MIT CEHS Center for Environmental Health Sciences

NEWSLETTER

Supported by NIH NIEHS Core Center Grant P30-ES002109

CEHS Newsletters can also be downloaded from our website http://cehs.mit.edu/news/newsletter

Fall/Winter 2016/2017

An Element of Caution

Could chemicals key to sustainable technologies pose unseen environmental risks?

Article by Leda Zimmerman, MIT Spectrum

Hemond, third from left, with students, collecting sediment in Thoreau's bog. Photo: Courtesy of the researchers.

More than 150 years ago, Henry David Thoreau pondered the biology of Massachusetts peat bogs, calling them "little oases of wilderness in the desert of our civilization." He would likely be troubled to learn that today in a wetland named for him, MIT biogeochemist Harold Hemond PhD '77 is extracting the airborne metals released by industrialized society, including rare earth elements (REEs), increasingly indispensable in consumer electronics, computers, and clean energy technologies.

For Hemond, William E. Leonhard Professor in the Department of Civil and Environmental Engineering, the presence of these substances in Thoreau's Bog—a body of water he has studied for four decades—is an opportunity to anticipate and perhaps prevent problems as society changes its chemical footprint: "We need to be proactive in understanding what kind of impacts we are making," he says. Hemond's research is part of a novel investigation, supported by MIT's new Environmental Solutions Initiative (ESI), into the potential effects of REEs on the environment and humans.

"Use of these materials has gone up tenfold in a decade, but there's been very little testing of their toxicity," says John Essigmann SM '72, PhD '76, the William R. and Betsy P. Leitch Professor in Residence, whose lab straddles the departments of chemistry and biological engineering. "Many materials released in large amounts in the past, like asbestos, DDT, and lead in gasoline, seemed very constructive at the time but ultimately proved destructive to biological systems." Along with Bevin Engelward, professor of biological engineering, Essigmann became Hemond's partner on the ESI grant through the activities of the MIT Center for Environmental Health Sciences.

Essigmann and Engelward are studying how these new environmental chemicals might affect human health. This means closely examining Hemond's bog

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In This Issue

Upcoming Events

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Robert Harris-Lecture
to be held on
May 4, 2017

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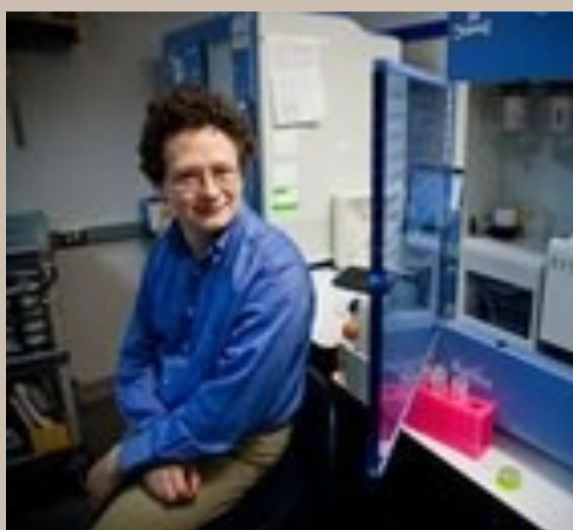
David Schauer Lecture
to be held on
Sept. 28, 2017

Honors and Awards

Nolan Named a Recipient of the Presidential Early Career Awards for Scientists and Engineers

Professor **Elizabeth Nolan** is one of 102 scientists and researchers named by President Obama as recipients of the Presidential Early Career Awards for Scientists and Engineers (PECASE), the highest honor bestowed by the United States Government on science and engineering professionals in the early stages of their independent research careers.

http://chemistry.mit.edu/nolan-named-recipient-presidential-early-career-awards-scientists-and-engineers



Levine a Recipient of the MIT 2017 Excellence Award

We are delighted to announce that Dr. **Stuart Levine**, the Director of the BioMicro Center facility and CEHS Genomics Facilities Core, will be one of the recipients of an MIT Excellence Award in March 2017. The Excellence Awards are an Institute-wide acknowledgement of the extraordinary efforts made by members of our community toward fulfilling the goals, values, and mission of MIT. They are among the highest honors that MIT bestows on staff. http://hrweb.mit.edu/rewards/mit-excellence-award/2017-award-recipients

CEE announces new leadership appointments

Professor **Colette Heald** will serve as associate head of the department of Civil and Environmental Engineering; Professor **Jesse Kroll** will chair the CEE Graduate Education Committee.

http://news.mit.edu/2016/cee-announces-new-leadership-

CEHS Facilities Core Update

CEHS re-organizes the Bioanalytical Facilities Core to the new Bioimaging and Chemical Analysis Facilities Core to meet the needs of our Center Members.

