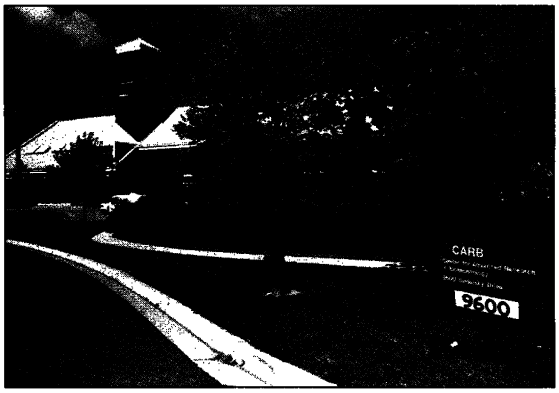
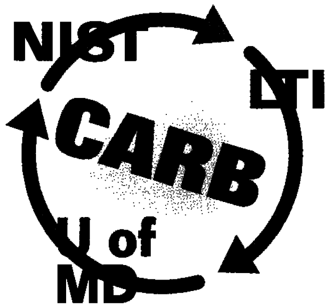
Novel Program I: Advanced Research in Biotechnology

DARROW MONTGOMERY





On a roll. Government, corporate, and university funding keeps the wheels of science turning at CARB.

Why did first-year doctoral student Ram Samudrala turn down offers from Cornell University and the University of Pennsylvania to study at what looks like a giant ski lodge on recently converted farmland in suburban Maryland? "I was completely blown away," he says, by the Center for Advanced Research in Biotechnology (CARB) in Rockville.

Samudrala isn't alone: *Forbes* magazine has called CARB "one of the 12 hottest addresses for science in the United States." Samudrala and his five fellow grad students like its dual focus on pure and applied research. That approach allows them to tackle basic research problems with one eye on industry—and gives them twice the career opportunities after graduation.

This idea is one of the hottest in science academe. It's a response to the unsustainable cycle of a growing number of postdocs competing for a shrinking number of tenure-track positions—from whence, if successful, they begat more postdocs. Seeking new models, leading scientists in government and academia are trying various experiments to bring the real world on campus. At CARB, this philosophy is reflected in the exchange lecture series between CARB researchers and researchers from Life Technologies Inc. (LTI), a biotech company in nearby Gaithersburg that develops new reagents for gene sequencing. It's also part of the reason crystallographer Andrew Howard of Molecular Simulations Inc. in Burlington, Massachusetts, is working at CARB to develop computer software for analyzing complex x-ray diffraction data. The data hold the blueprint of a protein's three-dimensional structure, which industry needs for rational drug design.

CARB was founded in 1985 as a joint venture between the Department of Commerce's National Institute of Standards and Technology (NIST), the University of Maryland, and Maryland's Montgomery County. Each year, it receives about $3.5 million from NIST and the university, and about $1 million in miscellaneous research grants and industrial contracts. Its role as a breeding ground for industry-savvy Ph.D.s is a byproduct of its main mission—to boost the U.S. economy by doing the sort of basic research the biotech industry needs but cannot afford to do on its own. "The basic training is to teach [the graduate students] to be good scientists," says Philip Bryan, one of CARB's 13 faculty scientists. "But they're also getting exposed to a different culture."

That culture is ever-present on the 8-acre campus. For example, faculty scientist Osnat Herzberg receives funds from American Cyanamid Co. to investigate the structure and activity of beta-lactamase, an enzyme that makes bacteria antibiotic resistant. Faculty scientist Fred Schwartz receives funds from Life Technologies to help elucidate the means by which restriction enzymes recognize specific bits of DNA. And Bryan received funds from Procter & Gamble Co. to make minute changes in the 3D structure of the protein subtilisin—an enzyme used in soap powders and other detergents to remove stains such as blood and egg—to better withstand its harsh environment.

But CARB's contacts and contracts with industry do not mean researchers are driven by the profit motive, says its director, molecular biophysicist Roberto Poljak, who came to CARB in 1992 from the Pasteur Institute in Paris. Take the soap-powder enzyme. "The distinction between our research and industrial research is that we didn't start out to make a better detergent enzyme," says Bryan. "We were looking at the energetics of protein folding, how it causes proteins to achieve their specific three-dimensional shape and how it affects their activity."

Much of the work at CARB is concerned with what Bryan calls "trying to understand the second half of the genetic code." By that he means the process by which long chains of just 20 different amino acids create more than a thousand proteins in a myriad of shapes. Samudrala will be working on one aspect called "threading," a novel technique for predicting the structure of one protein from the way its string of amino acids line up with—or thread through—pieces of other proteins of known 3D structure. "Most academics don't care about the research once they've solved a problem," says Samudrala. "But for us there's the impetus to push it on through to its practical applications."

Lan Wang, a fourth-year grad student who's working on the subtilisin-folding problem, agrees. "You feel very excited," she says. "You can see where your results can go in the very near future."

Despite their obvious enthusiasm for applied research, Wang and Samudrala want to pursue academic research once they get their Ph.D.s. Poljak says that preference may change as time passes. "Between you and me, [in the current job market] they may not be able to realize that ambition," he says. "They may have to go into industry." Whatever happens, however, Poljak is confident his students will be better prepared than most to succeed.

–Rachel Nowak

Novel Program II: Environmental Management

As part of her graduate program at Duke University, Rebecca Fawver has studied biometry, environmental physiology, ecology, regression, and global ecosystems. And after classes ended last spring, she worked as an assistant in an intensive biodiversity field course. But Fawver, 26, has no intention of becoming a research scientist. "I didn't want to get an M.S. or Ph.D. I plan to work with people, in a management position."

