Biomedical scientists attend a job fair to explore career options.

BAZAAR

BIOLOGY'S NEW JOB

A hotel ballroom in Cambridge, Massachusetts, offers a snapshot of a rapidly changing world. It's 10:30 on a sunny but brisk New England morning, and the double doors won't open for another half hour. Already, a line of 100 people snakes down the hallway, past several meeting rooms, all the way to the escalators. They appear to be corporate neophytes looking for their very first jobs—and many are. Fresh out of school they may be, but they're hardly entry-level applicants. They are, in fact, highly trained university scientists, mainly postdoctoral fellows, who are here to trade academic aspirations for biotech careers.

Thousands of life scientists have flocked to the annual biotechnology job fair since its launch by the journal *Science* in 1997. The rising turnout—this year's fair drew a record 700 scientists—illustrates a significant shift in the field. Not long ago, many academics shuddered at the thought of "selling out" to industry and looked down on peers or protégés who made the move. But with the recent boom in biotechnology and genomics, the private sector is becoming an attractive alternative—intellectually as well as financially—for many young scientists, even those with stellar academic credentials. It's a change with important implications not only for the scientists themselves but also for the broader research community, affecting the relationship between academia and private industry and overturning assumptions about how biomedical science advances in the United States, where and by whom.

Some of the job seekers at the Cambridge job fair don't want their mentors to know about their interest in biotech; others say they've come with their mentors' blessings. Either way, when the doors finally open, they hand over their curricula vitae—the price of admission—to a woman at the entrance, who collects about 400 in the first hour. Past fairs drew that many attendees in an entire day. The room is packed with booths representing 30 biotech heavyweights—Genzyme, Genaissance and

BY DELIA K. CABE


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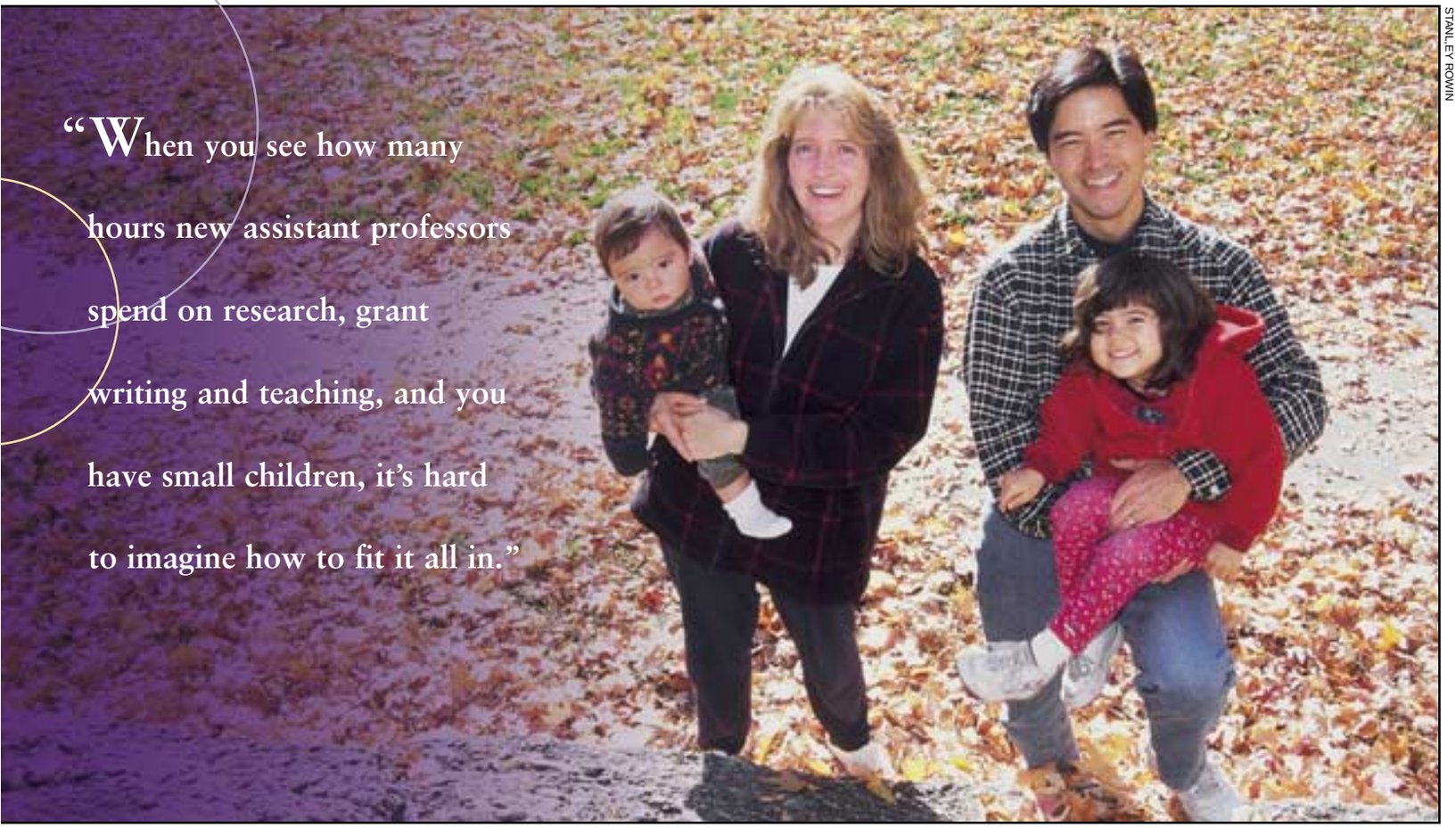
IN SCIENTIFIC INNOVATION

