



MIT Center for Environmental Health Sciences Newsletter

From the Ocean to the Gut: The Impact of Microbial Populations on Human Health Brings CEHS Researchers Together

What do the Ocean Coastal Waters, the Human Gut, and a specific mouse animal model have in common? Well, that's easy: the Center for Environmental Health Science's Environmental Systems & Health Research Core brought together **Martin Polz** from the Civil and Environmental Engineering (CEE) Department, **David Schauer** from the Biological Engineering Division and the Division of Comparative Medicine (DCM), **Jim Fox** from DCM and our Animal Models Facility Core, and perhaps in the future, **Ed DeLong** (CEE), to help answer this question. We depend on vastly diverse microbial populations from global energy and matter cycles to protection against in our gastrointestinal tract.

This field of environmental health is forging into new frontiers that cross many boundaries to bring groups of scientists and engineers together with their unique perspectives and tools, to answer some complex environmental health questions in a controlled laboratory setting.

A rich collaboration is taking place between these three diverse researchers, and is centered on studying the ecology of the human gut using new tools and new expertise. There is a huge complexity of microbial communities living inside the gastrointestinal tract, and these communities depend on each other and the gut itself to live, communicate, and flourish; this makes it extremely difficult to study them. Many of these microorganisms are still unidentified because they cannot be cultured, and the organisms that do grow in culture do not reflect the population inside the gut, a very complex environment. The challenge is to be able to under-

stand and observe the dynamics, interactions, and effects of these microbial communities on human health. This is a large challenge, but with the collaboration of the CEHS Animal Model Facility Core and the labs of David Schauer, Jim Fox, and Martin Polz, the challenge is being addressed like never before.

Several studies indicate that the microflora of the gut provide essential nutrients for the body, may cause differentiation of the host intestine in adults, may play a large role in immune development of the host, and aid in digestion and protection against ingested pathogens. Of course, these same microorganisms can play a role in causing or enhancing progression of some diseases, such as Inflammatory Bowel Disease, Hepatitis, and possibly even colon cancer. David Schauer, Director of the Environmental Health & Systems Core of CEHS, has been studying this area and has realized through his research and through his collaborations with Jim Fox, the need for development of better quantitative tools and animal models to capture and better understand these significant phenomena.

This collaboration resulted in a novel application of a mouse model with a well-defined gut microbial population, consisting of eight common bacterial species (the eight altered Schaedler flora); this may be the most complex, yet well-defined and stable animal model developed to date, and the observed structure of its G.I. tract is comparable to that of a wildtype mouse. Through close collaboration with Jim Fox of DCM, these 8 microbial species may be added to or subtracted from, using the Animal Model Core Facility's tools and expertise. This allows the

(Continued on page 2)

MIT-CEHS Newsletter
Summer/Fall 2005

In this issue

<i>Feature: From the Ocean to the Gut...</i>	1
<i>CEHS & GEM⁴</i>	3
<i>CEHS Events</i>	3
<i>CEHS Brag Corner</i>	4
<i>Recently Published</i>	4
<i>What's new at CEHS</i>	4

Newest Member of CEHS' ESH Research Core



Ed DeLong, Professor of Biological Engineering Div. and Civil and Environmental Engineering Dept., was also just recently elected to the American Academy of Arts and Sciences.



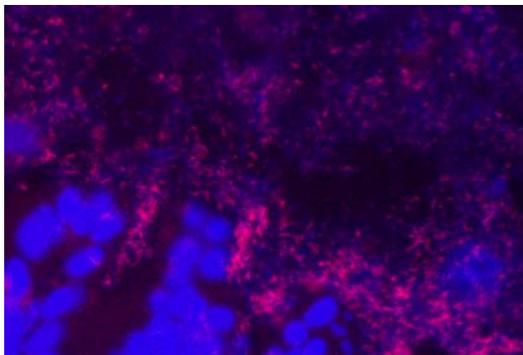
“This project is an excellent example of how the Center for Environmental Health Sciences brings together researchers from diverse fields but with common interests...”

(Continued from page 1)

group to study the impact of each species of microbe on the health of the host and to identify their spacial arrangement along the G.I. tract, as well as their resulting dynamics upon perturbation. But how did they quantitatively study these issues and begin to explore some of the unknown relationships between gut flora and host using this unique animal model?

