MIT CEHS Center for Environmental Health Sciences

NEWSLETTER

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Spring 2016

A Healthy Breakdown

Researchers discover how some organisms process oxalate, a molecule that can harm humans.

Article by Peter Dizikes, MIT News Office

A wide variety of fruits and vegetables contain oxalate. But humans and most other animals lack the ability to metabolize this molecule — that is, to break it down while digesting it. And so for some people, a buildup of oxalate is associated with kidney stones, arthritis, and even kidney failure.

Researchers have discovered how some organisms can safely process oxalate, which is found in many fruits and vegetables. This discovery could lead to new ways to lessen the harmful effects that can occur when oxalate builds up in humans, who cannot metabolize this molecule.

At the same time, some plants, fungi, and bacteria are able to break down oxalate. Now MIT scientists, in collaboration with colleagues at the University of Michigan, have identified a previously unknown mechanism through which this process occurs, a discovery that could help researchers drive toward new ways of lessening oxalate's harmful effects on humans.

The team used X-ray crystallography to identify precisely how a recently-discovered enzyme, thiamine pyrophosphate-dependent oxalate oxidoreductase (OOR), metabolizes oxalate using a "bait-and-switch" mechanism to break apart the troublesome molecule.

"This is unprecedented chemistry, what this enzyme does," says Catherine Drennan, a professor of biology and chemistry at MIT, whose lab team made the discovery. "This particular enzyme just takes it [oxalate] and splits it. It's always fantastic when the structure shows you the answer and it's something you never guessed."

"Simple, elegant, beautiful"

The findings are detailed in a newly published paper, "One-carbon chemistry of oxalate oxidoreductase captured by X-ray crystallography," appearing today in *Proceedings of the National Academy of Sciences*. Drennan is the corresponding author of the paper.

The molecule oxalate has two carbon atoms and four oxygen atoms. The carbons are connected to each other, and

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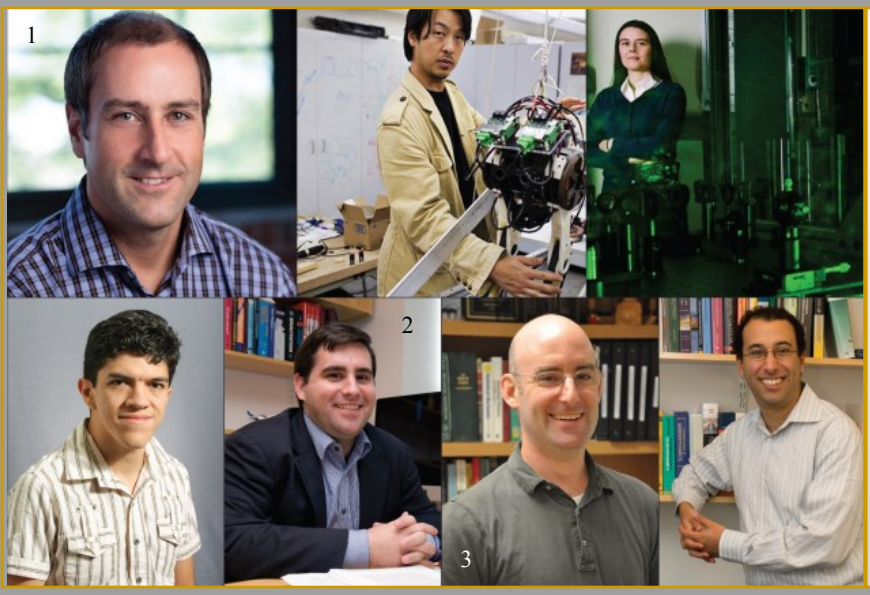
In This Issue

Upcoming Events

Robert Harris-Lecture
to be held on December 1, 2016

Gerald Wogan Lecture
to be held on November 17, 2016

HONORS AND AWARDS



Congratulations to Center Members who have been granted tenure!

Mark Bathe (1), **Steven Barrett** (2), **Jesse Kroll** (3), and **Elizabeth Nolan** (4).

http://news.mit.edu/2016/tenured-engineers-0510

http://chemistry.mit.edu/nolan-promoted-associate-professor-tenure

Congratulations to Professor **Timothy Swager** who received the 2016 Esselen Award. This award, which annually recognizes a chemist "whose scientific and technical work has contributed to the public well-being", is one of the most prestigious honors provided by the Northeastern Section of the American Chemical Society.

http://chemistry.mit.edu/swager-named-recipient-2016-esselen-award

Congratulations to Professor **Michael Yaffe** who received a Bronze Star Medal for heroic and meritorious achievement of service in a combat zone. A true hero at the bench, on the field, and at the hospital (performing surgery).

