Joshua Hamilton, Ph.D.: A certain kind of scientist

By Laura Stephenson Carter

Early in his career, Joshua Hamilton was chastised for calling himself an eclectic scientist. Young researchers were expected to develop expertise in a specific area so they could attract funding, publish their work, get promoted, be granted tenure, and develop an international reputation.

Things have changed. In today's interdisciplinary environment, being well versed in other fields is an asset. By defying that long-ago advice, Hamilton has become a tenured full professor in DMS's Department of Pharmacology and Toxicology; the director of two important interdisciplinary programs at Dartmouth—the Superfund Basic Research Program Project on Toxic Metals and the Center for Environmental Health Sciences (CEHS); and a collaborator on several other major research projects. He is well funded and has developed an international reputation.

Grew up: Born in Salem, Mass., and grew up in Marblehead, Mass.; Orchard Park, N.Y.; and Marion, Mass.

Education: Bridgewater State College, Bridgewater, Mass., '80 (B.S. in biology); Cornell '82 (M.S. in genetics); Cornell '85 (Ph.D. in genetic toxicology)

Training: Postdoctoral research fellowship at Dartmouth

First paying job: Mowing lawns. "When I was 12, I made a business proposition to my dad that if he would buy me a lawnmower that I could use for this business, I would pay him back. I charged $3.00 to mow a lawn. I kept $2.00 and gave him $1.00 until I paid off the lawnmower."

Most famous relative: Alexander Hamilton, a signer of the U.S. Constitution and the first secretary of the treasury

Favorite summer activity: Anything to do with water—boating, sailing, fishing, swimming, waterskiing, and wakeboarding

In graduate school, "you . . . learn more and more about less and less," rues the eclectic-minded Hamilton.

"The cartoon image in science," says Hamilton, is "of the blind men feeling the elephant, where one feels the tail and says, 'It's a rat,' and the other one feels the trunk and says, 'No, it's a snake,' and the other one feels a leg and says, 'No, it's a hippopotamus.'" But, he continues, "it's when you put all the pieces together that you realize what the actual structure is of the thing that you're looking at."

Putting the pieces together has been key to CEHS research on the arsenic that occurs naturally in many of New Hampshire's private wells. Researchers from different departments are studying arsenic's relationship to the incidence of cancer; investigating the movement of toxic metals through aquatic food webs; exploring how toxic metals interact with cellular proteins; determining arsenic's effect on DNA repair; looking at arsenic as an endocrine disrupter; trying to understand the geology related to arsenic in groundwater systems; and finding out where old arsenic mines are located.

"I think our biggest contributions scientifically have been the discovery of arsenic as an endocrine disrupter," says Hamilton, whose latest study on the topic was published late in 2007 in *Environmental Health Perspectives*. By disrupting important hormones, arsenic is believed to contribute to cancer, cardiovascular disease, and diabetes.

The CEHS also engages in public outreach and helps shape public policy at both the state and federal level. "We were one of the principal groups whose new research findings led to the U.S. EPA [Environmental Protection Agency] lowering the U.S. drinking water standard for arsenic," says Hamilton. He rattles off the names of some Dartmouth colleagues, saying that the EPA "cited Margaret Karagas's epidemiological studies, my work on arsenic as an endocrine disrupter, and Aaron Barchowsky's work on arsenic and cell signaling as new information that compelled them to consider the maximum contaminant level in drinking water." The new guidelines—which were adopted in 2001 and took effect in 2006—dropped the maximum acceptable level of arsenic in drinking water from 50 parts per billion to 10 parts per billion. Even that, Hamilton argues, is still too high.

When he was young, Hamilton dreamed of being a marine biologist, but by the time he got to college marine biology was feeling a funding pinch. "People in the field [suggested] that I might look at other career paths," he says. So in graduate school at Cornell, he pursued an interest in genetics, figuring he could always apply what he learned to marine biology later on. But then he got hooked on genetic toxicology, "looking at how chemicals and radiation damage DNA, which can lead to birth defects and cancer." After getting his Ph.D., he did a postdoctoral fellowship in Dartmouth's chemistry department with an inspiring scientist—toxic metals researcher Karen Wetterhahn. "She was really an amazing person, probably the smartest person I've ever met," says Hamilton, "and in science, that's saying a lot."

When he joined the DMS faculty in 1990, he continued to work closely with Wetterhahn. In 1994, Wetterhahn was at a conference where an administrator from the National Institute of Environmental Health Sciences suggested that she apply for a Superfund Basic Research Program grant, because of Dartmouth's expertise in metals toxicology. Over the next few weeks, Wetterhahn, Hamilton, and others scrambled to put a grant proposal together and, in 1995, Dartmouth's Superfund Basic Research Program Project on Toxic Metals was born. It has been going strong ever since.

