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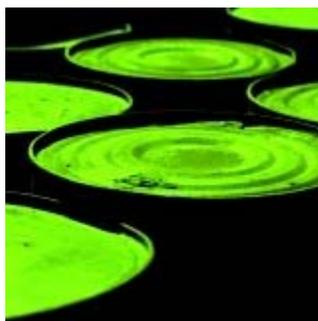
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CAREER DEVELOPMENT : ARTICLES

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Opportunities Abound in Toxicology

Brian Vastag
United States
20 June 2008

Nadia Moore first became intrigued with toxicology as an undergraduate measuring ammonia in the water of a fish hatchery where breeding stock were getting sick. She finished her degree in biochemistry and went to work at a toxicology laboratory associated with the [Pacific Northwest National Laboratory](#) (PNNL) in Richland, Washington, analyzing chemicals tested on animals. But by then she had begun to realize that the type of analytical chemistry she had been doing was just "one little piece of the whole toxicology picture," Moore says. She wanted a more holistic view.

So she transferred to a risk-assessment project at Toxicology Northwest, a contract laboratory linked to PNNL. Moore liked the work but felt she lacked the knowledge to fully understand what adverse health effects might lurk in the data. So in 2003, she entered the [toxicology Ph.D. program](#)

at the [University of Washington](#) (UW), Seattle. "I wanted to bridge molecular biology and human health," she says. Over the past 5 years, Moore has developed proteomics tools to probe how alcohol damages the developing brain, part of a larger project on fetal alcohol syndrome.

So far in her career, Moore has toured several major subfields of toxicology: environmental toxicology, chemical analysis, risk assessment, and the study of basic toxicity mechanisms. Each type of work, whether at the bench or a desk, contributes to the mandate of the field: to assess the potential harm of drugs and chemicals.

"The ultimate goal is the protection of human health," says James Popp, a toxicology consultant and former president of the [Society of Toxicology](#) (SOT), the field's main professional organization in North America.

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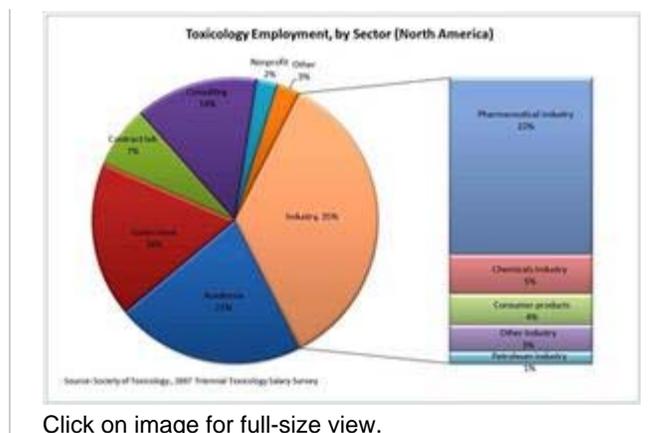
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companies employ toxicologists to assess whether new drugs and new products are safe (see chart). Academic toxicologists often explore molecular mechanisms of toxicity, whereas government agencies employ toxicologists to review and regulate drugs and chemicals. Nearly a third of toxicologists work in industry.



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But the toxicology workforce is graying and a labor

shortage looms, according to experts and data collected by SOT. "We're looking for new blood and wondering where the next generation is going to come from," says David Eaton, a toxicologist and associate vice provost for research at UW.

A 2007 salary survey conducted by SOT found 434 unfilled Ph.D.-level toxicology jobs in North America. Of those, 130 were postdocs. This is a substantial number for a relatively small field, says Popp; about 9000 toxicologists work in the United States and Canada. Further, annual demand is outstripping supply: About half the open positions go unfilled each year. "This is no surprise to anyone who does any recruiting," says Popp. Filling open positions has "gotten much more difficult."

Europe also faces a "serious unmet need for toxicologists," says Timothy Hammond, a toxicologist at AstraZeneca's [facility in Alderley Park](#), U.K.--although Hammond thinks toxicology recruiting has "hit the bottom of the curve," at least in Europe. The U.K.'s [Medical Research Council](#) is launching a new center for drug safety sciences that will include a toxicology training program. The European Union's [Innovative Medicines Initiative](#) also includes funds for training 25 new master's-level toxicology students each year.

