Center for Environmental Health Sciences

The overarching goal of the Center for Environmental Health Sciences (CEHS) is the study of the biological effects of exposure of people and the human ecosystem to environmental agents. Such studies help us understand and predict how exposure to environmental agents affects human health and the dynamic relationship we have with other living things. Three fundamental components influence the physiological effects of environmental exposures: the nature of the exposure, the duration of that exposure, and how well the exposed organism is equipped to deal with the exposure—i.e., the organism's genetic susceptibility. Environmental health research at MIT encompasses a wide range of disciplines, and the CEHS continues to bring together faculty members who employ a diverse set of research tools to tackle problems relevant to environmental health sciences. During the past several years, the CEHS has begun to include focused efforts on problems of particular relevance to the developing world, along with adding more human population-based studies. We also have reached out increasingly to the MIT engineering community, because our engineering colleagues are critical players on the front lines of efforts to address the reality of environmental hazard remediation.

Organization

Fulfilling the requirements of the National Institute of Environmental Health Sciences (NIEHS), our sponsoring agency, the CEHS is composed of an Administrative Core, a Community Outreach Education and Engagement Core (COE2C), a Career Development Program, a Pilot Project Program (including Translational Pilot Projects), and a Global Environmental Health Sciences Program. In addition, the CEHS has four facilities cores, including an Integrative Health Sciences Facilities Core. Research activities are grouped into the following themes that build on the strengths of the Center's membership:

- DNA damage, DNA repair, and genomic stability
- Microbiomes and environmentally induced diseases susceptibility
- Inflammation chemistry and biology
- Bioengineering applied to environmental health
- Chemistry and transport of pollutants in the atmospheric, water, and soil

The CEHS membership currently consists of 45 science and engineering faculty and researchers, which is an increase of one new faculty member over the past year. Forty-four members are from MIT and one is from Harvard University (Professor David Hunter). Of the MIT members, the Center has one senior research scientist and two principal research scientists. The members of the Administrative Core, which is charged with the Center's overall operation, include William R. and Betsy P. Leitch Professor in Residence Professor of Chemistry, Toxicology, and Biological Engineering John M. Essigmann, director; Professor Bevin P. Engelward, deputy director; Amanda Tat, administrative officer; Sophea Chan Diaz, financial administrator; Kimberly J. Bond Schaefer, senior administrative assistant; and Lany Leung, event coordinator. The Community Outreach Education and Engagement Core (COE2C) helps communities

avoid exposures to environmental hazards that can adversely affect public health. In this broad mission, COE2C partners with three MIT departments: the MIT Museum to reach the general public, the MIT Edgerton Center to reach students and teachers, and the MIT Catalyst Clinical Research Center to reach health professionals. The COE2C continues to be led by Dr. Kathleen Vandiver, director, with support from Ms. Amy Fitzgerald and Dr. Amanda Gruhl, outreach coordinators.

The CEHS continues a long tradition of providing its membership with state-of-the-art research facilities that reflect, nurture, and support the Center's research directions. The CEHS researchers use four facilities cores; each core contributes to the research efforts of at least 10 Center members. The cores include the Bioanalytical Facilities Core, the Genomics and Imaging Facilities Core, the Animal Models Facilities Core, and the Integrative Health Sciences Facilities Core.

Under the direction and co-direction of Drs. John Wishnok and Koli Taghizadeh, respectively, the Bioanalytical Facilities Core provides Center members with the latest tools, techniques, and expertise in the characterization and quantification of almost any molecule in a biological system—including modifications of cellular molecules such as DNA, RNA, and protein—as well as state-of-the-art proteomics and metabolomics research capabilities. This core operates as a resource for the Center, as well as all of MIT, and provides invaluable training for students and postdoctoral scholars to become proficient in biological mass spectrometry and other state-of-the-art analytical methods. In May 2015, the Center purchased an inductively coupled plasma mass spectrometry (ICP-MS) with support from the Office of the Vice President for Research. This instrument will allow Center members and others in the MIT community to measure trace amounts of a host of inorganic compounds, including toxic metals. The ICP-MS will be delivered and installed in July 2015.

Drs. Stuart Levine and Robert G. Croy oversee the Genomics and Imaging Facilities Core, which provides Center members with a variety of sophisticated quantitative imaging technologies and an integrated facility for DNA sequencing and analysis, data storage and management, data mining, biostatistics, and modeling. These tools are critical to the goal of moving CEHS research to higher levels of complexity in an attempt to understand the response of an organism to environmental influences at the systems level.

The Animal Models Facilities Core, directed by Professor James G. Fox, provides Center members with the latest technologies for the application of animal models to environmental health research, including the generation of genetically engineered mice, embryo rederivation of imported mice, colony management, and preparation and interpretation of murine tissues by histological and image analysis.