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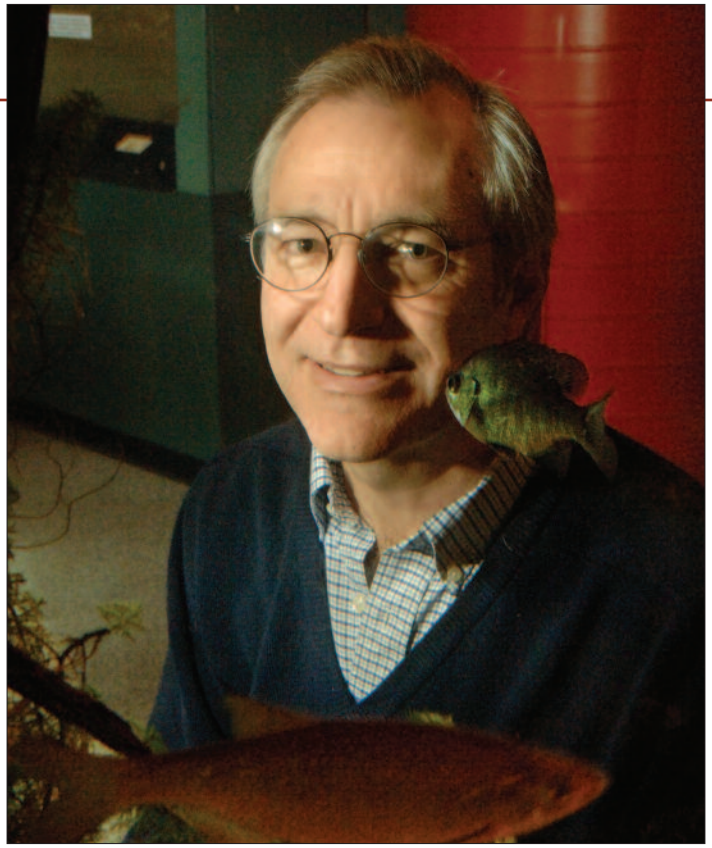

JON GILBERT FOX

He may have ended up as a toxic metals expert rather than a marine biologist, but Hamilton still loves to gaze into the fish tank at the local Montshire Museum of Science.

With Wetterhahn as director and Hamilton as associate director, and several faculty members from other disciplines on board, "we began this process of interdisciplinary research," Hamilton says. At the time, it was rare for a university to "put a collection of people together with such different expertise looking at problems in such a different way."

The first few meetings were amusing. Hamilton recalls one where an epidemiologist kept referring to her study design as an "ecologic" project. "Finally one of us said, 'Wait a minute, when you say "ecologic" are you talking about environment?' She said, 'Oh, no, that's an epidemiology term.'" She had to take a lot of time "just telling us the real basics [of] epidemiology." The researchers spent the next year educating each other so they could talk about their shared efforts. "Then we started having very fruitful discussions," says Hamilton. "It really illustrated to me some of the challenges, [as well as] the power of interdisciplinary studies."

He admits that it takes a certain kind of scientist to do interdisciplinary work—someone who's "really comfortable stretching beyond their own comfort zone and disciplinary boundaries," he says. Scientific training tends to be very narrow. "When you go into graduate school, you become more and more focused down and learn more and more about less and less until you know everything about nothing. You can reach a point where you're so highly specialized that it can be really challenging to bridge sideways."

Tragically, Wetterhahn died in 1997 as a result of a lab accident the year before. A few drops of a rare form of mercury had spilled on her latex glove (at the time no one knew the gloves offered inadequate protection against the deadly metal), and a lethal dose penetrated her skin. It took several months for the poison to silently work its way into her brain. By then it was too late to do anything.

"It was surprising, shocking to everyone," Hamilton says. "She was the most careful person in the world when it came to lab work." Her death "definitely made us more committed to understand the nature of these toxins and redouble our efforts to be careful," says Hamilton. "We do everything we can to be safe in the lab, [but] there are risks."

After Wetterhahn died, Hamilton took over as director of the Dartmouth Superfund project, whose funding was renewed in 2000. Its success was a catalyst for the development of the CEHS, whose focus is the relationship between environmental toxins and human health. That led to still more interdisciplinary efforts. Two of them were funded with National Science Foundation biocomplexity grants—one on cholera and another on how the zooplankton *Daphnia* responds to environmental stressors.

Dartmouth is especially well suited for interdisciplinary research, says Hamilton. "People are very collegial here. Because we're a relatively small research university, compared to others, people are more willing to look . . . for collaborations."

The Environmental Health Sciences group collaborates in more arenas than just research. Its mission includes sharing its expertise with the public; providing free access to information, in person and on the web; and participating in educational outreach projects. "We feel it is fundamentally important to be able to explain to the general public and other stakeholders what we do and why it's important to society," says Hamilton. "So, for example, we have websites that are written in lay language. We also conduct town-meeting-style public presentations."

The CEHS has made a mark all across northern New England with its outreach: Advising EPA and town officials involved in the clean-up of an abandoned copper mine in South Strafford, Vt. Teaming up with experts from Vermont Law School to write a 2004 report on lead laws that's still requested by legislators, lawyers, and health-care professionals. Helping a legislative task force look at lead-poisoning policies. Working with the Montshire Museum of Science in Norwich, Vt., to create an Environmental Detectives program for K-12 students. The latter collaboration led to Hamilton being invited to serve on the museum's board of trustees and to the creation of the Dartmouth-Montshire Institute for Science Education.

"It's really appealing to be able to work with collaborators," Hamilton says. "I can still be an expert in what I do, but I can apply that to many, many different and interesting problems that . . . I would never tackle, and really never be competent to tackle, by myself." ■