Key contacts by instrumentation type:

Bioimaging: Robert Croy rgcroy@mit.edu and Christy Chao christyc@mit.edu (Metaphor only)

Mass Spectrometry: Michael DeMott msdemott@mit.edu and Stephen Slocum sslocum@mit.edu (ICP-MS only)

Below are two recently obtained mass spectrometry instrumentations.

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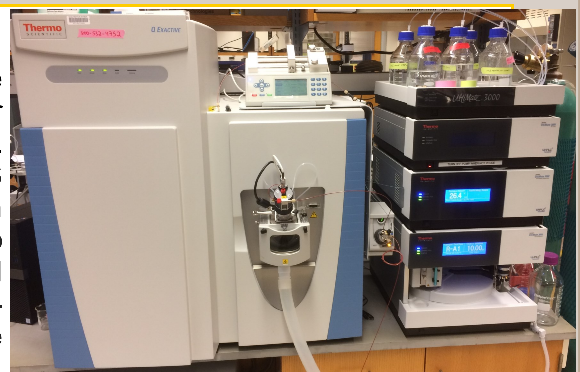


The Bioimaging and Chemical Analysis Facilities Core located in 16-720 recently purchased a new Thermo Fisher Q Exactive Hybrid Quadrupole-Orbitrap Mass Spectrometer. From the company literature: "This benchtop LC-MS/MS system combines quadruple precursor ion selection with high-resolution, accurate-mass (HRAM) Orbitrap detection to identify, quantify and confirm more compounds rapidly and with confidence. The Q Exactive is equally useful for untargeted or targeted screening and a broad range of qualitative and quantitative applications, environmental and food safety, clinical research, and forensic toxicology where sensitivity and mass accuracy of small molecules is critical." In our core facility, the Q Exactive is paired with a Dionex UltiMate 3000 UHPLC system with a conventional LC pump that has a minimum flow rate of 20µl/min, so proteomics analysis is currently not possible, but in the future we hope to acquire a nano-flow pump to expand the system's capabilities. For additional information or training on the Orbitrap instrument, contact Dr. Michael DeMott (msdemott@mit.edu).