To do that, she is spending about $20,000 a year on a 2-year professional program at Duke's School of the

Environment, where the curriculum is loaded with policy and economics as well as science. Next May she expects to graduate with a master of environmental management degree. When she does, she'll join the growing ranks of grads who plan to use their scientific education not in research or teaching but as background for diverse careers in business or government.

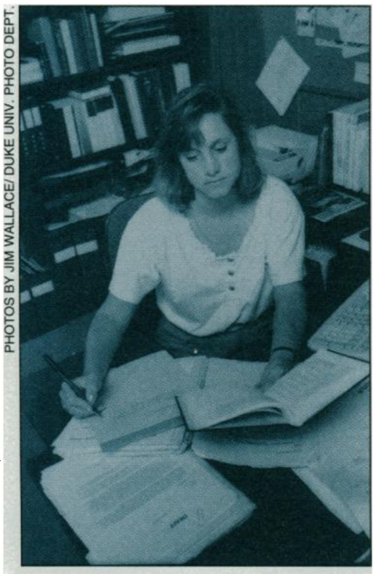
Duke and a handful of other top schools offer graduate degrees that blend natural science, social science, and business in a curriculum rooted in real-world problems and solutions. At Duke, the School of the Environment began as a school of forestry in 1938, but its mission has grown to encompass fields from marine science to ecotoxicology. In 1991, the school dropped the word "forestry" from its name.

What's unique about such schools is that they explicitly package natural and social science, explains Jarod Cohon, dean of Yale University's School of Forestry and Environmental Studies. In the past, environmental professionals have been forced to patch together their own educational programs, perhaps combining a research-oriented degree with an M.B.A. or on-the-job training. But today, schools such as Duke and Yale take their cue from schools of public health and business. The goal is to produce scientifically savvy professionals who can manage a preserve for the Nature Conservancy, write regulations for the Environmental Protection Agency (EPA), or plan logging operations for Weyerhauser Inc.

The idea is timely. Indeed, while many areas of higher education are retrenching, leading environmental schools are hiring more faculty and enrolling more students. Most schools offer research-oriented Ph.D. programs too, but it's the professional programs that are growing most rapidly, fed in part by a seemingly insatiable demand from students. At Duke, applications have been increasing at an annual rate of 20% in the past few years, says Norman Christensen, dean of the School of the Environment. And so far, at least, grads are getting jobs: A 1992 survey found that 95% of management students found work within a few months of graduation.

Part of the attraction is the promise of business skills as well as scientific understanding. For example, Fawver has taken classes in economics, sustainable development, and conflict resolution, and she's eager for more training in speaking, negotiating, and writing. "It's skills, not knowledge per se, that I'm interested in."

PHOTOS BY JIM WALLACE/DUKE UNIV. PHOTO DEPT.



Policy wonk? Rebecca Fawver hopes Duke's novel 2-year environment program, housed in the Levine Science Research Center, will spawn a career in, say, government.

Even science courses emphasize real-world problems and require students to work in groups. Says John Fitzpatrick, who earned a B.S. in biology at Brooklyn College before coming to Duke, "In a traditional undergrad [science] class, you learn the progression of thought in a field and review the experiments already done. Here, it's like, 'Here's the information, now how do we apply it?' "

Duke's management degree requires an independent project, but students typically tackle an existing environmental problem, such as managing a heavily used estuary, rather than conducting original research. "Students who want to go on as scientists are better served by traditional science degrees," admits Christensen, who was trained as a botanist.

Indeed, the backgrounds of students in the Duke program vary widely. For example, management student Elizabeth Cummings majored in political science and never considered becoming a scientist. But while working as a consultant, she realized that her successful colleagues knew much more science than she did. "They could go look at a site and understand the hydrology," she says. "I needed a better working knowledge of how a watershed works, and I didn't feel that learning on the job would be sufficient."

On the other hand, biology major Fitzpatrick considered getting a Ph.D. in ecology, but instead chose the professional program with an emphasis on conservation biology. He reasoned that the program could give him both the scientific insight as well as the real-world skills needed to make a practical contribution to the field. "It's the best of both worlds," he says.

–Elizabeth Culotta

Novel Program III: Undergraduate Nanotechnology

When Felipe Chibante arrived at the Houston laboratory of Rice University chemist Richard Smalley, he'd never even heard the term nanotechnology. Rather, he was merely an undergraduate chemistry major who figured to become a physical chemist one day. Six years later, and 6 months after completing his postdoc, Chibante is a full-fledged member of a new field that's forcing universities to change their approach to teaching and research. What converted Chibante was a pathbreaking initiative in nanotechnology devised by Rice University officials committed to riding the curve of scientific progress on their campus and abandoning traditional disciplinary groupings in undergraduate and graduate education.

At Rice, as at a growing trickle of universities across the nation, administrators are keeping a close eye on the changing needs of the marketplace as they prepare students for careers in science. Over the last 15 years, for example, Rice has created a Quantum Institute, which combines faculty from the physics; chemistry; space physics; astronomy; materials science, and chemical, mechanical, electrical, and computer engineering departments; an Institute for Biosciences and Bioengineering; and a Computational and Information Technology Institute. The common denominator is uniting several disciplines and producing graduates and postgraduates who can more easily find real-world uses for fundamental research.

The nanotechnology initiative, conceived by Smalley 2 years ago, is expected to influence Rice's undergraduate education in the same way over time. A new building will house both the initiative and the university's department of chemistry, and six faculty positions have been created—three in physics, two in chemistry, and one in electrical engineering—to get it rolling. Another special feature: Undergraduate teaching labs will be constructed alongside research labs. Nanotechnology will also be a part of undergraduate courses, although there won't actually be a course on the topic. "We're still forming it out of the mists," says Smalley about the initiative.

Fortunately for Chibante, the mist didn't have to