



Superfund Research Program

The Superfund Research Program (SRP) supports practical research that creates benefits, such as lower environmental cleanup costs and reduced risk of exposure to hazardous substances, to improve human health. SRP funds colleges, universities, and small businesses, including the Dartmouth College Toxic Metals Superfund Research Center (Dartmouth SRC), to advance this work across the nation.

Research Highlights

Studying the adverse health effects of arsenic



Dartmouth SRC researchers Mary Lou Guerinot, Ph.D., and Brian Jackson, Ph.D., led a team that measured arsenic in a previously underrecognized source — common foods. Arsenic exposure is associated with a diverse range of health effects, including several types of cancer, cardiovascular disease, and lung disease.¹ Researchers detected significant concentrations of arsenic in organic brown rice syrup, used as an alternative to high fructose corn syrup in many foods, including toddler formulas.² Their research

inspired further studies of arsenic in the diet, and they are continuing to identify and quantify dietary sources of arsenic to better reduce exposures.

In other work, Bruce Stanton, Ph.D., and his team are identifying cellular changes in lung cells that occur with arsenic exposure.³ Their results may explain why arsenic reduces the ability of the immune system to fight lung infections.⁴ They found that when human epithelial cells, which normally line the inside of airways, were exposed to arsenic, they had decreased amounts of a protein that is important for producing mucous.³ With less mucous, bacteria and viruses are more likely to linger and cause infections.

Public health and mercury contamination in fish

Celia Chen, Ph.D., and the Dartmouth SRC Research Translation Core brought together an international group of scientists and policy stakeholders in 2010 to establish the Coastal and Marine Mercury Ecosystem Research Collaborative (C-MERC). Their goal was to review current knowledge — and knowledge gaps — relating to mercury contamination of the world's marine fish, a global environmental health problem. In 2012, C-MERC authors published a series of 11 scientific papers related to their findings, including sources of mercury, how marine fish absorb mercury, effects on human health, and policy implications. They also produced a companion report, *Sources to Seafood: Mercury Pollution in the Marine Environment*, summarizing the C-MERC findings.⁵



Chen, far right, collects samples near the Callahan Mine Superfund site in Brooksville, Maine. (Photo courtesy of Dartmouth SRC)

Dartmouth



(Photo courtesy of Dartmouth SRC)

Dartmouth SRC researchers seek to understand ways in which arsenic and mercury in the environment affect ecosystems and human health. Their work focuses on reducing exposures and understanding pathways that contribute to disease. They communicate their results to communities, grass-roots organizations, and state and federal agencies.

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Videos to inform the public about mercury

To explain research findings on arsenic in well water and mercury in seafood, Dartmouth SRC produced two 10-minute videos.

The video, *In Small Doses: Arsenic*, targets residents relying on wells for their drinking water. It explains how naturally occurring arsenic moves into groundwater, what can be done to remove it, and current science surrounding the question of how much is too much. The video also stresses the importance of testing water from private wells.⁶

The video, *Mercury: From Source to Seafood*, explains how mercury accumulates in seafood and the potential health effects from mercury exposure. It also describes health benefits of eating fish with lower concentrations of mercury, and the need to keep mercury from entering the environment.⁷



Dartmouth SRC also reaches out to the community through science festivals. Michael Paul, left, explains how arsenic can get into drinking water, to fourth grade students at a New Hampshire water festival. (Photo courtesy of Dartmouth SRC)

Research overview

- Studying arsenic in food, and factors that control arsenic absorption by grains, especially rice. (Mary Lou Guerinot, Ph.D., mary.lou.guerinot@dartmouth.edu)
- Studying how arsenic affects the immune system, and causes or worsens bacterial infections in the lung. (Bruce Stanton, Ph.D., bruce.a.stanton@dartmouth.edu)
- Determining whether arsenic affects glucose and blood pressure during pregnancy. (Margaret Karagas, Ph.D., margaret.karagas@dartmouth.edu)
- Using field studies and laboratory experiments to learn how changes in the environment, such as temperature and salt content in water, might affect accumulation of mercury in various organisms in estuaries. (Celia Chen, Ph.D., celia.y.chen@dartmouth.edu)

Sharing results

- Dartmouth SRC builds partnerships with target communities in northern New England to enhance their ability to understand and address the health risks posed by toxic metals in the environment. These communities include owners of private wells, consumers of food products of concern, and parent groups. (Mark Borsuk, Ph.D., mark.borsuk@dartmouth.edu)
- Dartmouth SRC facilitates the understanding and application of research by partnering with government agencies, hosting collaborative workshops, collecting community feedback on risk perceptions, engaging in Web-based communication, and providing media training. (Celia Chen, Ph.D., celia.y.chen@dartmouth.edu)

Other contributions to advance science

- The Dartmouth SRC research support facility provides vital access to expertise, research resources, and state-of-the-art instrumentation for its research projects. (Brian Jackson, Ph.D., brian.jackson@dartmouth.edu)
- The Dartmouth SRC integrated, multidisciplinary training experience provides early-career scientists access to teams of diverse professionals and encourages innovation to develop solution-oriented approaches to complex environmental health problems. (Bruce Stanton, Ph.D., bruce.a.stanton@dartmouth.edu)

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For more information on the National Institute of Environmental Health Sciences, visit www.niehs.nih.gov.

For more information on the Superfund Research Program, visit www.niehs.nih.gov/srp.

For more information on the Dartmouth College Toxic Metals Superfund Research Center, visit www.dartmouth.edu/~toxmetal.

¹ Naujokas M, Anderson B, Ahsan H, Aposhian H, Graziano J, Thompson C, Suk W. 2013. The broad scope of health effects from chronic arsenic exposure: update on a worldwide public health problem. *Environ Health Perspect* 121(3):295-302.

² Jackson BP, Taylor VF, Karagas MR, Punshon T, Cottingham KL. 2012. Arsenic, organic foods, and brown rice syrup. *Environ Health Perspect* 120(5):623-626.

³ Bomberger JM, Coutermarsh BA, Barnaby RL, Stanton BA. 2012. Arsenic promotes ubiquitinylation and lysosomal degradation of cystic fibrosis transmembrane conductance regulator (CFTR) chloride channels in human airway epithelial cells. *J Biol Chem* 287(21):17130-17139.

⁴ Kozul CD, Ely KH, Enelow RI, Hamilton JW. 2009. Low-dose arsenic compromises the immune response to influenza A infection in vivo. *Environ Health Perspect* 117(9):1441-1447.

⁵ Dartmouth College Superfund Research Center. 2012. Sources to Seafood: Mercury Pollution in the Marine Environment. Available: www.dartmouth.edu/~toxmetal/assets/pdf/sources_to_seafood_report.pdf [accessed 1 June 2015].

⁶ Dartmouth College Superfund Research Center. 2011. *In Small Doses: Arsenic*. Available: www.dartmouth.edu/~toxmetal/InSmallDoses [accessed 1 June 2015].

⁷ Dartmouth College Superfund Research Center. 2012. *Mercury: From Source to Seafood*. Available: www.dartmouth.edu/~toxmetal/mercury-source-to-seafood [accessed 1 June 2015].