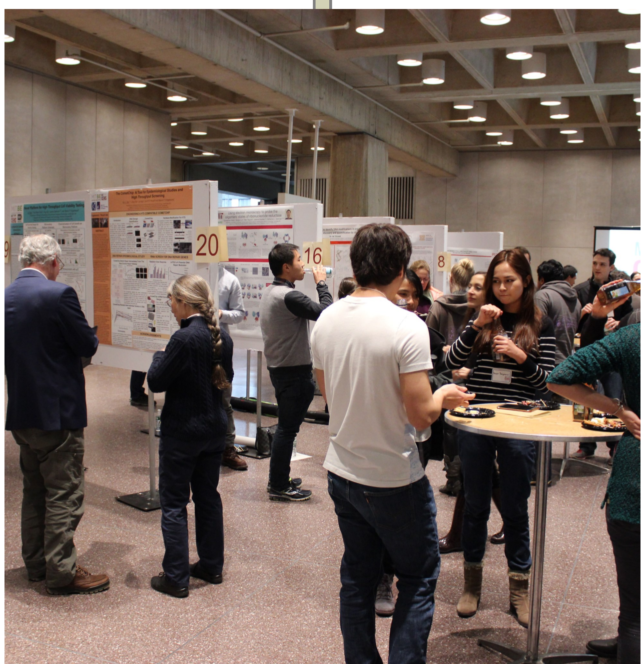
AGILENT 7900 INDUCTIVELY COUPLED PLASMA MASS SPECTROMETER

The CEHS Bioimaging and Chemical Analysis Facilities Core purchased an Agilent 7900 inductively coupled plasma mass spectrometer (ICP-MS). It is perfect for trace metal, nanoparticle, soil and other environmental analysis applications. The Agilent 7900 has a high matrix tolerance, allowing for a more versatile sample base, as well as a helium collision cell, which enables an improved signal to noise ratio. The 7900 has the widest dynamic range of any quadrupole ICP-MS, with the sensitivity range spanning 11 orders of magnitude. This permits the analysis of trace elements and majors in the same run, greatly reducing the complexity of method development and widening the range of results. The software package allows for automated analysis and easy interpretation of the data. The ICP-MS can also be paired with other analytical tools, in particular HPLC, allowing for metal speciation if desired. Additionally, there is a Milestone Ultrawave microwave sample digestion system in order to dissolve challenging sample matrices, e.g. soil and other geological samples, further increasing the possibilities for analysis.

For additional information or training on the ICP-MS instrument, contact Dr. Stephen Slocum (cehs.bioanalytics@gmail.com).

2017 CEHS Poster Session Winners

The Center for Environmental Health Sciences (CEHS) at MIT held its annual poster session on January 18, 2017 at Building 13 Lobby. The session highlighted the work of the environmental health research communities of MIT and some of our sister institutions. Over 60 posters were presented from the science and engineering laboratories affiliated with the Center. We would like to thank all of the poster presenters for participating in this event.



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 we 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 ten MIT departments (in both the School of Science and the School of Engineering) plus one Harvard faculty member from the Harvard School of Public Health (HSPH).

This year's CEHS cash prizes are awarded in two categories, graduate students and postdoctoral scholars. For each category, the prize for first-place is $1,000, second-place prize is $500, and the third-place prize is $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.

Undergraduate and Graduate Students, Postdoctoral Scholars, and Research staff presented the results of their research at MIT's Building 13 Lobby. The CEHS 2017 Poster Winners are mentioned below.

Mr. Jonathan Franklin from Professor Jesse Kroll's lab won first place in the graduate student category. Jonathan presented his work on the "Measurements of I/SVOC from Mobile Sourcing using online Thermal Desorption EI-MS." In second place is Ms. Le "Lizzie" Ngo from Professor Bevin Engelward's lab, presented her work on "Novel Microarray Colony Formation Platform for High-Throughput Viability Testing." Finally, in a third place tie is Mr. Daniel Rothenberg, from Professor Forest White's lab, presented his work on "Profiling the Translatome with Bioorthogonal Non-Canonical Amino Acids" and Ms. Jules Stephen from the Liz Nolan lab presented on "Methionine Oxidation Increases the Protease Sensitivity of Calprotectin by Altering Its Oligomeric State."

In the postdoctoral scholar category, first place went to Dr. Supawadee "Apple" Chawanthayatham from Professor John Essigmann's lab, who presented on "Mutational Spectra of Aflatoxin B1 in vivo Establish Biomarkers of Exposure for Human Hepatocellular Carcinoma." Second place went to Dr. Yehuda Brody, from Professor Paul Blainey's lab, who presented his work on "'Lineage Sequencing' for Deeper Insights into Exposure-Induced Somatic Mutations." And lastly, another third place tie went to Dr. Victor Hernandez-Gordillo, from Professor Linda Griffith's lab, after presenting his poster: "Toward the Development of an Organotypic Intestinal Model to Recapitulate Epithelial-stromal Interactions" and Dr. Annelien Zweemer from the Douglas Lauffenburger's lab presented her work on "Apoptotic Cell Bodies Elicit Gas6-mediated Migration of AXL-expressing Tumor Cells."

http://news.mit.edu/2017/center-environmental-health-sciences-selects-poster-winners-0223