Genentech; Merck, Millennium and Millipore, for example. People form new lines inside, this time for a chance to make an impression during a 10-minute interview.

Lisa Flanagan, an NIH postdoctoral fellow at Harvard Medical School, strides into this bazaar with an open mind and a simple mission: to gather data while making contact with a select handful of recruiters. While other attendees say they've decided to work in biotech, Flanagan is still unsure. She has talked to friends who left academia for the private sector. Her impression? Industry offers more of a team approach and more resources, two aspects she likes. "At a company, if you want to explore a new technique instead of having to set it up in your own lab from ground zero," she says, "you can go down the hall to another division of the company that is already using it. Your research can move all the faster." But she wonders to what extent scientists in biotech must justify the direction of their research, and she wants to know how much autonomy and freedom they have. She will seek answers to these questions by talking to company scientists rather than recruiters. Today, she simply wants to make contacts and learn more about each company's research.

Before the fair, Flanagan checked *Science*'s Web site for the list of exhibitors, then pored over each company's site to determine geographic location (her destination: Boston or California) and research focus (her specialty: neuroscience). She whittled down her list to five companies: Genentech, Merck, Aurora, Genzyme and Axys. As she enters the ballroom, she scans a map of exhibitors, locates the Genentech booth and weaves through the crowd toward the far corner of the room. Craning her head to scout the best path, she scans corporate banners bearing cheery come-ons: "Consider the Possibilities!" "How Far Do You Want to Go?"

Across the river in Boston, her husband is on a more traditional career path. Edwin Monuki, an HHMI physician-



STANLEY ROWIN

Lisa Flanagan and Edwin Monuki hope to find jobs that will enable them to balance their scientific careers with the needs of their family.

postdoctoral fellow, is tucked away in an eighth-floor lab in a Harvard Medical School research building, finishing a grant application and preparing a presentation that he will give in Detroit the following week. Without question, he will stay in academia. "My desire to do clinical pathology is always easier to pursue in an academic setting," he says. "I guess I never really imagined it any other way." With a few months left in his fellowship, Monuki has received one offer, but he will look into other university hospitals on both coasts before committing himself.

