CAREER DEVELOPMENT : ARTICLES

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Plumbing the Green Genome

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Nathan Springer's maize lab at the University of Minnesota, St. Paul, is less than 5 years old, but he and corn go way back. Springer first worked in a cornfield while in high school, so he and corn are close. He especially appreciates the crop's--and his work's--seasonal rhythms. "Right now, we're packing all our seeds and getting ready to plant, and there's a time when you're doing all of your genetics, and there's a time when you do all your harvesting and you open up your bags and see what you got back." Apparently, he's not alone in his affection for the plant. "People who work on corn really seem to develop an attachment to this organism," he says.

"I kind of clicked my heels three times and said there must be a better way." --Carl Simmons

Springer works in plant genomics, an area that marries the verdant milieu of greenhouses and growth rooms--and sometimes even cornfields--to the florescent-lit world of bench and computational science. He is typical of plant-genome scientists, whose work often combines a passion for understanding their subjects' inner workings with a belief that their findings will help counter some of humanity's most urgent problems: hunger and malnutrition, the demand for renewable energy, and climate change. This variety of applications and potential motivations means that aspiring plant-genome scientists have a variety of career paths to consider.

WORKING IN THE FIELD

What is plant genomics, exactly? Plant-genome scientists offer a variety of definitions, few of them pithy. According to Crispin Taylor, the executive director of the American Society of Plant Biologists in Rockville, Maryland, and a former editor for *Science* Careers, plant genomics is "a discipline and a set of tools, both." The tools include high-throughput sequencing and hardware and software to process the resulting data. Researchers use the multiple-gene viewpoint these tools afford to answer a wide range of questions about the nature of plants, such as how a

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species evolved to colonize a particular niche or fend off pests or disease or how it can tell when a neighbor is blocking the sun. Defined narrowly--as a discipline distinct from other areas of plant biology--plant genomics is the study of the organization of genomes themselves.


Nathan Springer

However it's defined, the plant-genomics profession expanded greatly with the start of the National Plant Genome Initiative (NPGI), says Jeff Dangl, the John N. Couch Professor at the University of North Carolina, Chapel Hill. A multiagency program, NPGI began in 1998 and has now awarded more than $800 million in research grants. "That money changed the landscape completely in plant science," hastening the completion of the first plant genome sequence (of the model organism *Arabidopsis thaliana)* and funding work on the genomes of crop species, says Dangl, who recently chaired a committee that evaluated NPGI's accomplishments and made recommendations about its future.

FINDING A FOOTHOLD IN PLANT GENOMICS


Jeff Dangl

Springer's career has reflected the shifting landscape wrought by NPGI: Much of his formal training was in molecular biology and genetics, but he now uses both genomics and epigenetics to study how gene expression is regulated in maize. In addition to its utility for answering basic scientific questions, Springer appreciates how genomics has made his work more relevant to other areas, such as plant breeding and physiology. Genomics gives plant biologists working in related fields "opportunities to start talking about what experiments not only are interesting but are important to do," he says.

There are some disadvantages to his chosen career path, Springer concedes. As in many fields, getting your research funded is a challenge in plant genomics. But the NPGI money--and the large projects it spawned--created a different challenge. For researchers on these large, multi-investigator projects, "to carve out a project that is appropriate for graduate student training is hard," he says. On the other hand, "as a postdoc who was funded on these projects, I essentially had seven or eight advisers ... who were all interested in my career and helped me out, and I had interactions across universities that I wouldn't have had working on a more traditional project," he says.

To avoid the pitfalls of working on large genomics projects--such as always being in the middle of a long author list--graduate students and postdocs considering joining a lab should look carefully at what that lab is doing with the data it generates, Springer suggests. "If the only reason they're doing genomics is to make a community resource, it's probably not a great project to be on as a student," he says. "Find a lab that has biological questions that they care about."

Students can also separate themselves from the pack by seeking training in quantitative genetics and plant biology, beefing up their computational skills, and learning "to think like an evolutionist," says Dangl. "You need to know molecular biology and genetics to survive, but what distinguishes you is other skills."

"A GREAT TIME TO BE IN AGRICULTURAL INDUSTRY"

As Carl Simmons was finishing a postdoc at Yale University in the mid-1990s, he realized he'd had enough. Not of the plant physiology, biophysics, and genetics he studied at Yale and as a graduate student at the University of California, Davis, but of the departmental politics and stiff competition for limited funding he saw in academia. "I kind of clicked my heels three times and said there must be a better way," he says. He joined Pioneer Hi-Bred, a subsidiary of DuPont based in Johnston, Iowa.


Carl Simmons

Simmons started in the disease-resistance group and has worked for the past 10 years as a computational biologist for the company. His role is to manage and analyze genomics data; depending on the project and the researcher he's working with, he sometimes has a hand in the project's design as well. Although the bulk of Pioneer's work is with maize and soybeans, Simmons says, the company also works with rice, sorghum, and microbial pathogens. "Sometimes it's fun to skirt across and work on different projects," he says.

One danger of private-sector work, he notes, is that researchers may "work very hard, and [then] they stop that project cold and you have nothing"--no final product--"to show for it." To mediate the risk, he advises looking for an industry position in which you can accrue publications or patent applications as a public record of your accomplishments. Another problem with industry, he says, is that someone else often sets the research agenda. "If there's something you really want to focus on and make it your baby, you should go into academia," he says.

Nevertheless, Simmons encourages budding researchers to consider agricultural industry careers. "We do great science here," and Pioneer is hiring, he says. He sees an increased appreciation among investors, politicians, and environmentalists of the importance of agriculture to "feeding, clothing, and fueling the world." Additionally, "the seed industry is investing a lot in genetics research," he says. "This is a great time to be in agricultural industry."

TRANSLATION THROUGH COLLABORATION


Susan McCouch

Susan McCouch wants to help hungry people. Accomplishing that, the Cornell University professor believes, means going beyond the identification and characterization of rice genes or curating a comparative plant-genome database. McCouch has worked for 2 decades to cultivate collaborations with researchers in developing countries, collaborations that she says are vital to translating genomics discoveries into food for the world's neediest people.

McCouch came to Cornell in 1986 as a graduate student. She chose to work on rice because of its central place in the diet of many developing countries. She constructed the first map of the rice genome, identifying markers in its DNA that indicate the presence of particular traits. After earning her Ph.D., she spent 5 years at the International Rice Research Institute in the Philippines. Then she returned to Cornell as a faculty member.

Since then, many researchers from what McCouch calls "the rice-growing world" have trained in her lab, and rice breeders all over the world now use maps and markers she developed. Rice genomics is a top research priority for countries such as China and India, but it still receives little attention--or money--in the United States, she says. Funding constraints have pushed her into even more collaborations. Collaborators in the rice-growing world are equipped to apply knowledge to a particular variety of rice growing in a particular environmental niche and eaten by people of a particular culture, she says.

McCouch finds knowing that her work is delivering tangible benefits immensely satisfying; she believes it's important for aspiring plant-genome scientists to consider how their work will be translated. "Most people come into the field believing that it can alleviate human suffering in some ways. But if you just leave it up to the market, you end up saying only people who can buy their way in can benefit," she says. Although it's most important to train in a lab doing good science, she recommends that trainees also "look for a networked approach that will enable them to see their science through to some kind of impact."

In its 25 April 2008 issue, *Science* explores how current knowledge of plant genomes is lending insights to investigations from biochemistry to ecosystems. Also online, an interactive feature including informational graphics, video clips, and more, as well as accompanying Web resources, explore how plant genome research is contributing to our understanding of plant biology and evolution and leading to tangible benefits for society.

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