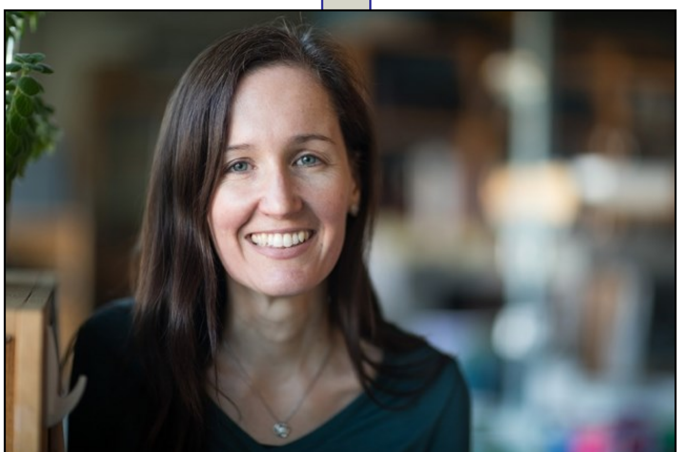
Exploring the Tug-of-War Over Metals During Infection

Chemist Professor Elizabeth Nolan studies the battle between microbes and hosts for essential metals.

Article by Anne Trafton, MIT News Office

During bacterial infections, microbes and their hosts engage in a tug-of-war over essential metals. Microbes, which need metals such as iron to survive, try to scavenge them from the host, while the host tries to lock them up so microbes can't get them.

Both sides deploy many proteins and other molecules in this struggle, and by studying these complex interactions, MIT associate professor of chemistry Elizabeth Nolan hopes to glean information that could be useful in helping scientists design new drugs to fight bacterial infections.



"Understanding how our innate immune system works is important for thinking about the development of new ways to treat infectious disease," says MIT associate professor of chemistry Elizabeth Nolan. Photo: Bryce Vickmark

"Understanding how our innate immune system works is important for thinking about the development of new ways to treat infectious disease," says Nolan, who recently earned tenure in MIT's Department of Chemistry.

Metals including iron, zinc, magnesium, and calcium help cells with a wide range of functions, including cell respiration, catalyzing chemical reactions, signal transduction, and maintaining structural integrity of proteins and nucleic acids. About 30 percent of cellular proteins require help from metal ions.

Nolan first got interested in the study of metals in biological systems, known as bioinorganic chemistry, when she took an advanced inorganic chemistry course during her junior year at Smith College. She applied to graduate school at MIT and ended up working in the lab of Stephen Lippard, the Arthur Amos Noyes Professor of Chemistry at MIT, who studies the roles of metals in cancer treatment and synaptic transmission.

At that time, Lippard's lab was beginning to work on designing molecules that could be used as sensors for zinc. These sensors can be used in living cells, and when they encounter their target metal, they light up, allowing the metal's location to be visualized. Nolan worked on the zinc sensors and later, sensors for mercury.

After doing a postdoctoral fellowship in protein biochemistry and antimicrobial peptide biosynthesis at Harvard Medical School with Professor Christopher T. Walsh, Nolan returned to MIT to start her own lab, where she began a research program focusing on the battle for metals between hosts and microbes.

"We're interested in mammalian proteins that modulate metal ion availability and also the machinery that microbes use to acquire metals that they need from the host," she says.

Fighting for iron

Many bacteria produce molecules called sider-

News Article (con't)

ophores to help them obtain metals such as iron from their hosts. Once secreted into their environment, siderophores grab onto the metal and then re-enter bacterial cells along with their iron haul.

One area of Nolan's research focuses on not only unraveling this process, but also exploiting it for possible therapeutic benefit. In one project, researchers in her lab are working on using siderophores to deliver antibiotics. Most antibiotics in clinical use are very broad-spectrum, killing not only harmful microbes but also beneficial species. However, Nolan has shown that when antibiotics are attached to siderophores specific to certain strains of bacteria, they only kill those microbes.

In another recent study, Nolan's lab and researchers at the University of California at Irvine used modified siderophores from *Salmonella* to immunize mice against infection with that pathogen, and they are now working on expanding that approach to other microbes.

Nolan also studies proteins that mammals, including humans, use to defend themselves from bacterial infection. One such protein is calprotectin, which scavenges metals so that bacteria can't grab them, effectively starving the microbes. In 2015, Nolan and her colleagues discovered that calprotectin can sequester iron, depriving microbes of the critical nutrient and strongly inhibiting their growth.