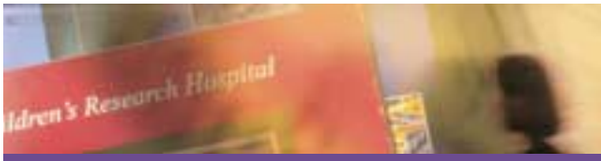
The options and pressures facing this dual-science-career couple, who possess comparable credentials and related research interests, typify those of today's postdoctoral fellows. Monuki, who is 37, and Flanagan, 33, met at the University of California, San Diego, where they were doctoral students in neuroscience and he was also working toward his medical degree. Married for six years now, they have a 3-year-old daughter and an infant son. Raising children has made them thoughtful about balancing their careers with parenthood. Spending as much time as possible together as a family is important to them. They alternate dropping off and picking up their children at day care so that, each day, one gets the chance to arrive earlier and the other stay later at his or her respective labs, which are in buildings opposite each other on Avenue Louis Pasteur in Boston's Longwood Medical Area. They try to avoid coming in to work on weekends, but Monuki realizes that may change once he starts his own lab.

Monuki credits two factors with cementing his stay in academia. One is great mentors; the other is a successful graduate career, during which he published several papers. After talking with a friend who works in human resources at a biotech company, Monuki came away thinking that doing "what's best for the company" is the antithesis of what he loves about academia. "That gets to the heart of it. I guess it would be awful if a company drops your project in the middle. The main thing is [academic] freedom," he says. "But the biggest reason I want to keep doing research in academia is that I really like to do it."

His wife isn't so sure she wants the tenure track. "When you see how many hours new assistant professors spend on research, grant writing and teaching, and you have small children, it's hard to imagine how to fit it all in," Flanagan says. "Basically, there is no good time at the early stages of your career to have kids. The best time would be when you already have tenure, but biologically that's a bit late."

For Flanagan and others, the private sector now offers a viable alternative. HHMI investigator Shirley Tilghman sees the broadening of opportunities as a boon for new scientists. "One of the things that I think is most positive over the last 25 years is that the options for postdoc fellows have greatly expanded from when I was in training," says Tilghman, who chaired a National Research Council (NRC) committee examining the job scene facing life scientists at this critical point in their careers.

Today's life scientists are 32 years old, on average, when they earn their Ph.D.s and twice as likely to receive a postdoctoral fellowship as their counterparts three to four decades ago, Tilghman's committee notes in its 1998 report, *Trends in the Early Careers of Life Scientists*. Nearly 8,000 people in the United States earned life sciences Ph.D.s in 1996—more than triple the number granted in 1963, and the biomedical sciences accounted for nearly all of the increase, the committee found. The average life scientist will, after a fellowship of five or more years, secure a permanent position between ages 35 and 40. But here's the catch: While universities still



CAREER RESOURCES

Trends in the Early Careers of Life Scientists
A 1998 report by the National Research Council's Committee on Dimensions, Causes, and Implications of Recent Trends in the Careers of Life Scientists, chaired by HHMI investigator Shirley Tilghman. Also available in print.
www.nap.edu/books/0309061806/html/index.html

Career Development Center for Postdocs and Junior Faculty
A collaborative effort of HHMI, the American Association for the Advancement of Science (AAAS) and the Burroughs Wellcome Fund. Affiliated with Next Wave, which offers extensive career information.
nextwave.sciencemag.org/feature/careercenter.shtml

GrantsNet
Another collaboration between HHMI and AAAS, GrantsNet speeds the search for funds for graduate and undergraduate training in the biomedical sciences and undergraduate science education.
www.grantsnet.org

Phds.org
Science career library provides graduate students and others with extensive resources.
www.phds.org/

Biospace
A clearinghouse about the biotechnology industry, including job listings.
www.biospace.com

Sciencejobs.com
Online jobs site affiliated with BioMedNet, *NewScientist* and *Cell*.
www.sciencejobs.com/bio/

Post-docs.com
Recently launched site highlights postdoctoral positions at universities and elsewhere, with related resources.
www.post-docs.com

Guide to Nontraditional Careers in Science
A 1999 book by Karen Young Kreeger that examines how scientists use their skills in new careers in writing, business, law, technology transfer and other fields.