http://www.bidmc.org/Centers-and-Departments/Departments/Surgery/Surgery-News/2016/April-2016/Surgeon-Receives-Bronze-Star.aspx

Congratulations to Professor **Katharina Ribbeck** who was awarded the 2015-2016 Harold E. Edgerton Faculty Achievement Award. The award was established in 1982 as a tribute to Institute Professor Emeritus Harold E. Edgerton, for his active support for younger, untenured faculty members. Each year, a faculty committee presents the award to one or more junior members of the faculty, in recognition of exceptional distinctions in teaching, research, and scholarship.

http://news.mit.edu/2016/ribbeck-thale-edgerton-award-0420

NOTEWORTHY

Cell phones *do* cause cancer, at least in rats

In an unprecedented move, the NIEHS sent out a blast email to hundreds of stakeholders announcing the results of a cell phone study showing a link to brain cancer. Prior to this study, there have been extensive studies focused on possible deleterious effects of cell phones. Relevant epidemiological studies have not conclusively shown an effect of cell phone use on cancer. However, these human population studies have confounding factors, such as inaccurate records for cell phone usage and lifestyle factors (e.g. smoking, drinking, etc.). Turning to animal studies, the National Toxicology Program (NTP), under the NIEHS, has conducted the largest animal study of its kind at the NTP (the largest cell phone study with animals, ever). This study has shown that rats exposed to cell phone radiation had a low yet detectable increase in cancer. Specifically, they observed tumors in the brains of male rats (but not female rats). They also observed schwannomas of the heart. The results of the NTP study have already been sent to relevant regulatory agencies, with possible far reaching consequences. Remember to use your headset! - Bevin Engelward, CEHS Deputy Director

The NTP is providing the findings to the public. A report has been posted at http://biorxiv.org/content/early/2016/05/26/055699. The report is titled, "Report of Partial Findings From the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Hsd: Sprague Dawley SD Rats (Whole Body Exposure)."

New Frontiers: Postdoctoral Transition Seminar

Postdocs: Need help preparing for your job interviews?

We can help! Sign up for the New Frontiers: Postdoctoral Transition Seminar

Recognizing the importance of having a great seminar for job interviews, this series is specifically aimed at providing postdocs with the opportunity to give and get feedback on their job talk. Talks are advertised to the entire CEHS community and are attended by senior faculty who ask questions that help in preparation for interviews. Subsequently, the speaker is invited to lunch with CEHS faculty who provide constructive feedback and advice on the interview process. This format provides valuable feedback for postdocs enabling them to hone their slides in preparation for a competitive job market.

For more information and for online sign up, please see: https://cehs.mit.edu/career-development/postdoctoral-seminars. Please contact Kate Dupont (kbdupont@mit.edu) if you have additional questions about the program.

CEHS 2016 Poster Session Winners

The Center for Environmental Health Sciences (CEHS) at MIT held its annual poster session on May 4 in the Walker Memorial Building. The session highlighted the work of the environmental health research communities of MIT and some peer institutions. Approximately 50 posters were presented from the science and engineering laboratories affiliated with CEHS.

The CEHS has an overall mission to study the biological effects of exposure to environmental agents in order to understand and predict how such exposures affect human health. Moreover, by uncovering the chemical, biochemical, and genetic bases for environmental disease, sometimes researchers are able to leverage that understanding to delay or even prevent the development of disease in human populations. To that end, the center brings together 39 MIT faculty members from a total of nine MIT departments in both the School of Science and the School of Engineering, plus one Harvard University faculty member from the Harvard School of Public Health.

This year's CEHS cash prizes were awarded in two categories, graduate students and postdocs. For each category, the prize for first-place was $1,000; second-place was $500, and third-place was $200 plus CEHS memorabilia. The cash prizes were made possible by the Myriam Marcelle Znaty Research Fund, which was established over 30 years ago to support the research of young scientists at MIT.

Graduate students, postdocs, and research staff presented the results of their research at MIT's Morss Hall.

Anthony R. Soltis from Professor Ernest Fraenkel's lab won first place in the graduate student category. Soltis presented his work on the "Multi-Omic Data Collection and Integrative Modeling of High-Fat Diet-Induced Obesity Reveals Features of Hepatic Insulin Resistance." In second place was Joseph M. Azzarelli and Rong Zhu from Professor Timothy Swager's lab, who presented their work on "Wireless Hazard Badges for Organophosphate Acetylcholinesterase Inhibitors." Finally, in third place was Chen Gu, from Professor Peter Dedon's lab, presenting his work on "Phosphorylation of Human TRM9L Modulates its Functions in Oxidative Stress Management and Tumor Growth Suppression."

