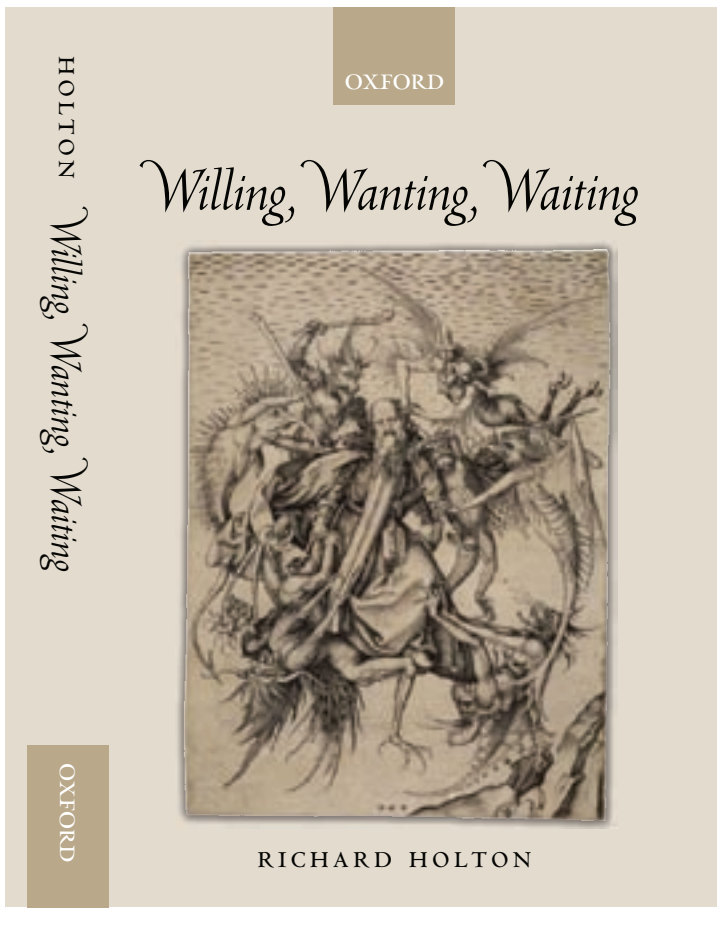

IMAGE COURTESY OF OXFORD PRESS AND RICHARD HOLTON

The cover of Richard Holton's book, 'Willing, Wanting, Waiting'

MISTI selects first winners of Global Seed Funds

A project to develop a networked underwater energy-harvesting robot and a study of stem cell-based engineered tissues are among the international faculty research collaborations that will receive nearly half a million dollars in funding as part of a new program by the MIT International Science and Technology Initiatives (MISTI).

Of the 104 proposals received for the inaugural 2008-2009 MISTI Global Seed Funds, 27 were awarded funding. Faculty and research scientists from 26 departments across the Institute submitted proposals for projects in 42 countries. All awardees include undergraduate, graduate or postdoctoral student participation.

Teams will collectively use the $457,400 in grant money to jump-start international research projects and collaboration with faculty and student counterparts abroad. Funds will be used to cover international travel, meeting and workshop costs to facilitate the projects. MISTI will provide cultural preparation for participating students before their departure.

The MISTI Global Seed Funds program was initiated through funding from the Office of the Provost to enhance the internationalization of MIT research and education.

"By enabling MIT students to participate in faculty-led international projects, we hope to increase opportunities for hands-on, global learning and connection to innovation around the world," said Richard Samuels, director of the Center for International Studies.

MISTI Global Seed Funds includes a general pool for projects in any location and several country-specific funds supported by outside donors.

MIT's largest international program, MISTI is a pioneer in applied international studies. Since 1994, the program has placed more than 3,000 MIT students in professional internships and research positions with its network of leading companies, universities, research institutes and NGOs around the world. MISTI currently operates in nine countries: China, France, Germany, India, Israel, Italy, Japan, Mexico and Spain. The program is a part of the Center for International Studies.

MISTI will launch the next MISTI Global Seed Funds call for proposals in May 2009, with a deadline in early fall.

Visit web.mit.edu/newsoffice/2009/misti-seedfund-0224.html for a complete list of the seed fund winners.

WELLING: Alternative-energy enthusiast wins Gates scholarship

Continued from **Page 1**

will now pursue a doctorate in mechanical engineering at Cambridge as one of 100 Gates Cambridge Scholarship recipients (out of more than 700 applicants).

In addition to his studies and work on alternative energy, Welling is a teacher. He has participated in MIT's CETI (China Educational Technology Initiative), teaching mechanical engineering in English through the hands-on bicycle design work. As a lab assistant for the Department of Mechanical Engineering, Welling has taught basic machining and assembly techniques as well as Matlab and Solidworks.

MIT students have won 15 of the prestigious Gates scholarships since the program was established in 2000 by the Bill & Melinda Gates Foundation. The scholarships cover tuition, room, board, travel and stipend for study at Cambridge.

South African activist photographer visiting MIT through March 10

Zanele Muholi, an award-winning South African photographer and video artist, will be on the MIT campus through March 10 as the 2009 Ida Ely Rubin Artist-in-Residence.