Exciting science

Nolan, who was awarded the 2016 MIT School of Science Teaching Prize for Graduate Education, says some of her favorite things about teaching are sharing her excitement about science and helping her students learn to think critically.

"In my advanced classes something I enjoy doing is drawing examples from the literature — thinking about how we test a hypothesis and asking, what are some of the experiments and data that led to the model we currently have for some complex biochemical system?" she says.

She also tries to stoke her students' excitement about science, which she says is one of the things she likes best about being at MIT.

"I like the willingness of people to collaborate and be excited about new ideas," she says. "There's an open-mindedness in terms of trying something new and high-risk. I enjoy being surrounded by really smart, talented, and creative students and colleagues, and I think that just makes everyone better."

http://news.mit.edu/2017/faculty-profile-elizabeth-nolan-0104

MIT CEHS

News Article

Zeroing in on the Chemistry of the Air

Professor Jesse Kroll examines how pollutants change chemically as they waft around the globe.

Article by David L. Chandler, MIT News Office

We breathe it in and out every few seconds, yet the air that surrounds us has chemical activity and variations in its composition that are remarkably complex. Teasing out the mysterious behavior of the atmosphere's constituents, including pollutants that may be present in tiny amounts but have big impacts, has been the driving goal of Jesse Kroll's research.

"The ultimate objective," atmospheric scientist Jesse Kroll says, "is to understand what policies could help, and what changes policymakers could make to minimize the negative health and climate effects of particulate pollution." Photo: Ian MacLellan

Kroll, an associate professor of civil and environmental engineering and of chemical engineering who earned tenure last year, has been especially focused on studying the role of organic compounds in the air. These carbon-containing compounds include natural emissions from plants as well as products of combustion — everything from gaseous emissions that come from fuel burning in internal combustion engines, to components of soot and other particulate matter that arise from forest fires and other open flames. Such particles are smaller than a micron in diameter but can have outsized environmental effects.

"If you inhale them, they can cause adverse health effects, and they also can affect the Earth's climate by affecting the amount of sunlight that comes through," Kroll says.

However, a large fraction of organic particulate matter is not directly emitted into the atmosphere, but instead is formed within the atmosphere from oxidation reactions of gaseous organic species. Understanding such chemical transformations and their effects on atmospheric composition is a daunting task.

"It's not just that there are a lot of different compounds," Kroll explains. "Once in the atmosphere, they oxidize, and each one can form 10 or 100 more chemical products, which in turn can form many others. It's a deeply complex system, so from a chemist's perspective, it's a really fascinating field."

Analyzing these processes requires both detailed sampling and testing out in the field, and complex laboratory experiments that reveal the sequence of changes these chemicals go through once they enter the atmosphere.

Kroll originally hails from Austin, Texas, where his father was a professor of archaeology and classics at the University of Texas. He started to develop an interest in chemistry while in high school. "I figured out that chemistry was really

News Articles (con't)

something that grabbed me, because it could be related to something very tangible in the real world," he recalls.

He moved to the Boston area for college, where he completed his undergraduate studies at Harvard University, majoring in chemistry and earth and planetary sciences. In a freshman environmental chemistry class, he says, "I got to study environmental chemistry, and I knew that was something that I wanted to work on. It was complex but tractable." He went on to earn his PhD in chemistry there and then moved on to a postdoc position at Caltech, where he spent three years.

Next he moved into industry, taking a job at Aerodyne Research in Billerica, Massachusetts, where he worked on developing instruments for measuring atmospheric chemistry — some of which he still uses in his research. Then, in 2009, he joined the MIT faculty.

He says that with organic aerosols in the atmosphere, "there are so many different reactions and so many different molecules involved, we can't hope to measure them all." In addition, the mix of chemicals varies greatly from one region to another. So part of the challenge for atmospheric chemists is to decide how to narrow the problem and which compounds to focus on as being most relevant to both health and environmental effects.

"We try to strike a balance between having an accurate-enough description of this chemistry, but in a simple enough form to be useful for modelers and ultimately policymakers," he says.

Most of Kroll's work is in the laboratory, where individual chemical compounds can be introduced into reactors, varying from small flow tubes to sealed chambers the size of a small room, and oxidized under controlled conditions. He and his team then withdraw samples in real-time from those reactors, to make precise measurements of the evolving chemistry within.