In the postdoc category, first place went to Collin Edington and Xin Wang from professors Linda Griffith and Steven R. Tannenbaum labs (respectively), presenting on "Construction and Evaluation of the In Vitro Central Nervous System Models." Second place went to Renan Escalante-Chong, from Professor Ernest Fraenkel's lab, who presented his work on "Integrative Approaches for Cell Signature Generation in ALS Patients at NeuroLINCS." And Nikolaos Tsamandouras, from Professor Linda Griffith's lab, took third place after presenting his work on "Assessment of Population Variability in Hepatic Drug Metabolism Using a Perfused 3-D human Liver Bioreactor Along with Modeling and Simulation Techniques."

http://news.mit.edu/2016/understanding-exposure-to-environmental-agents-cehs-poster-winners-0517

There's Something in the Air

Professor Colette Heald studies atmospheric gases and particles, and how they affect air quality and climate.

Article by David L. Chandler, MIT News Office

Winds that blow across the Sahara desert in North Africa pick up particles of soil and sand, and typically carry them westward. Many of these grains travel across the Atlantic, leading to poor-visibility days in the southern U.S. and Caribbean, transporting nutrients to far-flung ecosystems in South America, and impacting hurricane formation in the Atlantic.

That's just one example of the myriad ways that the behavior of tiny particles blown by the wind can have large-scale local, regional, and even global effects on the complex systems that govern Earth's atmosphere. For Colette Heald, trying to unravel the intricate patterns of the atmosphere's composition and chemistry, and the way these affect ecosystems, air quality, and even the climate itself, has been the driving force of her career.

Heald, who earned tenure at MIT last year, is the Mitsui Career Development Associate Professor in the Department of Civil and Environmental Engineering and also holds an appointment in the Department of Earth, Atmospheric and Planetary Sciences. Originally from Canada, she was born in Montreal and grew up in Ottawa, where her father was a paper industry executive and her mother a nurse. An older sister, who still lives in Canada, is an aerospace engineer.

Heald earned her BS in engineering physics at Queen's University in Kingston, Ontario, and while there started doing summer research projects with faculty members at the University of Toronto. That's when she got introduced to the field of atmospheric science. "I was so excited," she says, to discover the deep connections between the kind of technical engineering research she had studied and the global environment. That led her to pursue a doctorate in atmospheric chemistry at Harvard University.

Coming from all directions

"That seemed like a flip from physics," she recalls, "and I was concerned that I didn't have the chemistry background for it." But she soon discovered that the field "is so interdisciplinary; people come from a variety of directions" and bring different perspectives to the research.

Colette Heald describes her current work as "trying to understand the sources, transformation, and impact of gases and particles in the atmosphere, which is very dynamic with a lot of chemical compounds that interact." ***Photo***: Bryce Vickmark

She immediately became fascinated by the use of satellite data to study the atmosphere and its interactions. The timing was good: The first satellites measuring atmospheric pollution had been launched just a few years earlier.

One of the things measured by satellites was the concentration of carbon monoxide in the air. That compound "is produced from all kinds of combustion processes, and it's a nice indicator because it stays in the atmosphere for about a month," she says, "so we can use it to investigate the transport of plumes from sources to continents down-wind."

Heald describes her current work as "trying to understand the sources, transformation, and impact of gases and particles in the atmosphere,

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which is very dynamic with a lot of chemical compounds that interact." In a sense, she says, her focus is on figuring out what's missing — where the holes are in models of the atmosphere, and how to fill those gaps. "I take an endpoint perspective," she says. "I integrate the knowledge we have, and look for new ways to analyze the data to see what's missing in our models."

The effects are often subtle and hard to tease out from the chaotic mix of atmospheric processes. For example, in summer months the plumes of dust that constantly waft away from the Sahara desert end up in the North Atlantic and can make landfall in the United States and contribute to poor air quality in Florida. In the winter months winds blow the dust, which bears a complex load of assorted minerals, across to South America.

Trans-Atlantic fertilizer

One of those minerals is phosphorus, which happens to be a key limiting element for the growth of plants in the Amazon basin — so those African breezes are actually contributing to the Amazon's fertility. That's the kind of complex interaction, she explains, that would never be derived solely from theoretical modeling or experimental observation but requires the integration of different disciplines and approaches. "That gives you a sense of the challenge," she says.

