Center for Environmental Health Sciences

The overriding goal of the Center for Environmental Health Sciences (CEHS) continues to be to study the biological effects of exposure to environmental agents so that we may better understand and predict how such exposures affect human health. 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—in other words, the organism's genetic susceptibility. Environmental health research at MIT encompasses a wide range of disciplines, and 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 last year or two, CEHS has begun to include focused efforts on problems that are of particular relevance to the developing world in addition to adding more human-population based studies.

Organization

CEHS continues to be comprised of an administrative core, the Community Outreach and Education Program (COEP), the Pilot Project Program, three research cores, and three facilities cores, although there is a major change in organization that has been developed during the last year or two and which will be implemented in the coming year. Center membership currently consists of 27 faculty scientists and engineers, 26 from MIT and one from Harvard University (Dr. David Hunter). In addition, the Center has two research scientists who direct or codirect two of the Center's facilities cores. The members of the administrative core, which is charged with overall operation of the Center, include Professor Leona Samson (Biological Engineering Division [BE]), director; Professor Peter Dedon (BE), deputy director; Jacqueline Breen, administrative officer; Sophea Chan, financial assistant; and Julie Coiro, administrative assistant. The COEP is responsible for all outreach activities of CEHS, which emphasizes K–12 education for teachers and students as well as adult and community outreach through the Museum of Science and the MIT Museum. The COEP is administered by Dr. Kathleen Vandiver, director; Professor Bevin Engelward (BE), codirector; and Amy Fitzgerald (Edgerton Center), coordinator.

Research in CEHS is currently organized into three research cores that build on the strengths of the Center's membership. These are the Mutation and Cancer Research Core, the Bioengineering for Toxicology Research Core, and the Environmental Systems and Health Research Core. The theme of each core derives from the members' research interests, and all are linked by the center's overarching focus on defining how biological systems respond to exposure to environmental agents. The Mutation and Cancer Research Core, directed by Professor Dedon, addresses the relationships between DNA damage, DNA repair, mutation, and cancer associated with exposure to environmental and endogenous chemical and physical agents. The Bioengineering for Toxicology Research Core, directed by Professor Linda Griffith (BE, Mechanical Engineering), was created to facilitate the development of new experimental tools and analysis methods relevant to environmental influences on human health, with a range

of approaches spanning the molecular-cellular systems length scales. The mission of the Environmental Systems and Health Research Core, directed by Professor David Schauer (BE), is to understand the relationships that link environmental processes and human health in terms of exposure to chemical agents as well as biota. This is most aptly illustrated by the triad of dependent interactions of aflatoxin, hepatitis virus, and human liver cancer, which has been a research foundation for CEHS since its inception over three decades ago.

Three state-of-the-art facilities cores reflect CEHS's research directions. The cores are heavily used by CEHS researchers, with each contributing to the research of at least 10 members. Under the direction of doctors John Wishnok (BE), Koli Taghizadeh, and Paul Skipper (BE), the Bioanalytical Facilities Core provides center members with the latest tools, techniques, and expertise in the characterization and quantification of chemical substances and modifications of cellular molecules such as DNA and protein. The core operates as a resource for the center and provides training for students and postdocs to become proficient in mass spectometry analysis. The Genomics and Bioinformatics Facilities Core is directed by Dr. Rebecca Fry, and provides center members with an integrated facility for microarray fabrication and analysis, database storage, database management, data mining, 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 the organism to environmental influences at the systems level. The Animal Models and Pathology Facilities Core, directed by Professor James Fox (Division of Comparative Medicine, BE), provides center members with the latest technology 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 tissue by histological and image analysis.

Accomplishments in 2006–2007

CEHS has maintained a strong volume of research support, totaling over $6.4 million in 2006–2007. These research programs are funded through a variety of sources, including the National Institute of General Medical Sciences, the National Cancer Institute, the Department of Energy, the National Science Foundation, the American Cancer Society, the Defense Advanced Research Projects Agency, and the National Institute of Environmental Health Sciences (NIEHS).