Muholi, who is known for her evocative portraits of black lesbians and transgender people in South African townships, will present a public program today, teach a hands-on photography workshop, and meet with students and faculty.

Muholi says of her work, "My aim is not to make nice pictures but to crack open the issues." She received the 2005 Tollman Award for the Visual Arts, which led to her photography exhibit and book, "Only Half the Picture." Her film, "Enraged by a Picture," which was screened at the Out in Africa gay and lesbian film festival in 2005, documents responses to her photography.

Muholi will present a program titled "Is'khathi" (which roughly translates from the Zulu as "period in time" or "time of the month") at 7 p.m., today, in the Broad Institute auditorium. It is free and open to public.

Muholi will explore the idea of creating community through visual imagery in a photography workshop on two consecutive Fridays, Feb. 27 and March 6, from 6:30 to 9 p.m. Cost is $20 for students, $40 for MIT affiliates. Register through the Student Art Association web site at saa.mit.edu/classes.

GREEN: MIT buildings utilizing green technology

Continued from **Page 1**

for more than a third of our national energy consumption, says Glicksman, that is a significant number.

Early adopter

In 2001, MIT's Green Building Task Force set Institute-wide goals and standards aimed at conserving energy and reducing greenhouse-gas emissions. "MIT was an early adopter of a green building policy and goals, and our expertise has evolved and strengthened over time," says Steven M. Lanou, deputy director for environmental sustainability and a member of the Campus Energy Task Force. "Our newest buildings — the MIT Sloan School of Management, NW35 [the new Ashdown House], and the David H. Koch Institute for Integrative Cancer Research — are expected to be the greenest to date."

For the new Koch building, Walter E. Henry, director of Facilities' Systems Engineering Group, and others modeled and tested airflow in laboratory fume hoods, which suck out noxious chemical fumes, to determine whether a drop in the velocity of the air entering the hoods would maintain their effectiveness. They found that a 20 percent reduction would keep the fume hoods safe while drastically reducing energy use.

Another significant marker of change is MIT's commitment to hold new construction and renovation up to scrutiny by the USGBC's Leadership in Energy and Environmental Design (LEED®) Green Building Rating System. LEED certifications of platinum, gold and silver aim to encourage and accelerate global adoption of sustainable green building. All new construction and major renovations undertaken by MIT since 2001 have or are expected to meet or exceed the LEED silver standard, Lanou says.

The MIT Sloan project is unlike any building project at MIT. From the start, a high level of green design was set as a goal; and in order to achieve that goal, the team adopted a version of the integrated design process, according to Henry. In the typical design process, work is linear, so that the different disciplines work one after the other. The integrated process includes all of the architects and engineers from the beginning so they can more effectively work as a team. From this new process, the designers for the MIT Sloan project were able to develop what will probably be the greenest building at MIT.

The design team of the Koch Institute, under construction on Main Street, also incorporated aspects of integrated design. In addition to the low-flow fume hoods, the building will filter its stormwater en route to the Charles River, use reflective roof material, recover heat in the HVAC system, and recycle or salvage at least 75 percent of construction waste.

Among the features of NW35, the new graduate student housing at Pacific and Albany streets, are a stormwater management system, use of recycled materials, a reflective roof with provisions for future solar panels, and low-VOC paints and adhesives. MIT Sloan, the Koch Institute and the graduate dorm are expected to receive gold or silver LEED designations.

"As an institute built around innovation," says Lanou, "MIT has an obligation to demand and uphold the highest standards in environmentally friendly infrastructure."

Economist Robert C. Merton to receive Muh Award

Robert C. Merton, a Nobel Prize-winning economist whose work revolutionized financial markets and helped launch the growth of the risk-management industry, will receive the 2009 Robert A. Muh Alumni Award presented by the School of Humanities, Arts, and Social Sciences.

The award, given every two years, honors an MIT graduate for noteworthy achievements in the humanities, arts or social sciences. The ceremonies include a public lecture by the recipient.

"The Muh Award is a singular opportunity for us to recognize MIT graduates who have made extraordinary contributions, and whose life work calls on deep knowledge in the disciplines of our School," said Deborah Fitzgerald, the Kenan Sahin Dean of the School of Humanities, Arts, and Social Sciences. "We are delighted to present Bob Merton with this year's award."

Robert C. Merton

Currently the John and Natty McArthur University Professor at the Harvard Business School, Merton received a PhD in economics from MIT in 1970. Along with MIT faculty members Fischer Black and Myron Scholes, he developed the conceptual foundation for determining prices for stock options and other complex securities. With Scholes, Merton won the Nobel Prize in Economic Sciences in 1997 for this work. Merton also made path-breaking contributions to the theory of portfolio selection and consumer behavior that have provided a starting point for voluminous economic research on financial markets.

Merton has applied his theoretical insights about securities markets in practical settings. He was a founding principal of Long Term Capital Management, and is currently the developer of SmartNest, a pension management system that addresses deficiencies associated with traditional defined-benefit and defined-contribution plans.