Martin Polz brings to this collaboration his expertise in studying structure/function relationships in large populations of microorganisms in coastal waters. Martin and others involved in this field of “environmental microbiology” feel that we are at an important crossroad. As Martin writes, “...microbes are the most ubiquitous organisms on Earth, yet the dynamics that govern their interactions and evolution remain almost completely unknown.” Both Martin Polz and CEHS’s newest member, Ed DeLong, use genomics, modeling, and other new quantitative approaches to discover new microbes, the roles they play individually and in relationship to other microbe populations, as well as their impact on global and human health. Martin is especially interested in understanding how new pathogens may arise in a population through environmental and evolutionary influences. He has brought his unique perspective and quantitative tools to the rich collaboration with Jim Fox and David Schauer, centered on the ecology of the gastrointestinal tract.

This interdisciplinary approach resulted in the first published study that used quantitative molecular methods to research levels and spacial distribution of these eight microbial gut species, sampled directly from the entire length of the G.I. tract of the ASF mouse model. The results also pointed to a large difference in fecal sampling and sampling directly from the gut, showing that the two may not correlate very closely. This study is largely significant, because it allows for culture independent studies of a defined, yet complex population of gut flora in a quantitative and spacial manner. Through this collaboration, the dynamics of these populations can now be studied after, for example, infection of the host with a pathogen, or addition or subtraction of some of the eight ASF flora from the gut (which has been made possible through Jim Fox’s Animal Models Core). The group



Mucispirillum schaedlerii, a spiral-shaped intestinal bacterium, primarily colonizes the mucus layer (pink is the bacterial and the blue are the nuclei of the intestinal epithelium)

can then observe changes in the population levels, metabolism, and spatial organization of the microorganisms and how this affects the health of the host. The group is now able to examine individual differences between mice and differences between how some microorganism populations may change upon environmental perturbation. This may lead to information about individual microbe and pathogen niches in the gut, their crosstalk amongst and competition with other species, and their role in both protection and causation of disease in the host.

This project is an excellent example of how the Center for Environmental Health Sciences brings together researchers from diverse fields but with common interests, and provides them with an excellent facility core like the Animal Models Facility to begin to tackle complex environmental health issues in a controlled, quantitative manner. These interactions allow us to forge into unknown waters with cutting edge tools, both literally in the global oceans, and figuratively inside the living body. Both scenarios consist of highly complex populations of microorganisms coexisting with and contributing to the health of humans, individually as well as globally.

— Katy Wack

For more information, please explore the following links:

1) <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?CMD=search&DB=pubmed>

Sarma-Rupavtarm RB, Ge Z, Schauer DB, Fox JG, Polz MF. *Spatial Distribution and stability of the eight microbial species of the altered schaedler flora in the mouse gastrointestinal tract.* Appl Environ Microbiol. 2004 May; 70(5): 2791-800.

The Environmental Health and Systems Core

<http://cehs.mit.edu/environmental.html>

The Animal Models Facility Core

<http://cehs.mit.edu/animalmodelpathology.htm>

Information on the highlighted CEHS researchers

<http://cehs.mit.edu/members.html>

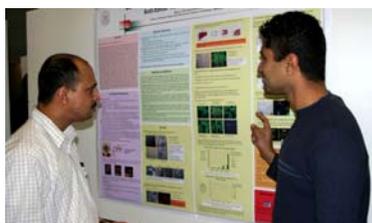


CEHS Plays a Major Role in the Creation of Global Alliance for Environmental Health Science & Technology

GEM⁴, a global enterprise for Micro-Mechanics and Molecular Medicine being spearheaded by Dr. Subra Suresh of the MIT Department of Materials Science and Engineering, was launched in October 2005. The GEM⁴ vision will bring together researchers and professionals from major institutions across the globe with distinctly different, but complementary, expertise and facilities to address significant problems at the intersections of select topics of engineering, life sciences, medicine, and public health.

CEHS will play a major role in GEM⁴ by heading up the establishment of the Environmental Health Science and Technology (EHST) Global Alliance. The alliance will initially involve key research organizations such as MIT, Johns Hopkins University (JHU), and Chulabhorn Research Institute (CRI) in Thailand. It is anticipated that several other institutions will join the alliance.

A working group of CEHS members including Drs. John Essigmann, Ram Sasisekharan, Gerry Wogan, Rebecca Fry, Pete Dedon, Bevin Engelward and Leona Samson along with Drs. Skorn Mongkulsuk and Mathuros Ruchirawat from CRI, and Dr. John Groopman from JHU met with Dr. David Schwartz, Director of the NIEHS, and Dr. William Suk, from NIEHS, to begin the process of defining the scope as well as major objectives and goals of the EHST Global Alliance. Dr. Leona Samson, Director of the CEHS, stated that this is an exciting and important endeavor that provides great opportunity to pool knowledge and resources from around the world to address issues of environmental health sciences that have a major global impact.



