Holly Goodson

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At Notre Dame, Holly Goodson teaches freshman engineers what they need to know about Cell Biology. It is an eye-opening experience for both parties. "I always start with a quote from a Cornell report on curriculum that says Biology will be to Engineering in the 21st century what Physics was to 20th century Engineering," says Goodson, a cytoskeletal researcher in Notre Dame's Department of Chemistry and Biochemistry. To hook her engineers, Goodson uses nanotechnology—"Engineers love molecular motors," she reports—and makes sure to include biology's surefire topics—sex and disease.

There is a serious biological agenda here, Goodson explains. Her would-be engineers need an understanding of the nature of biological materials, how energy is stored and transduced in biological systems, and the power of variation and natural selection to come up with designs beyond human imagination.

Goodson predicts that teaching would-be engineers or budding computer scientists is something that more cell biologists will be doing in this new century. It's vital that it be done right, according to Goodson, who volunteered to teach the engineers' course. "This course is very important, but it could be done in a completely counterproductive way," Goodson declares. "Modern cell biologists know so much today and we tend to bury students in our success by overwhelming them with details." The average cell biology course requires a huge amount of memorization that is not only irrelevant for future engineers, it blinds them to what they could learn from biology, she contends. "It's more important for them to learn the general principles of signal transduction than to memorize the specific details of one pathway."

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Goodson protects precious research time by teaching her engineers—300 strong—in back-to-back lectures in the spring semester. "Spring is a nightmare," Goodson reports. "But then I get the fall off and can really concentrate on the lab." Her lab is focused on the microtubule cytoskeleton, particularly the function of microtubule plus-end tracking proteins or "+TIPs."

Goodson also collaborates at Notre Dame with mathematical physicist Mark Alber and others on computational modeling of microtubule dynamics. And she continues a longtime fascination with Molecular Evolution, a field she helped pioneer in a small way while still a graduate student in the Stanford lab of James Spudich. That's where she discovered an unconventional myosin in yeast. Myosin is a protein usually associated with cell motility, yet yeast aren't considered conventionally motile. This raised questions for Goodson about the evolution of cytoskeletal proteins. In recent work, Goodson has been mapping the phylogenic descent of actins and myosins across the kingdoms of life.

Phylogeny Proceeds Zoology

"Molecular evolution is an interest that still fascinates Holly," says Meg Titus, who was a postdoc in the Spudich lab when Goodson arrived. Goodson's work went in other directions after Stanford, says Titus, but her friend has never lost her curiosity about evolutionary patterns. "Holly was one of the first people to start doing phylogenies of myosin," according to Titus, who is now at the University of Minnesota.

"Holly is just so enthusiastic. That was apparent from day one, but she was also extremely bright—scared the socks off of me. The other thing I learned is how Holly can think broadly about lots of different things, ideas, and approaches, and then bring them together in what she does."

Goodson's ability to meld disparate disciplines impressed Vladamir "Volodya" Gelfand who is at the Northwestern School of Medicine. He knows Goodson from the Chicago Cytoskeleton Club. The regional seminar group was first organized six years ago by Goodson and Gary Borisy.

"Holly has always been very strong in

combining experimental Cell Biology with [mathematical] modeling. There are not very many cell biologists who can do both. Actually, she is one of the very few who are equally proficient in both." Gelfand says that in her work on the microtubule cytoskeleton, Goodson is linking three disciplines—Computational, Cell, and Evolutionary Biology—into one approach.

The Goodson approach to everything from evolution to teaching engineers can probably be traced to her parents and to growing up "in the middle of nowhere," according to Goodson. "Nowhere" was a working family farm some distance from Greencastle, Indiana. Her father, Felix Goodson, was a DePauw psychology professor. He was also a leading proponent of "Evolutionary Psychology." Goodson recalls, "I grew up reading Stephen Jay Gould and arguing about evolution around the table." Her mother, Cheryl Jamison, went back to school to get her doctorate in Anthropology as soon as Holly, the oldest of four, was in high school. Today her mother is a researcher in Sociology at Indiana University.

Looking Under Rocks

Goodson also grew up "outside," as she puts it. "I loved playing in the creek and looking under rocks. Looking in the genome is kind of like looking under rocks. You never know what you're going to find." Her science instruction in rural Indiana was terrible, she recalls, although Goodson never had any doubt that science was what intrigued her.

At Princeton, Goodson was "sucked" into classical Biology by the lectures of the legendary John T. Bonner, and into Cell Biology, by a young member of the faculty, Pamela Silver. Her time as an undergraduate in the Silver lab working on nuclear transport sealed her lifelong interest in the question of cell organization, Goodson says.

Outside the lab, Goodson played clarinet in the Princeton University Band or PUB as it was known to its rowdy, hard-celebrating members. PUB was her wild escape from science, says Goodson. It was also where she met her future husband, Mike Hildreth, a saxophonist and a high-energy physicist. Matching geography to their respective careers narrowed their graduate school options to places with "atom smashers" and great Biology labs. That took them to the Bay Area, where Goodson earned her doctorate in Biochemistry at Stanford in 1995. For postdoctoral fellowships, it took them to Geneva, Switzerland. Hildreth worked at the CERN particle physics lab and Goodson joined the University of Geneva lab of Thomas Kreis.

"That's when I went over to the dark side and started working on microtubules," Goodson laughs. "Coming from the Spudich lab, tubulin was the dark side." Still, in her own mind, Goodson saw grappling with the complexities of plus-end microtubules in the Kreis lab as yet another way to get at the basic mechanisms of cell organization.

A Double Offer

Then tragedy struck. In October 1998, Kreis was killed in the crash of Swissair Flight 111 in the sea off Nova Scotia. It was a difficult period that even today Goodson is reluctant to dwell on. It fell to the senior postdocs to shut down a famous laboratory, help Kreis's graduate students finish up, and then scramble for jobs themselves. Notre Dame made the perfect double offer, Goodson recalls. For her husband, Notre Dame was a physics position within two hours' drive of the Tevatron particle accelerator at Fermilab in Illinois. For Goodson, it was a faculty slot in a biochemistry department comfortable with her eclectic research interests.

"I never expected to end up back in Indiana, but here I am," admits Goodson. She's extremely pleased with Notre Dame and with South Bend. "What is particularly good about Notre Dame is the presence of small but vibrant groups of both cell biologists and biophysicists. Then there's the collaborative nature of the faculty."

She and her husband live with their 12-year-old son, Andrew, "in a house in the woods on a river." The location is a pleasant reminder of Goodson's own "outside" childhood. On vacation, the family likes to travel to wilder parts of the world, says Goodson. Her son's passionate interest in exotic animals has taken them on trips through the rain forests of Costa Rica and over the Andes.

For all its woodsy charm, the house is 15 minutes, door to door, from her campus lab. Goodson calculates a savings of least an hour a day over urban peers. On an annual basis, that nearly covers her lecturing, she figures. Still, Goodson doesn't begrudge teaching.

Recently elected to a three-year term on the ASCB Council, Goodson wants to speak up for ASCB members like herself who see teaching as a significant part of their careers: "I enjoy teaching future cell biologists, but I think that it's almost more important to teach non-biologists," Goodson believes. "A large number of the problems facing society are biological. It is our responsibility as biologists to give our students the foundation on which to make informed decisions about these issues." ■

—John Fleischman

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