"There needs to be a strong coupling between observational work and modeling," Heald says, "and these are models that take decades of development and a large community of scientists." Much of her research focuses on aerosols, particles of matter so small that they virtually defy gravity and can stay aloft for weeks. Another major area of her research is the complex interaction between the atmosphere and the biosphere.

One thing that makes the modeling difficult is that many of the important processes in atmospheric chemistry involve transport across ocean basins, and "there are not a lot of observations available" over vast stretches of ocean. For example, for dust "we have long-term records in Barbados and in Florida, but we have to connect the dots" to extrapolate to the missing areas. Satellite data are helping to fill in the blanks, but careful calibration is required to make sure these measurements dovetail with the ground-based records.

Heald's modeling work has showed, for example, that in recent decades winds have been slowing over Africa, and that could reduce the flow of those aerosols to the Americas. Since those particles have an overall cooling effect, by radiating back incoming sunlight, their reduction leads to an overall warming, she explains.

Heald says she has always been interested in many different subjects and had a hard time initially in college deciding what she wanted to major in, even considering art history. "My sister told me, you'll always be able to experience art and literature, but it's hard to pursue science and engineering as a hobby!"

While acknowledging that many women have experienced discrimination in their scientific education and careers, "I feel very fortunate," Heald says, about the support and encouragement she received throughout her education and early career. "I was never discouraged, always only encouraged. I never felt that any doors were closed to me."

The community of atmospheric chemists, she says, "is very collegial, and I'm grateful for the smooth path I've had and the friendly collaborations I've developed along the way. I know not all fields are like that, so when I have a chance to help or give back, I try to get involved."

http://news.mit.edu/2016/faculty-profile-colette-heald-0428

Global Reductions in Mercury Emissions Should Lead to Billions in Economic Benefits for U.S.

Benefits from international regulations may double those of domestic policy.

Article by Jennifer Chu, MIT News Office

Mercury pollution is a global problem with local consequences: Emissions from coal-fired power plants and other sources travel around the world through the atmosphere, eventually settling in oceans and waterways, where the pollutant gradually accumulates in fish. Consumption of mercury-contaminated seafood leads to increased risk for cardiovascular disease and cognitive impairments.

In the past several years, a global treaty and a domestic policy have been put in place to curb mercury emissions. But how will such policies directly benefit the U.S.?

In a new study published this week, MIT researchers report that global action on reducing mercury emissions will lead to twice the economic benefits for the U.S., compared to domestic action, by 2050.

In a new study published this week in the *Proceedings of the National Academy of Sciences*, MIT researchers report that global action on reducing mercury emissions will lead to twice the economic benefits for the U.S., compared with domestic action, by 2050. However, those in the U.S. who consume locally caught freshwater fish, rather than seafood from the global market, will benefit more from domestic rather than international mercury regulations.

The researchers calculated the projected U.S. economic benefits from the Minamata Convention on Mercury, a global treaty adopted in 2013 to reduce mercury emissions worldwide, compared with the Mercury and Air Toxics Standards (MATS), a national regulation set by the U.S. Environmental Protection Agency to reduce mercury pollution from the country's coal-fired power plants.

Overall, while both policies are projected to lead to roughly the same amount of reductions in mercury deposited on U.S. soil compared to a no-policy case, Americans' consumption of mercury by 2050 are estimated to be 91 percent lower under the global treaty, compared to 32 percent under U.S. policy alone. The researchers say these numbers reflect the U.S. commercial fish market, 90 percent of which is sourced from Pacific and Atlantic Ocean basins — regions that are heavily influenced by emissions from non-U.S. sources, including China.

From their projections of reduced mercury consumption, the researchers estimated health impacts to the U.S. population under both policies, then translated these impacts into economic benefits. They characterized these in two ways: projected lifetime benefits from an individual's reduced exposure to mercury, including willingness to pay for lowering the risk of a fatal heart attack, cost savings from avoided medical care, and increased earnings; and economy-wide benefits, or the associated productivity gains of a national labor force with improved IQ and fewer heart attacks, as a result of reduced exposure to mercury.

Based on these calculations, the team estimated that by 2050, emissions reductions under the Minamata Convention on Mercury would lead to $339 billion in lifetime benefits and $104 billion in economy-wide benefits in the U.S., compared to $147 billion and $43 billion, respectively, from MATS. The global treaty, then, should lead to more than twice the benefits projected from the domestic policy.

"Historically it's been hard to quantify benefits for

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global treaties," says Noelle Selin, the Esther and Harold E. Edgerton Career Development Associate Professor in MIT's Institute for Data, Systems and Society and in the Department of Earth, Atmospheric, and Planetary Sciences. "Would we be able to see a U.S. benefit, given you're spreading reductions and benefits around the world? And we were."