This year, the Integrative Health Sciences Facilities Core (IHSFC) leadership has been reorganized. It is now led by David H. Koch Professor of Science Michael Yaffe and Professor James G. Fox with the support of the Hospital Liaison Program directors (Drs. Scott Floyd and Catherine Ricciardi) along with the clinical and translational consultants (John J. and Dorothy Wilson Professor Sangeeta Bhatia; Goulder Professor of Civil and

Environmental Engineering and Engineering Systems Emeritus David Hunter Marks; Underwood-Prescott Professor of Biological Engineering Peter C. Dedon; Associate Professor of Biological Engineering Jacquin C. Niles; and Drs. Ravi Thadhani, Susan Erdman, and Avrum Spira). The IHSFC was developed to help CEHS members translate their research activities for the clinical and epidemiological realms. This effort involved formalizing a relationship between CEHS and the MIT Catalyst Clinical Research Center to develop a facilities core that would provide services to CEHS members involved in human health research, particularly studies with clinical human samples, clinical research, and statistics for human population-based studies and other activities.

Another major program in the CEHS is the Global Environmental Health Sciences Program, led by Dr. Gerald N. Wogan (director) and Professor Dedon (co-director). This program focuses on developing collaborative relationships between CEHS members and international researchers in environmental health, as well as on developing research training and education exchange programs for graduate students and postdoctoral scholars. Our global efforts thus far include Thailand, Vietnam, and Singapore.

The CEHS has a long-standing commitment to fostering the careers of its young scientists and junior faculty. The Career Development Program, directed by Professors Bevin P. Engelward and Leona D. Samson, provides a broad range of opportunities for the advancement of its members at all stages of their careers. From research resources to career coaching to global opportunities for outreach, the CEHS provides resources that promote success and enable community engagement in environmental health. These types of opportunities and resources are:

- Mentoring
- Financial support
- Research resources
- Speaking opportunities for junior faculty
- New Frontiers seminar series for postdocs
- Translational research support
- Outreach opportunities
- Global program in public health
- Responsible conduct of research

The Center continues its successful and popular Pilot Project Program, which is overseen by the Center director and the deputy director along with the Internal Advisory Committee. This program provides initial support for junior investigators and support for senior investigators to establish new lines of research in environmental health sciences and toxicology. The program also motivates investigators from other fields of research to apply their expertise to environmental health research and promotes the development of novel COE2C activities arising directly from the research of our Center members.

Finally, the Translational Pilot Project Program, which is an offshoot of the regular Pilot Project Program mentioned above, was created to encourage CEHS members and others to pursue translational research in which fundamental research activities are moved progressively from cell-based systems to animal models and ultimately into human clinical and epidemiological studies. The importance of this type of research warrants special funding outside of the regular Pilot Project Program. Starting this year, the Translational Pilot Project Program has partnered with the Theron G. Randolph Translational Pilot Project gift to encourage investigators to take basic environmental health research to the translational level, especially in the areas that connect environmental exposures to allergy and immunity. A gift from Ms. Vilma Kinney has enabled this new direction for the CEHS.

Accomplishments in 2014–2015

The CEHS has maintained a strong volume of research support, totaling over $8.088 million in FY2015 and resulting in at least 300 publications. These research projects are funded through a variety of sources, including the National Institutes of Health (NCI, NIAID, NIBIB, NIMH, and NIEHS), the National Science Foundation, Department of Defense, Food and Drug Administration, the Singapore-MIT Alliance for Research and Technology, and various foundations and industries. Our institutional Training Grant in Toxicology, now in its 42nd year, was recently renewed and will be managed by the CEHS.

In February 2015, a call for Pilot Project and Translational Pilot Project proposals was issued which resulted in the award of three pilot projects (one basic science pilot projects and two translational pilot projects). These funded projects started on June 1, 2015.

The National Institutes of Environmental Health Sciences mandates that each of its 22 Core Centers participate in a program for community engagement and outreach. The goals are two-fold: (1) develop partnerships with community members to translate and disseminate the Center's research science, and (2) evaluate outreach models, disseminate the results at local and national levels, and promote models for national implementation.