With the continued support of our NIEHS Center Grant, we have been able to provide support for a number of pilot projects for the year 2006–2007. Pilot project funding allows for the conduct of novel research activities that utilize multidisciplinary approaches to the study of environmental health sciences. During 2006–2007 we were able to fund seven projects for the period July 2006–June 2007 and five projects for the period May 2007–April 2008. Investigators and the pilot projects supported include the following:

July 2006–June 2008

- Associate professor Jeffrey Coderre (Nuclear Engineering), The Role of Vascular Endothelial Cell Damage in Tissue Response to Low-Dose Radiation
- Professor John Essigmann (BE), Transcriptional Networks Affected by Agents that Suppress Toxicity and Carcinogens by Aflatoxin B1: Implications….
- Assistant professor Roman Stocker (Civil and Environmental Engineering), Microfluidic Investigation of Motility of Environmental Pathogens: *Helicobacter Pylori*
- Professor Steve Tannenbarum (BE), Developing a Strategy for interrogating the Metabolic State of Hepatocyte Cultures
- Kathleen Vandiver, director, COEP, CEHS, The Cell is a Molecular Machine (Continued)
- Associate Professor Michael Yaffe (Biology/BE), A High Throughput Automated Microscopy-Based RNAi Screen for Modifiers of the DNA Damage Response

May 2007–April 2008

- Associate Professor Sangeeta Bhatia (Health Sciences and Technology, Electrical Engineering and Computer Science[EECS]), Microscale Engineered Liver Tissues for Evaluating Chronic Toxicity of Environmental Toxicants
- Associate Professor Bevin Engelward (BE), Development of a High-Throughput DNA Damage Sensor for Environmental Health Studies
- Associate Professor Jongyoon Han (EECS), Monitoring Low-Abundance Enzyme Activity by Preconcentration and Reaction in Micro/Nanofluidic Device
- Professor Douglass A. Lauffenburger (BE), Systems Biology Analysis of Nuclear and Membrane-Initiated Signaling by Endocrine Disrupting Chemicals
- Research Scientist Lisiane Meira (CEHS/BE), A Clinical Study of a Base Excision-Repair Activity, Genetic Polymorphisms, and Chronic Inflammation

Through our Center Grant funding we continue to support the COEP, which promotes community-level scientific literacy through a variety of programs targeted to students and their teachers from grade four through the undergraduate curriculum, as well as to continue to provide faculty with outreach resources for both the research and facilities cores. One of the goals of the COEP program is to create opportunities for MIT academics to participate in public health education.

COEP continues to run three highly successful activities: the after school sessions in October on environmental health science for Summerbridge Cambridge, an excellent academic program for local middle school students; the two-day summer workshop on environmental health science research for teachers in July; and the classroom instruction sessions at the Edgerton Center on environmental health topics such as cell division and

groundwater for students. In addition the creation of a new exhibit at the MIT museum called The Cell has reached students and families from the local community.

A major highlight of the center's activities in 2006–2007 was the Fourth Annual CEHS Poster Session. This event attracted over 150 participants comprised of CEHS members, students, postdoctoral scientists, and staff, as well as other MIT faculty members, presenting 53 scientific posters in an afternoon session at MIT. This year the Myriam Marcelle Znaty Research Fund sponsored cash-offered prizes to poster participants and the son of the late Myriam Znaty presented the awards to the winning students and postdoctoral scientists. Graduate Students who tied for the 1st Prize of $500 include:

- Alexandria Sams from the Griffith lab, who presented her work on "Development and Characterization of an in vitro Culture System as a Physiological Model for Chronic Hepatitis B Infection"
- Dominika Wiktor-Brown from the Engelward lab, who presented her work on "The Impact of Age, Exposure, and Genetics on Homologous Recombination in vivo" and
- Paul Huang from the White lab, who presented his work on "Quantitative Phosphoproteomic Analysis of EGFRvIII Cellular Signaling Pathways in Glioblastoma Multiforme."

A 2nd Prize of $100 was awarded to Lauren Frick, a graduate student in the Essigmann lab. Ms. Frick presented her work on "Alleviation of 1,N6-ethanoadenine Genotoxicity by the *Escherichia coli* Adaptive Response Protein AlkB." A 3rd Prize of a CEHS T-shirt, mug, and lanyard was awarded to Marcos Marcos, a graduate student in the laboratory of Roman Stocker. Marcos presented his work on "Bacteria Fighting Turbulence: A Microfluidic Study."

The Postdoctoral Fellows/Associates winners included:

- 1st Prize of $500 awarded to Michelle Williams, a postdoctoral associate in the Tannenbaum lab, who presented her work on "Lipid Peroxidation of Nitrated Proteins from iNOS Induced Macrophages Using Biotin Labeling and Capture"
- 2nd Prize of $100 awarded to Shiva Kalinga from the Dedon lab. Dr. Kalinga presented his work on "Genomic Approaches to Understanding Cellular Determinants of DNA Damage."
- 3rd Prize of a CEHS T-shirt, mug, and lanyard was awarded to Diana Borenshtein from the Schauer lab. Dr. Borenshtein presented her work on "Long-term Metabolic Effects of Acute Intestinal Infection in Mice."