Tracing the policy-to-impacts pathway

Determining how regulatory policies will ultimately lead to health and economic benefits is a complex and convoluted problem. To trace the pathway from policy to impacts, Selin and co-author Amanda Giang, a graduate student in MIT's Institute for Data, Systems, and Society, began with estimates of mercury reductions set by both the Minamata Convention and MATS.

The team then used an atmospheric transport model to trace where emissions would settle over time, based on the reductions proposed by each policy scenario. From regional depositions of mercury, they then estimated the resulting mercury concentrations in fish and mapped these concentrations to seafood sources throughout the world.

Next, the team correlated seafood sources to fish consumption in the U.S., and calculated changes in human exposure to mercury through time. They used epidemiological models to estimate how changes in mercury exposure affect incidence of health impacts, such as heart attacks and IQ deficits. From there, Selin and Giang used economic valuation methods to translate heath impacts into economic benefits — namely, lifetime and economy-wide benefits to the U.S.

Understanding the drivers

While the researchers were able to come up with benefits in the billions for both the global and domestic policies, they acknowledge that these numbers come with a significant amount of uncertainty, which they also explored.

"We're trying to understand different drivers in the variability of these numbers," Giang says. "There's a lot of uncertainty in this system, and we want to understand what shifts these numbers up and down."

For example, scientists are unsure how far different forms of mercury will travel through the atmosphere, as well as how long it will take for mercury to accumulate in fish. In their analysis, Giang found that, even taking into account most of these uncertainties, the economic benefits from the global treaty outweighed those from the domestic policy, except when it came to one key uncertainty: where people's seafood originates.

"We do find that in our scenario where everyone is eating local fish, the benefits of domestic policy are going to be larger than the Minamata convention," Giang says. "Our study points to the importance of domestic policy in terms of protecting vulnerable populations such as subsistence fishers or other communities that do rely on U.S. freshwater fish."

"There are a ton of uncertainties here, but we know that mercury is a dangerous pollutant," Selin adds. "When you put in a policy, how do you think about its ultimate environmental and human effects? We think this method is really a way to try and move that forward."

"This is a terrific and very comprehensive study from a great research group," says Charles Driscoll, professor of Environmental Systems at Syracuse University. "The study is timely because of challenges to the domestic Mercury and Air Toxics Standard through a Supreme Court ruling. This analysis of benefits builds considerably on the analysis of benefits conducted by the EPA when they established MATS. I think this is an important study and hopefully it will have considerable impact."

This research was funded, in part, by the National Science Foundation.

http://news.mit.edu/2015/reductions-mercury-billions-economic-benefits-1228

MIT CEHS

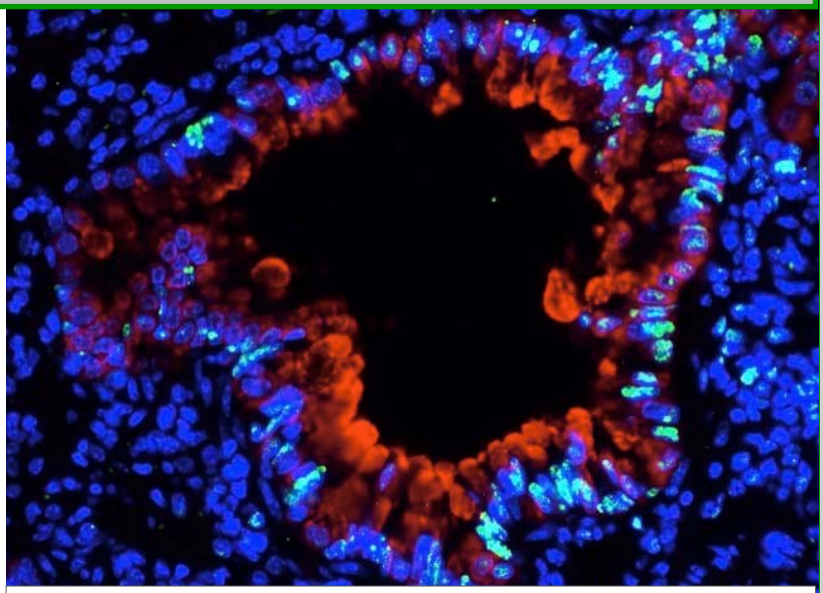
NEWS ARTICLE

Asthma Linked to DNA Damage

Allergies induced by dust mites can harm DNA in lung cells.