CEHS EVENTS



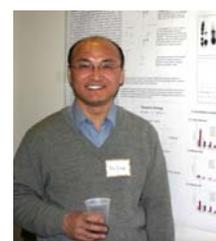
The **2nd Annual CEHS Poster Session** held last spring had a great turnout. Over 125 people attended and over 50 posters were presented.

The scientific research presented was intellectually stimulating and highlighted the many collaborations among the CEHS member labs.



In addition, the **CEHS Retreat** was held in July at the Endicott House in Dedham. This was a great opportunity to share some fascinating results as well as presenting new hypotheses to consider.

Check out Future Upcoming Events and Seminars at <http://cehs.mit.edu/CEHSEvents.html>.





Center for Environmental Health Sciences

Massachusetts Institute of Technology
77 Massachusetts Avenue, 56-235
Cambridge, MA 02139

Phone: 617-253-6220
Fax: 617-452-2066
E-mail: cehs@mit.edu

WHAT'S NEW at CEHS

Jackie Breen joined CEHS as the financial administrator in May. Jackie came to us from Tufts-New England Medical Center where she spent eight years as a Sr. Research Administrator. Prior to that she was at the Harvard School of Public Health for 20 years.

Bevin Engelward, PhD and Professor of Biological Engineering, has accepted the post of Co-Director of CEHS' Community Outreach and Education Program (COEP), in addition to her contribution to the CEHS Mutation and Cancer Research Core.

Rebecca Fry, PhD, has been appointed as the Director of the CEHS Genomics and Bioinformatics Research Core; she served as Co-Director of the core for three years.

Christian Rheault is the new Computer Technical Support Specialist for CEHS. In addition to his technical experience and abilities, he is also an MIT alumnus.

Kathy Vandiver, PhD, joined CEHS in July as the Director of COEP. Kathy has been teaching science and writing curriculum for Middle Schools in Lexington, MA for the past 16 years. She has an MA in education from the Harvard School of Education, and PhD from Cellular Biology and Anatomy Dept. at Tufts School of Medicine.

CEHS Brag Corner

Gerry Wogan, Co-founder of CEHS and member of the Mutation and Cancer Research Core, was awarded the \$250K Mott Prize, recognizing his outstanding recent contribution to the cause or prevention of cancer.

Leona Samson, Director of CEHS, and Jim Fox, Director of the Animal Models and Pathology Facilities Core, were both elected to the Institute of Medicine.

Penny Chisholm and Ed DeLong, both members of CEHS' Environmental Systems & Health Research Core, were named Moore Foundation Investigators in Marine Science in 2004, each receiving \$5.5 million in funding for research during the next 5 years.

COEP is featured in the NIEHS Environmental Health Perspectives' "Beyond the Bench" (January 2005), highlighting the work that COEP is doing with teaching basic molecular biology and genetics to middle school students using LEGO Life Science Sets.

David Schauer, Peter So and Bruce Tidor have all been promoted to the rank of Full Professor in the Division of Biological Engineering. Prof. Schauer is Director of the Environmental Systems and Health Research Core, and Profs. So and Tidor are both members of the Bioengineering for Toxicology Research Core.

Catherine Drennan, Mutation and Cancer Research Core, received the 2004 Harold E. Edgerton Faculty Achievement Award, recognizing young faculty members for outstanding achievement in research, scholarship and teaching.

Recently Published



B.Engelward's research was featured on the October 2004 cover of Molecular Cancer Research.

Kovalchuk O, Hendricks CA, Cassie S, Engelward AJ, Engelward BP. (2004) In vivo recombination after chronic damage exposure falls to below spontaneous levels in "recombomice." Mol Cancer Res, 2(10): 567-73.

Niess JH, Brand S, Gu X, Landsman L, Jung S, McCormick BA, Vyas JM, Boes M, Ploegh HL, Fox JG, Littman DR, Reinecker HC. (2005) CX3CR1-mediated dendritic cell access to the intestinal lumen and bacterial clearance. Science, 307(5707):254-8.

Thompson JR, Pacocha S, Pharino C, Klepac-Ceraj V, Hunt DE, Benoit J, Sarma-Rupavtarm R, Distel DL, Polz MF. (2005) Genotypic diversity within a natural coastal bacterioplankton population. Science, 307(5713):1311-3

Special mention: Linda Griffith's work with liver cells was mentioned in a feature article in the journal Nature. Khamsi, R. (2005) Labs on a chip: meet the stripped down rat. Nature, 435 (7038): 12-3. (See publication in Current Drug Metabolism http://www.bentham.org/cdm/CurrentIssue.htm)