Our support for communities in the surrounding towns near Boston continued to deepen in several ways. Last year we mentioned advising the Mystic River Watershed Association (MyRWA) and its sister organization, the Friends of the Malden River (FoMR), on toxicology matters. These two organizations encompass several environmental justice communities such as the towns of Malden, Chelsea, and Everett, as well as a total of 22 towns along the urban river with a legacy of serious industrial pollution. The FoMR is trying to obtain funding to conduct a human health risk study for the Malden River, and they asked CEHS to help generate preliminary data for their proposal. The CEHS COE2C established the Malden River as a case study site for MIT graduate students in the Civil and Environmental Engineering Department. This connection has been a productive partnership. Furthermore, COE2C Director Dr. J. Kim Vandiver has provided leadership in the filing of a Public Involvement Plan for 378 Commercial Street in the City of Malden with the Massachusetts Department of Environmental Protection. This action prompted a Public Hearing in Malden, where Honeywell, Inc. presented its plans. Further actions to clean up the river are being explored by the FoMR in collaboration with MIT.

In August 2014, the COE2C visited three of the five Abenaki Tribal Nations in Maine to listen to community health concerns. These Tribes occupy land that in some cases was highly contaminated by industrial pollution. Several excellent exchanges followed: Professor Darren J. Ranco (Penobscot) of the University of Maine presented a seminar at MIT, Professor Noelle Eckley Selin (a Center member) gave a talk on mercury fate and transport in Presque Isle, ME to the Micmac Tribe, and Dr. Vandiver attended the Tribal Environmental Health Summit in Boston, MA sponsored by the EPA Region 1. These exchanges are moving the Center towards research projects of mutual interest. In working with health professionals, in 2014 there were a record-breaking number of professional development sessions for nurses, including a pre-conference DNA Hands-on workshop at the American Public Health Association (APHA) Conference in New Orleans, LA. Additionally, the COE2C completed a new exhibit at the MIT Museum entitled CometChip Detection Technology for DNA Damage and Repair. This display demonstrates how CEHS research can lead to significant breakthroughs in understanding gene-environment interactions. Lastly, our NIEHS sponsor requires COEC programs to evaluate their outreach models and to promote models for national implementation. This past year has been productive in that regard. The first injection-molded sets of our hands-on DNA and protein models have been manufactured and should be ready for distribution soon. MIT patents have been filed and are pending. Thus important gains have been made this year.

For the eleventh consecutive year, the Center offered its highly popular CEHS Poster Session in May 2015. This event has attracted over 100 participants, including CEHS members, faculty, students, postdoctoral scholars, scientists, and staff. The Myriam Marcelle Znaty Research Fund, administered by Underwood Prescott Professor of Biological Engineering, Chemistry and Toxicology Steven R. Tannenbaum, continues to sponsor cash prizes, the dollar amounts of which have increased significantly from prior years, for the best poster presentations in both graduate student and postdoctoral scholar categories. The CEHS Poster Session receives overwhelmingly positive feedback in terms of promoting scientific exchange and collaborations, as well as introducing the CEHS to the broader MIT community.

In the past year, the Center hosted eight Friday Forum lectures. This long-standing series of informal research seminars is one of the most popular CEHS-sponsored events and has stimulated significant collaboration in environmental health research with new Center members. New Center members, potential members, and Pilot Project award recipients gave presentations.

The second CEHS-sponsored monthly seminar series is the Boston DNA Repair And Mutagenesis (DRAM) Seminar Series. For many years, the DRAM seminars have brought together scientists from institutions throughout New England who share an interest in the mechanisms of genome maintenance, and the consequences of mutations in humans and model organisms. This evening seminar series draws students, postdocs, and faculty from the UMass Medical School in Worcester, Northeastern, Harvard, Boston University, Yale, Tufts, and Brown. The DRAM seminar has become a vibrant part of the CEHS culture.

In addition, the Center established and held its first New Frontiers Postdoc Seminar Series. The Center recognizes the importance of having a great seminar for job interviews, and this seminar 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, which asks questions and offers advice that help in preparation for the postdoc's job interviews. Importantly, following the presentation, there is a private meeting of junior and senior faculty with the postdoc speaker at which there is a detailed discussion of speaking strategy, organization, and clarity. This format provides valuable feedback for postdocs, enabling them to hone their slides and talks in preparation for a competitive job market.

In addition, the Center continues to co-sponsor three named lectureships, the Robert S. Harris, Gerald N. Wogan, and David B. Schauer lectures. Professor Ian A. Blair presented the Gerald N. Wogan Lecture, *The Biochemistry of Mitochondrial Dysfunction,* in April 2015. Professor Eric Rubin presented the David B. Schauer Lecture, *Metabolic Heterogeneity in Mycobacteria and their Hosts—Daring to be Different,* in March 2015. And Professor Lorena Beese was scheduled to present the Robert S. Harris Lecture in October 2015.