Article by Anne Trafton, MIT News Office

House dust mites, which are a major source of allergens in house dust, can cause asthma in adults and children. Researchers from MIT and the National University of Singapore have now found that these mites have a greater impact than previously known — they induce DNA damage that can be fatal to lung cells if the damaged DNA is not adequately repaired.



An image of epithelial cells surrounding a lung bronchiole in mice with asthma induced by dust mites (cells are DNA repair deficient). Researchers have shown that this type of asthma also produces DNA damage in lung cells, which is indicated in green.

The findings suggest that DNA repair capacity, which varies widely among healthy individuals, could be a susceptibility factor that places an asthmatic patient at increased risk of developing asthma-associated pathologies, the researchers say.

"DNA damage is a component in asthma development, potentially contributing to the worsening of asthma. In addition to activation of immune responses, patients' DNA repair capacity may affect disease progression," says Bevin Engelward, a professor of biological engineering at MIT and a senior author of the study. "Ultimately, screening for DNA repair capacity might be used to predict the development of severe asthma."

Fred Wong Wai-Shiu, head of the Department of Pharmacology at the National University of Singapore, is also a senior author of the study, which appears in the May 1 issue of the *Journal of Allergy and Clinical Immunology*. The paper's lead author is Tze Khee Chan, a graduate student in the Singapore-MIT Alliance for Research and Technology (SMART).

Beyond asthma

Asthma is usually triggered by an exaggerated immune response to allergens such as dust mites, pollen, or pet dander. Immune cells flood the lung where the allergen has invaded, secreting immune chemicals called cytokines that drive inflammation and constriction of the smooth muscle, leading to narrowing of the airways and making breathing difficult. More than 300 million people suffer from asthma worldwide, and in the United States about 8 percent of the population is affected.

The research team focused on dust-mite-induced allergies because dust mites are ubiquitous and thrive in warm, humid climates. Dust mites provoke allergic symptoms, such as

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sneezing and watery eyes, and in sensitive individuals dust mites can even trigger allergic asthma. Up to 85 percent of patients with asthma are allergic to dust mites, making it the main trigger for allergic asthma.

When the researchers exposed mice to dust mites, to induce an asthma-like condition, they found an alternative pathway that contributes to asthma development. In these mice, the dust mites caused production of chemicals called reactive oxygen and nitrogen species (RONS), which are known for their potential to damage DNA and other biological molecules.

Furthermore, when DNA repair is inhibited using a drug called NU7441, more DNA damage and cell death are observed. There is a wide range of DNA repair capacity among people, so the findings suggest that asthma patients with poor DNA repair capacity could be more susceptible to asthma-induced inflammation and tissue damage.

Predicting and preventing damage

Although the mechanism is not known, dust mites can also directly induce DNA damage when they come into contact with cultured human cells.

"Our findings show that dust mites can not only induce an immune response, they can also cause direct DNA damage in the lung epithelial cells. These damaging effects are magnified when DNA repair is inhibited. It shows how important DNA repair is to prevent cell death," Chan says.

"Our current understanding is that inflammatory cells, such as eosinophils, neutrophils, and macrophages, produce free radicals that damage the cell. But right now what we observe is the epithelial cell by itself, without the other cells, can actually produce free radicals when exposed to dust mites. This is a finding that has not been reported before," Wong says.

The findings provide additional data to support the possibility of treating asthma patients with antioxidants to neutralize the RONS, in order to help prevent asthma-induced tissue damage. The researchers are now testing this approach in mice.

"This important report suggests that a paradigm shift may now be in order for allergens as environmental agents, and also for our understanding of the steps by which inhaled allergens interact with the lung to induce allergic asthma," says Michael Fessler, a senior investigator at the National Institute of Environmental Health Sciences, who was not involved in the research.

Finally, the results suggest that DNA damage may also be an important underlying factor in asthma exacerbation caused by inflammation during infectious diseases such as rhinovirus infection, the researchers say.

The research was funded by the National Medical Research Council of Singapore and the Singapore-MIT Alliance for Research and Technology (SMART).

http://news.mit.edu/2016/asthma-linked-dna-damage-0502

CEHS Participates in the MIT Open House Event

Article by Kathleen M. Vandiver, MIT CEHS COE²C Director

It was estimated that about 40,000 visitors attended the MIT Open House event on Saturday April 13, 2016. Overall, more than 380 activities were sponsored by various departments, labs, and centers, including our own Center for Environmental Health Sciences (CEHS). The CEHS activities were located in the lobby of Building 56 to meet the crowds as they funnel through this area on their way to the other activities. Passersby were drawn in by the activities and lingered to listen and then to participate further in the activities in our nearby rooms.