Merton will present the 2009 Muh Award lecture, titled "Observations on the Science of Finance in the Practice of Finance," at 5 p.m. on March 5 in the Wong Auditorium, Building E51-115, 2 Amherst St. The event is free and open to the public.

The Robert A. Muh Alumni Award was first announced in October 2000 at the 50th anniversary celebration of the School of Humanities, Arts, and Social Sciences (SHASS).

Muh '59, a life member of the MIT Corporation and past chair of the Humanities Visiting Committee, endowed the award to honor an MIT graduate who has made significant contributions to education, scholarship or performance, academic administration or arts management in the humanities, arts or social sciences. The award rotates among the three major areas in SHASS.

An interview with Merton appeared in Technology Review in April 2008. www.technologyreview.com/business/20501/.

CLASSIFIED ADS

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

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Typist wanted to help finish book in mathematical physics. Knowledge of LaTeX required. 100 handwritten pages left to type! Rate of pay is negotiable. Please contact N. Prakash at 617-492-8797.

MIT in the world

SPIN CYCLE

a new kind of washer

PHOTOS / **GWYNDAF JONES**

Children try out the bicilavadora at an orphanage in Ventanilla, Peru.

David Chandler
News Office

In many developing countries, electricity is unreliable or unavailable and water must be carried by hand, so conventional modern washing machines are not an option. Washing clothes can take up a significant amount of time, and doing laundry in open streams or lakes can add to water pollution, so the availability of a human-powered washing machine could make a big difference to the quality of life.

A pedal-powered washing machine that MIT students and staff built mostly from bicycle parts and empty barrels could solve many of these problems, and at the same time could be built locally and thereby create jobs.

Under development for almost four years, the new machine — dubbed "bicilavadora," combining the Spanish words for bicycle and washing machine — got its most rigorous workout last month when a team of MIT students took the latest prototype to an orphanage in the slums called Ventanilla outside Lima, Peru. With 670 resident children, the home generates enough laundry to keep the washer perpetually busy.

"The orphanage was like an oasis in the slums of Ventanilla," says Lisa Tacoronte, a junior in mechanical engineering who worked on the project. As the MIT team worked to set up the machine, "many of the children would watch us work, ask us questions at the same time or try to help us by holding things, or handing us tools while we built it."

The machine was designed to be easy and inexpensive to manufacture, mostly using parts and tools that are readily available almost everywhere in the developing world.

An earlier version of the washing machine, developed by mechanical engineering graduate student Radu Raduta, won first prize in the MIT IDEAS competition in 2005. That resulted in some funding for further development, which led Raduta to improve the design of the machine's inner drum so that it could be more easily manufactured and transported.

The machine's outer housing is made from a standard oil drum cut apart and welded back together to make a much shorter barrel, because "a full 55-gallon barrel is more laundry than any human can pedal," explains Gwyndaf Jones, a D-Lab instructor who worked on the earlier version and who led this year's Peru field trip. The inner, rotating drum is made from a set of identical plastic pieces bolted together, which can be taken apart and stored flat for easy transportation. That was the key part of Raduta's design.

"The hardest part to build is the inner drum," Raduta explains, "because it's submerged in water, and full of clothing that can have metal buttons, which abrades the inner walls. It has to be stiff enough to keep its shape, but if it's bare steel it will rust, and paint will peel off." The key part of his thesis research was figuring out how to make the drum strong enough, cheap enough and easy and inexpensive to ship. His latest version is made from molded plastic panels, and when disassembled it is compact enough to fit in a suitcase — which is how the students took it to Peru for the January trip.

The "motor" of the machine consists of a bicycle frame, minus its wheels, with the chain running forward to a gear at the end of the washer drum's shaft. "It uses a standard mountain bike gear range," Jones says. "The highest gear is the spin cycle, and the lowest gear is the wash cycle."

The test was not a total success: Some water leaked around the edges of the barrel, which could cause rust, and very inexpensive bearings used for the shaft were too stiff. But the basic design was well proven out, and with a few small changes an updated version should be able to handle the intensive workload. Further tests will be carried out this spring by other students.

While crucial pieces such as the inner drum segments were brought from MIT, others, including the outer drum and its supporting structure, were built on-site. "We improvised for whatever we didn't have and often learned how from locals like Wilbur and Gennard," two of the older orphanage residents, Tacoronte says. "For example, we were unable to cut the two sides for the door on the outer drum that were parallel to the curved surface. Wilbur took up a chisel and went at it with a hammer. The door was done in seconds."

She found the experience very inspiring. "The more time I spent there and the more amazing people I met, the more passionate and determined I became about finishing the lavadora and making sure it worked," she says. After the first test run, with the high-gear spin cycle successfully eliminating most of the water from the drum, she says, "The moment they pulled out the merely damp sheets was exhilarating."

In The World is a series that explores how people from MIT are using technology — from the appropriately simple to the cutting-edge — to help meet the needs of local populations around the planet. If you know of a good example and would like the News Office to write about it, please e-mail dlc1@mit.edu.

See video of the bicilavadora in action in Peru at:
web.mit.edu/newsoffice