The CEHS also sponsored two special seminars in November 2014. The speakers were Professor Ranco, who presented on "*Sustainability Science and Indigenous Research Methods: Protecting Wabanaki Basket Making Traditions from the Emerald Ash Borer,*" and Professor Peter Preiser, who presented on "*Dissecting Invasion in Plasmodium Faciparum: Reticulocyte Binding Protein Homologues Regulate Key Steps."*

Plans for 2015–2016

In the next year, the CEHS leadership will be actively engaged in strategic planning discussions to reflect both the evolution of the Center membership as well as the Center organizational chart should we have to resubmit a competitive renewal application in April 2016. If needed, a meeting will be scheduled with the External Advisory Committee to provide us guidance on this resubmission. The CEHS Center director and the deputy director will focus on the goals for 2015–2016, which are (1) to re-assess the Center membership, with the specific goal of attracting junior faculty and to help foster relationships where possible between scientists and engineers; (2) to stimulate Center members' participation in the Global Environmental Health Sciences Program, because environmental pollution ignores geopolitical boundaries and the diseases of the developing world indirectly impact the United States; (3) to re-examine the Career Development Program and the Integrative Health Sciences Facilities Core, to make sure they are fully in concert with best practices in our field; (4) continue our dialogue with members of the External Advisory Committee; and (5) to continue to make use of the Community Outreach Education and Engagement Core to showcase to our community some of the exceptional research performed by Center members. As always, the CEHS leadership will continue efforts to engage the broader MIT community in research activities related to environmental health sciences.

Global Environmental Health Sciences Program

The CEHS will continue our ongoing collaboration with the Chulabhorn Research Institute in Bangkok, which has been a developing world hub for research and training for many years. In addition, several Center members have laboratories and strong commitment in Singapore. Professors Samson and Engelward collaborate with several NIEHS-sponsored researchers on an arsenic exposure project in Vietnam.

Career Development Program

The Career Development Program conducts mentoring activities for junior members of the Center that will complement departmental mentoring efforts and enhance the participation of junior members in the Center activities. For many years, the faculty members of the Toxicology Training Grant (Professor Essigmann is the PI and Professors Dedon, Engelward, and Forest White serve on the Executive Committee) have run a series on Responsible Conduct of Research for the pre- and postdoctoral trainees. We have opened this series to all faculty members of the Center. This training is central to the development of young scientists. Junior faculty are also the primary presenters in our Friday Forum series, which recruits in part from previous awardees of our Pilot Project Programs. The opportunity to present in front of senior colleagues in this well-attended series gives excellent opportunities for career feedback. Finally, the online series of lectures to graduate students, postdocs, and junior faculty offered as part of the Responsible Conduct of Research program will be expanded by two sessions. The Center will continue the New Frontier Postdoc Seminar Series in addition to the new Grant Proposal Writing Workshop and the Page One Program, in which senior faculty evaluate the Specific Aims and Introduction sections of grant proposals by junior faculty to help them craft competitive proposals.

Integrative Health Sciences Facilities Core

This core will continue to provide Center members with guidance on moving their research activities toward translational and clinical applications. A formal mechanism will be developed to engage a larger percentage of the Boston biomedical community in the affairs of the Center.

Pilot Project and Translational Pilot Project Programs

The CEHS plans to continue providing funding for novel and innovative research projects related to environmental health issues and translational research projects. Priority will be given to projects that involve collaborations, new environmental health and toxicology research activities, junior investigators, and projects with a likelihood of subsequent independent funding. A potential call for pilot projects could be issued in late fall 2015 in addition to our standard spring 2016 call release. Emphasis will be given to activities that eventually lead to an NIEHS grant application. The CEHS will continue the partnership with the Theron G. Randolph Translational Pilot Project gift managers to fund investigators who conduct research that extends from basic environmental health research to the translational level.

Community Outreach Education and Engagement Core

We expect to complete the initial development of our molecular biology kits that can be disseminated both to K-12 teachers and to health professionals in the next year. Overall, in conjunction with the staff of the MIT Edgerton Center, the COE2C will continue to perform outreach activities in basic science and health education. These activities include the MIT Museum exhibits, teacher workshops, and the workshop series for healthcare professionals. Also in 2016, the COE2C plans to publish two educational papers, one of which is in translational medicine, describing novel teaching methods for simulating gene-environment interactions, and the other is on teaching methods for introductory chemistry that will include climate change information.

CEHS Sponsored and Co-Sponsored Lecture Series

The CEHS will continue the sponsored (Friday Forum, DRAM, Special Seminars, and New Frontiers Seminar Series for Postdocs) and co-sponsored (named lectureships) lecture series this upcoming year.

Poster Session

We will continue this successful activity again in 2016.

Newsletter

Our goal is to continue publishing a newsletter twice a year during the academic period. The newsletters are available online through our website which was redesigned in August 2014. All newsletter editions are distributed to Center members, our sponsoring agency (NIEHS), and peer P30 centers.

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