Our hallway tables offered the tools to isolate your own DNA. Many paused to follow the steps of the procedure that lead to a small tube of the invisible slimy DNA, while others chose to learn about cool research with RaDR mice. RaDR is a term that takes no time to say, but it does take time to explain. It's about the mice. With clever props and photos it became evident that the genes of RaDR mice provide a way for researchers to track DNA mutations. The mouse has a genetically engineered DNA insert that when mutated, leads to fluorescence. In this way researchers can learn a lot about how DNA can be damaged and repaired. Visitors got to see the mutant fluorescent cells, as they glowed brightly as Halloween paint under the microscope.

The table for isolating your DNA.

Models help to generate great conversations.

Professor Bevin Engelward, Deputy Director of CEHS, gave a presentation about the mission of our MIT Center, the environmental health work that we do in communities, and our ongoing research on water & air quality. It was a great opportunity to shine the spotlight on the CEHS faculty. Meanwhile in the room next door, children's voices could be heard as they learned about DNA using LEGOs and plastic models.

COE²C Director Dr. Kathleen Vandiver organized hands-on activities to teach about environmental health in engaging and innovative ways. On one side of the room, you could see LEGO bricks representing atoms that could be fashioned to tell the story of combustion. This construction activity was lively and the placemats on the tables provided the instructions for building. The combustion of fossil fuels produces air pollutants and particulates, as well as carbon dioxide, known to be the major contributor to climate change. Graduate student volunteers masterfully matched explanations to all levels of eager learners-- grandparents, parents, young adults and kids. The other major hands-on sessions in the room involved building with models of LEGO DNA. This was also a great hit for all ages, as the photos can attest. Participants traveled through three levels of learning at three different tables. First, they learned their DNA base pairs by working with the models through with trial and error to get "A-T" (Adenine –Thymine) and "C-G" (Cytosine-Guanine). Then they graduated to the next table to perform DNA replication using models for fun. At the third and last table, the activity provided a take-home memento, a gift as a reminder of a summertime DNA danger. The reminder was a talisman for UV radiation. Each visitor could select and create a string of UV beads. The UV beads reversibly change color in the presence of UV radiation, reminding all to wear hats, sunscreen, or long sleeves when outdoors for lengthy time in the summer.

Here's our early bird DNA team!

All in all, our MIT graduate student crews and other volunteers were stellar all day long! We owe them a huge debt of gratitude for a very long and constantly busy day. On the flip side, they mention feeling very rewarded by the opportunity to talk about environmental health science with so many keenly interested people. A special recognition and a hearty thank you to the organizers, presenters, and volunteers: Maria Allocca, Kimberly Bond Schaefer, Kim Davis, Mike Geeson, Amanda Chi Wen Giang, Jenny Kay, Amanda Mayer, Chris Mayer, Marcus Parrish, John Read, and Jordan Smith, especially to the COE²C Director, Kathleen Vandiver.

Toxicology Training Grantees Benefit from Ethics Training

One of the requirements of our Training Grant in Environmental Toxicology requires that we offer regular training in the area of Responsible Conduct of Research. This Spring there have been six training sessions from May 18 to June 22, 2016 on Wednesdays from 4-6 p.m. All CEHS members and their labs were welcomed to attend any session.

Topics for the "The Responsible Conduct of Science" Course included:

1. Wednesday, May 18, 2016 – Is Cancer the Result of Bad Luck?

Faculty Moderator: Bevin Engelward; Student Discussion Leaders: Steven Slocum, Nathaniel Chu, and Joshua Jones

A recent publication in Science gave rise to statements in the press that for some cancers, 2/3 of the risk for cancer is due to normal errors during cell division, as opposed to genetic factors and environmental exposures. A heated debate has ensued. Required reading includes:

- Variation in cancer risk among tissues can be explained by the number of stem cell divisions, Tomasetti and Vogelstein http://science.sciencemag.org/content/347/6217/78.full
- The New York Times: Cancer's Random Assault http://www.nytimes.com/2015/01/06/health/cancers-random-assault.html?_r=0. *If you have exceeded your 10 free article readings at the NY Times, please email kbond@mit.edu for a pdf of the article*
- Cancer Research UK: http://scienceblog.cancerresearchuk.org/2015/01/05/cancer-mainly-bad-luck-an-unfortunate-and-distracting-headline

2. Wednesday, May 25, 2016 – The Crispr Quandry

Faculty Moderator: Peter Dedon and Ram Sasisekharan; Student Discussion Leaders: Marcus Parrish, Jacob Guggenheim, Faye-Marie Vassel, and Djenet Bousbaine