But it's not all local lab work. Kroll and his students also participate in large, multi-institution field studies, including ground-based atmospheric measurements in California, Alabama, and Colorado, and large-scale lab projects such as a recent one carried out the U.S. Department of Agriculture's Missoula Fire Lab in Montana. There, inside a large controlled environment, researchers burnt various types of biomass to simulate wildfires, and then measured what came off. "We brought those emissions into a reactor we built, to simulate the aging of biomass burning plumes," Kroll says.

One of his classes (Traveling Research Environmental Experiences, or TREX) also focuses on fieldwork. Every January during MIT's Independent Activities Period, he co-leads a group of undergraduates to carry out air quality studies in Hawaii, monitoring the emissions and evolution of sulfur-containing gases emitted from the Kilauea volcano.

Part of all this effort aims to improve the detailed atmospheric models that are used to predict the progress of Earth's changing climate and the factors affecting it. "There are large and persistent gaps between what models predict and what people measure," in terms of the details of chemical interactions in the air, and even the amounts and compositions of these organic particles, he says, so it's important to keep plugging away at understanding and reducing those discrepancies.

"The ultimate objective," he says, "is to understand what policies could help, and what changes policymakers could make to minimize the negative health and climate effects of particulate pollution."

http://news.mit.edu/2017/faculty-profile-jesse-kroll-0201

Updates on the COE^{2}C Community Projects: Our Community Interactions in 2016

Article by Kathleen M. Vandiver, MIT CEHS COE^{2}C Director

The NIH-NIEHS P30 Program (our sponsoring agency) uses the term "community" to refer to a population in a geographic location or to a specific subgroup of people in the general population. The MIT Center for Environmental Health Sciences (COE^{2}C) uses both definitions. This article provides an update on three ongoing projects with our geographic communities, as well as an update on the dissemination work with our new teaching tools designed for educators here in the U.S. and abroad.

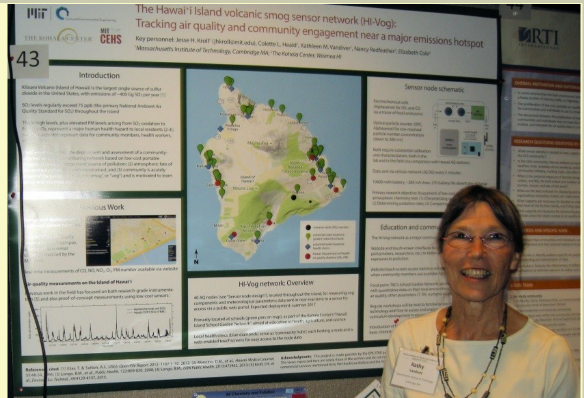
1) Our first community is the Environmental Justice (EJ) community of Malden, MA. Fifty percent of Malden's population speaks a language other than English at home. Malden's population is twenty percent Asian and the City has even greater diversity with additional immigrant populations from Africa, Haiti, and Europe. Within the City of Malden, the Malden River flows southward towards the Mystic River, and unlike the Charles River which flows along MIT campus, this river offers little in the way of public open space. Access to the Malden riverfront has been denied due to concerns for public safety as major industrial activities have polluted the area heavily during the early 1900s. Over time the MIT COE^{2}C has become active in the leadership of a grassroots organization called the Friends of the Malden River (FoMR), which the COE^{2}C has particularly helped FoMR connect with immigrant populations, such as the Chinese Culture Connection. The COE^{2}C was able to ask the EJ community members how they would want to use the greenway space along the Malden River factoring in cultural interests. And as a result, a comprehensive riverway walking path is being organized by the Mystic River Watershed Association (MyRWA). The COE^{2}C Director Dr. Vandiver provided examples of EJ requests in a public forum to the Massachusetts Department of Environmental Protection at the Everett City Hall. Additionally the COE^{2}C has performed the bi-directional task of involving MIT researchers in collecting samples for a human health risk study on the Malden River. This study is being undertaken by the Malden River greenway project and councilmen of the City of Malden are looking forward to this report as it will impact the City's redevelopment plans.