The Poster Session has become an annual event that receives overwhelmingly positive feedback in terms of promoting scientific exchange and collaborations, as well as introducing CEHS to the broader MIT community. An abstract book was published and we anticipate having this available on CEHS website for viewing.

The 2006–2007 year also saw several enhancements to CEHS Facilities Cores. The Bioanalytical Facilities Core acquired two major new instruments that will greatly benefit Center members interested in biomarker development, metabolomics, and proteomics. A very powerful new Agilent triple quadrupole time-of-flight mass spectrometer system was purchased using an award from the National Center for Research Resources on which Professor Dedon is the Principal Investigator. The other instrument is a new Agilent triple quadrupole mass spectrometer purchased jointly by the Center and several CEHS members. Both instruments will be available for use by CEHS members for their research projects.

Plans for 2007–2008

This past year, CEHS leadership has actively engaged in strategic planning discussions that reflect both the evolution of the Center membership and the new mandates of the NIEHS, the NIH Institute providing the major funding to support CEHS. There are three major objectives in the strategic planning process. Our current plan is to reorganize the research cores along disease-specific lines rather than the current disciplinary lines. This will be designed to foster greater interaction among the diverse Center membership and bring their various talents to bear on specific biomedical problems, such as inflammation, liver disease, and other human conditions related to environmental exposures. A second major effort is underway to create a new core in Global Environmental Health Sciences that focuses on developing collaborative relationships between CEHS members and international researchers in environmental health, and also on developing research training and education exchange programs for graduate students and postdoctoral level scientists. This global effort is being developed jointly with the Johns Hopkins University Center for Urban Environmental Health, the Chulabhorn Research Institute, and the MIT CEHS. Finally, CEHS will also create a new Integrative Human Health Science core to help Center members translate their research activities into the clinical and epidemiological realms. This effort involves formalizing a relationship between CEHS and the MIT Clinical Research Center to develop a core to provide services to CEHS members involved in human health research, particularly with involvement in the studies with clinical human samples, clinical research, statistics for human population based studies and other activities.

In the next year we will formalize these initiatives as we continue to evaluate the changing needs of CEHS members, as well as provide an opportunity to recruit new faculty whose research is relevant to the environmental health sciences.

Pilot Projects

CEHS will continue its long-standing and successful Pilot Project Program, the specific goals of which are to:

- provide initial support for new investigators to establish environmental health projects,
- allow exploration of possible innovative new directions representing a significant departure for established investigators in environmental health sciences, and
- stimulate investigators from other areas of endeavor to apply their expertise to Environmental Health research

We anticipate disseminating a call for proposals in January 2008 for funding beginning April 2009. It is anticipated that CEHS will provide $15,000–$25,000 for four to six novel and innovative research projects related to environmental health issues. Priority will be given to projects that involve collaboration and have a likelihood of subsequent independent funding. Also, CEHS will coordinate its Pilot Project Program with that of the Woods Hole Oceanographic Institute (WHOI) Center for Oceans and Human Health, which is jointly sponsored by the NIEHS and NSF and has several areas of research complementary to CEHS.

Community Outreach and Education Program Activities

The COEP will continue the activities described earlier with the additional development of new Edgerton Center teaching activities. These activities include MIT Museum events, teacher workshops, Teachers as Scholars sessions, and Edgerton Center events. We will also begin new programs involving teachers and students from the John D. O'Bryant School of Mathematics and Science in Boston. This Boston public school is comprised of 7–12 grade students participating in a curriculum enriched in math and science.

Friday Forum

CEHS will continue the highly successful Friday Forum series in which Center members and CEHS Pilot Project recipients share their research programs in monthly presentations at an event intended to promote interaction among members and attract new members to the Center in an informal social setting.

External Advisory Board

We anticipate a meeting with the CEHS External Advisory Board in late spring or early summer 2008 to review the goals and plans for the center over the next five-year period.

Poster Session

We will continue this successful activity again in 2007–2008. We will attempt to coordinate this with the WHOI Center for Oceans and Human Health to promote an exchange among members of these two research groups.

Newsletter

Two editions of CEHS Newsletter were published in the past year. The Winter/Spring 2006 issue was published in July 2006 and highlighted four decades of MIT research on aflatoxin. The Summer/Fall 2006 edition was published in January 2007 and highlighted gene-environmental interactions in the age of genome-wide association studies. Both editions of the newsletter were distributed throughout the MIT community and can also be read online at http://cehs.mit.edu/News.html.

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More information about the Center for Environmental Health Sciences can be found at http://cehs.mit.edu/.