TRAINING

In the United States, most graduate and postgraduate toxicology training is funded by the [National Institutes of Health](#) (NIH), particularly the [National Institute of Environmental Health Sciences](#) (NIEHS), which provides training grants to universities. The [Environmental Protection Agency](#) also funds "a few students," says Linda Birnbaum, director of the experimental toxicology division at EPA.

About 85 U.S. programs offer at least one type of toxicology degree. Most are graduate programs, but a few also offer a toxicology bachelor's degree. For students entering a graduate program, Popp says, grounding in basic biology is essential, and degrees in biology, biochemistry, and chemistry are the most useful. Birnbaum encourages toxicology students to also take courses in public health. And communications skills are vital but often overlooked; such skills can come from scientific writing and public-speaking courses.

People with associate's or bachelor's degrees can land entry-level toxicology jobs as laboratory assistants, technicians, or animal-care specialists. But a research or academic career requires an advanced degree. About half of employed toxicologists hold Ph.D.s, and among employers who hire toxicologists, 29% say postdoctoral experience is "absolutely" required and 38% say such experience is "desired," according to an SOT survey.

ALTERNATE ROUTES

Formal degree programs in toxicology aren't the only way to enter the field. The SOT salary survey found that just 57% of working toxicologists have a toxicology degree. The rest hold

degrees in physiology, biology, biochemistry, or other fields.

A few programs serve science graduates who want to go into toxicology; UW, for example, just launched a certificate program in biologics safety to teach basic toxicology to scientists working at biotechnology companies that develop protein and other medicines based on large molecules.

But many toxicologists get most of their training on the job. Popp trained as a veterinarian and studied chemicals that cause liver cancer. He spent 20 years as a toxicologist at various pharmaceutical companies and now consults in that industry, advising companies on whether a potential drug may cause liver problems. "They only call when there's a crisis, and then I get to be a detective and determine how serious the problem is in terms of successful drug development," he says.



Nadia Moore

Birnbaum, whose degree is in biochemistry, joined NIEHS in the 1970s to work in the newly formed [National Toxicology Program](#), a federal effort to catalog harmful chemicals. She says she devoured a standard toxicology textbook and then took a board exam offered by the American Board of Toxicology. "Once I passed, I was legitimate, I could call myself a toxicologist," she says. (Board certification is "helpful" but not "required," according to Popp.) In the decades since, Birnbaum has been instrumental in delineating the health effects of dioxins and other pollutants. "We laid the groundwork for the whole concept of body burden; you're never exposed to just one chemical, you're exposed to a mixture. And you have to assess the risk of the whole mixture," she says.

It's not only senior-level jobs that require a panoramic view of the field and an expansive skill set, Birnbaum says. Many junior government toxicology jobs also are integrative, requiring a big-picture view of data from environmental sampling, epidemiological studies, clinical trials, and animal and cell-based research. "You've got to put it all together and decide what the issues are," she says.

Senior toxicologists say the field of toxicology is undergoing a big change as pressure mounts to reduce animal use and genomics, proteomics, and other cell-based and molecular techniques supersede whole-animal studies. Last year, a National Research Council report recommended the development of alternatives to animal research. And in February, NIH and EPA announced a partnership to develop high-throughput toxicity testing of drugs and chemicals without animals. With such changes afoot, toxicologists need to be familiar with the latest techniques, Popp says.

However, Popp and Birnbaum both say that new technologies won't completely replace animal studies anytime soon, so beginning toxicologists should have a solid foundation of animal work. Says Popp: "We're not at the point where we can do all the toxicology we need without animals. If we don't know what's going on in animals, it's really difficult to predict what's going to happen in humans."

Moore is on the cusp of this technological change. She plans to graduate this summer and has already landed a job. She'll be returning to Toxicology Northwest, where she began her career as an analytical chemist. Now, though, she'll be a study director. Her goal: integrating proteomics into a traditional animal toxicology program to maximize the information obtained from each animal. "Now I just won't see a little piece of the pie," she says. "I'll be able to integrate everything and see how the chemicals affect the whole animal."

ADDITIONAL LINKS

- [Resource Guide to Careers in Toxicology from the Society of Toxicology](#)
- [Academic and Post-Doctoral Toxicology Programs](#)

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Comments, suggestions? Please send your feedback [to our editor](#).

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