The COE^{2}C director Dr. Vandiver (left) and the director of the Chinese Culture Connection, Mei Hung (right) point out local sites near the Malden River prior to asking the Chinese community "How would you like to use the Malden River?"

2) Secondly, the COE^{2}C has been working for several years with tribal communities in northern Maine, including the Passamaquoddy Tribe at Pleasant Point, ME. Our work with the Passamaquoddy environmental department members is tailored to meet their specific requests. Overall, MIT CEHS is kept up to date on many tribal environmental health issues as Dr. Vandiver participates in the monthly EPA Region 1 Tribal Conference calls. Additionally, Vandiver has regularly participated in the EPA Region 1 Tribal Summit Environmental Conferences. For example, Vandiver was an invited speaker on an educational panel representing MIT CEHS at the conference last Fall. From these regular exchanges, it is clear that Tribal Chiefs are very interested in youth education in environmental health. Also every August for the past three years, Vandiver and researcher Croy and Center Director Essigmann would visit Tribal lands in Maine. This past summer we listened to health concerns about soil contamination in the Passamaquoddy fields where traditional materials, like seaweed and fish, are used as fertilizer. Soil samples were collected from these fields for heavy metal analysis. As a follow up, Center Director Essigmann hosted the Passamaquoddy environmental team

Passamaquoddy native farmer (left) and environment department member (right) with COE^{2}C director (middle) look over a field that was fertilized by traditional methods.

at MIT this year and provided training using the inductively coupled plasma mass spectrometer (ICP-MS) to analyze the samples.



EPA STAR project "Hawai'i Island Volcanic Smog Sensor Network (HI-Vog)" was presented by COE^{2}C director Vandiver at the NAAMC Conference in St. Louis, MO along with other EPA community engagement grant recipients.

3) Our third community is also an indigenous community, but located much further away. Our community partner is the Kohala Center on the big Island of Hawaii. This organization is dedicated to improving the lives of Hawaiian natives. Founded in 2000, the Kohala Center helps to "turn research and ancestral knowledge into action, so that communities in Hawaii can thrive." For example, the Kohala Center has partnered with teachers to create community gardens at local schools where native plants are grown to encourage healthy food habits. Thus the MIT COE^{2}C connection provided CEHS faculty member Jesse Kroll with an excellent community partner and the Kohala School Garden sites all around the island that will provide nodes for an air quality sensors network. Air quality in Hawaii can become poor very quickly due to volcanic eruptions that can create fluctuating concentrations of volcanic particulates and SO_2 gases. Teachers at the garden schools will use the air sensor data not only to monitor air quality for their vulnerable populations, but they can also use the data to teach science to middle school children. For the latter purpose, the MIT COE^{2}C Director Vandiver prepared a teacher professional development course for the Hawaii Department of Education this year that we expect will be offered in June 2017. The COE^{2}C also represented the MIT research team at the EPA's STAR Awardees announcement last August at the 2016 National Ambient Air Monitoring Conference in St. Louis, Missouri. At this conference, the EPA gathered all the STAR Grant awardees to present their unique community challenges to each other. The formation of this cohort group was designed to help universities share their wisdom about working in communities.

An AP Biology student, in the Community Charter School of Cambridge, MA constructs a cell membrane protein from the model amino acids using the MIT Protein Set.

4) Lastly, the MIT COE^{2}C has a community that isn't geographically bounded, it's the community of science educators. Over the last ten years, the COE^{2}C has made great strides in responding to teachers' needs for environmental health science literacy tools. And in 2016, in collaboration with the MIT Edgerton Center, we had a breakthrough. Originally, we taught molecular biology concepts with LEGO-based models, however these models could not be taken to scale, therefore we manufactured injection-molded models of our own design for DNA and protein molecules. These models are unusual as they are designed to teach function as well structure. To take advantage of the novel capabilities that these new models provided, the COE^{2}C had to focus next on creating new teacher training and instructional materials. MIT is just beginning to disseminate these innovative molecular biology sets. The models have very broad utility and are appropriate for educating Middle School science, High School biology, AP Biology and adult learners, such as health professionals.