- "A new gene-editing tool might create an ethical morass – or it might make revising nature seem natural". Required reading includes: http://www.nytimes.com/2015/11/15/magazine/the-crispr-quandary.html?_r=0. *If you have exceeded your 10 free article readings at the NY Times, please email kbond@mit.edu for a pdf of the article*

3. Wednesday, June 1, 2016 – Movie Discussion: The Race for the Double Helix

Faculty Moderator: Forest White; Student Discussion Leaders: Sarah Lewis, Michael Mak, Jonathan Franklin, and Kate DuPont

In 1987 this award-winning documentary drama was originally produced for the BBC science series Horizon. - Staring Jeff Goldblum as 'Jim Watson' and Tim Piggot-Smith as 'Francis Crick' is about the race to solve one of the greatest mysteries of 20th-century science the structure of DNA. It is the story of the diligent research, creative analysis, and perseverance of James Watson and Francis Crick that led to the discovery. With the help of their colleague, Maurice Wilkins, they also earned the 1962 Nobel Prize.

TOXICOLOGY TRAINING GRANT (CON'T)

If you can find a way to watch it online, please do so, otherwise we also have three DVDs you can borrow.

4. Wednesday, June 8, 2016 – An Array of Errors

Faculty Moderator: Katharina Ribbeck; Student Discussion Leaders: Roman Hillebrand, Mary Anderson, and Ben Waldman

Discussion of literature on a Duke University case alleging misconduct in the interpretation of complex biological data. Required reading includes:

- http://www.economist.com/node/21528593
- http://videolectures.net/cancerbioinformatics2010_baggerly_irrh/
- https://www.youtube.com/watch?v=66dPIFMJ_-A

5. Wednesday, June 15, 2016 – Crime Lab Chemist sent to Jail

Faculty Moderator: Jesse Kroll; Student Discussion Leaders: Kim Davis, Dave VanInsberghe, and Isaak Mueller

Read the six articles published in C&E News using the link below: http://pubs.acs.org/iapps/wld/cen/results.html?line3=dookhan

6. Wednesday, June 22, 2016 – Academics Seek a Big Splash

Faculty Moderator: Steven Tannenbaum; Student Discussion Leaders: Nathan Stebbins, Jason Nguyen, Christy Chao, and Lauren Stopfer

Please read this article: http://nyti.ms/1KwYb3n. *If you have exceeded your 10 free article readings at the NY Times, please email kbond@mit.edu for a pdf of the article*.

CEHS Featured News Article (con't)

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each connects separately to two oxygen atoms. Crucially, it also has a double negative charge coming from two "extra" electrons in the molecule.

The OOR enzyme, a large and complex molecule, binds with oxalate in such a way as to neutralize the negative charge, and, in a separate action, it breaks the carbon-carbon bond at the center of oxalate. This is what the researchers call the "bait-and-switch" process — because the enzyme first binds oxalate using its positive charge to attract the negatively charged molecule, before altering the charge environment through two protein movements in order to break the oxalate down.

"There are [just] these two movements," Drennan observes. "The simplest things are the most elegant and beautiful."

The researchers made the discovery through X-ray crystallography, which reveals molecular structures at the atomic scale. By taking a series of X-rays during the OOR-oxalate reaction process, they were able to determine the dynamics of the interaction through which OOP metabolizes oxalate.

"By solving a number of structures, I call them snapshots, we can watch in a way the action take place, because we have a series of pictures at various different time-points along the reaction mechanism," Drennan explains. "And that's super-cool. I think my favorite thing about crystallography is when you can do that."

Ultimately, Drennan and her colleagues hope that identifying the mechanism of oxalate breakdown will help scientists figure out some ways of letting people reduce their oxalate levels if needed. Some people, as Drennan notes, carry the bacteria that can metabolize oxalate, but other people do not.

Drennan suggests it will be increasingly useful to grasp how these kinds of processes, or our lack of them, factor into human health issues.

"We have kind of been ignoring this huge aspect of human health," Drennan says. "I think as we start understanding the importance of those microbes [that are] doing chemistry for us, I think we're going to really appreciate it."

The paper has six co-authors in addition to Drennan. They are Marcus Gibson PhD '15, a former doctoral student in Drennan's lab who is now a postdoc at Princeton University; Percival Yang-Ting Chen, a doctoral student in Drennan's lab; Aileen Johnson '14, a former undergraduate in Drennan's lab; and Stephen Ragsdale, Elizabeth Pierce, and Mehmet Can, all of the University of Michigan.

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http://news.mit.edu/2015/organisms-process-oxalate-harm-humans-1228