In conclusion, three of the four the communities described above have been the major focus of MIT's Community Outreach Education and Engagement Core in 2016. The fourth community, the one that includes the Kohala Center on the Big Island is just starting up, and we look forward to providing further updates on this EPA Hawaii project in the future.

Toxicology Training Grant Reminder

Upcoming Dates for Toxicology Trainees:

- ⇒ Late Spring - Fundamentals of Toxicology Course
- ⇒ Late Spring - Responsible Conduct in Research Ethics Sessions

Reminder Message

Please remember to cite the Core Center Grant support, P30-ES002109, on your publications.

The National Institute of Environmental Health Sciences, our supporting agency, requires investigators who use the Center's resources and services acknowledge that support in the publications as well as any poster presentations and seminar talks. This acknowledgement also applies to recipients of Pilot Project funding.

NIEHS recommends using this acknowledgement text: "*Support for this research was provided by a core center grant P30-ES002109 from the National Institute of Environmental Health Sciences, National Institutes of Health*."

Dear CEHS Members -

Freezer meltdowns are a serious risk. This is just a friendly reminder to make sure your freezer batteries get checked at least once a year, and to arrange for filters to be cleaned. In most cases, it is worth it to pay the service fee to help prevent breakdowns. We also encourage you to install an alarm system that connects to your smart phone. If you are interested in getting an alarm, please let us know and we will share some options.

Bevin

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CEHS Featured News Article (con't)

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sediments, which date further back in time as they increase in depth. The sediments are vital records of atmospheric emissions, since this bog is fed exclusively by rainwater.

Measurements by the Hemond Lab reveal a host of REEs, likely released in large part by metal smelting processes. According to a preliminary chronology, these elements barely registered in 1900, but grew through the century and spiked to hundreds of parts per billion by mid-century. Then they began to decline, Hemond says: “Our working hypothesis is that increasing industrial activity put more of these chemicals in the air, and then the 1970 Clean Air Act helped reduce their presence.”

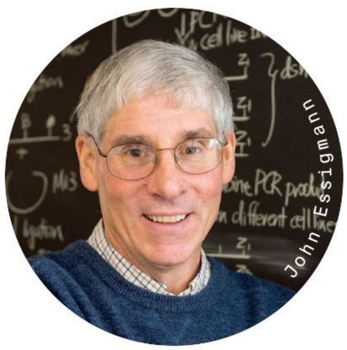

PHOTO: JUSTIN KNIGHT

PHOTO: RICHARD HOWARD

While this appears reassuring, Essigmann finds reason for concern. The bog reflects historic, regional atmospheric concentrations of REEs, so concentrations in regions lacking air regulations, or regions with aggressive mining and manufacturing practices, might currently be much higher. With expanding global use and discard of products incorporating REE-based technologies, concentrations could rise again as REEs find their way into the environment at unprecedented levels.

One element from Hemond’s bog samples drew Essigmann’s particular attention: cerium, now turning up as a fuel additive to make diesel engines burn more efficiently and at lower temperatures. This epitomizes why Essigmann calls REEs “a double-edged sword.” He explains, “On the one hand cerium oxide particles are good for the environment and sustainability, but on the other it’s been discovered that they escape from tailpipes, and we have to worry about the health consequences if we breathe them.” Using technology developed in the Engelward laboratory for measuring DNA damage, Essigmann’s preliminary research indicates that while these particles alone are not very toxic, hydrogen peroxide produced by the body’s inflammatory response to small particles can combine dangerously with cerium oxide. Together, says Essigmann, “they produce a very harsh chemical byproduct that breaks DNA.”

Before drawing conclusions about health impacts, Essigmann and Engelward await ongoing testing by Hemond, which will try to correlate concentrations of REEs taken from air samples with those from rain-fed bogs. “We will be able to tell you based on what you see in a bog anywhere in the world how much people breathe of REEs at any given time,” says Essigmann. Using concentrations typical in countries manufacturing REEs, Essigmann hopes to pursue further tests with these compounds using mouse models. If these experiments demonstrate lung damage, he believes the work might influence regulatory policy.

“Think of our work as due diligence,” says Hemond. “We want to be ahead of the curve this time.”

http://spectrum.mit.edu/fall-2016/an-element-of-caution/