—DKC

JOB BAZAAR

Three Scientists Choose New Paths

Many of the scientists who receive fellowships from the Institute or work in HHMI laboratories early in their careers still pursue the academic path. But that choice is far less automatic than it was even a few years ago, as illustrated by these three examples.

Jenifer Görlach
Technical Specialist
Myers, Bigel, Sibley & Sajovec
Research Triangle Park, N.C.

After the birth of her second child, Jenifer Görlach decided to look for a career away from research during the time remaining on her NIH grant to study antisense suppression in *Cryptococcus neoformans*. She met with a career counselor at Duke University, where she was a research associate in an HHMI laboratory after receiving her doctorate, to explore her options and learn how to market herself. Görlach also assessed the skills she had that she might apply to other kinds of science-oriented jobs, about which she gathered information. To learn about a possible career in science writing, for example, she interviewed technical writers at pharmaceutical firms.

The process paid off. Görlach landed a job at a law firm specializing in intellectual property issues, where she now assesses biotech-related innovations. She studies the experiments and supporting technical information from scientists, looks for similar products or techniques that are already patented, puts together a report and prepares the patent application. Early next year, she will take the exam that qualifies her to become a patent agent.

"Here I do everything but the bench work," she says. The only thing she misses is networking with colleagues at professional meetings.

Imre Kovesdi
Vice President and Chief Scientific Officer
GenVec
Gaithersburg, Md.

Imre Kovesdi, a native of Hungary, was older than his peers when he earned his science degrees in Canada and then joined an HHMI laboratory at The Rockefeller University. As his postdoctoral work neared completion, he was considering offers for tenure-track positions at several universities when a colleague asked whether he'd be interested in working as a molecular biologist in the medical research division of American Cyanamid Company. For Kovesdi, the issue was age, not salary. "I felt it would be difficult to compete in academia for grants and such with people 10 years younger than I am," he says.

After his first industry job, he again weighed jobs in academia and pharmaceutical companies. A headhunter, however, told him in 1993 about a start-up biopharmaceutical firm called GenVec. Kovesdi, the first scientist hired by the company, was named director of vector biology. GenVec now holds 300 patents and has a product candidate in phase 2 clinical trials. Kovesdi was named chief scientific officer last year.

Like many principal investigators in academia, he does no lab work at this point in his career. Instead, he works on strategy. "I still have a little bench space and my pipettes," he says. "I'm threatening my staff that I'm going back to cloning."

Clara Alarcon
Research Manager
Pioneer Hi-Bred International, division of DuPont
Johnston, Iowa

A native Guatemalan from a family of academics, Clara Alarcon came to the United States to get her Ph.D. in human nutrition at the University of Iowa. Most of her training, however, is in molecular biology. After carrying out postdoctoral research in an HHMI laboratory at Duke, where she learned protein biochemistry and yeast genetics, she returned to her husband's native Iowa.

The transition from human nutrition to agricultural biotechnology isn't much of a stretch. Working in a company like Pioneer Hi-Bred, she says, uses all her training in molecular biology and protein biochemistry. She assumed her research manager position in transgenics research with Pioneer in 1997 and now oversees seven people in her lab. "You can do as much biotech research as in academia," she says. "In addition to interacting with fellow scientists, I interact with other disciplines—finance, marketing, strategy. I do bench research and I still publish."

Family members who work in academia have asked her to talk to students about her nonacademic career. If they are definitely going into biotech, she tells them, they should do an internship or a postdoctoral fellowship in industry first. (Alarcon did a postdoctoral fellowship at Pioneer.) She also recommends acquiring management experience and "people skills."

Looking back, she says, "I wouldn't have done anything different. I don't miss academia, but I don't rule out the possibility of teaching at the college level, although not necessarily full time."

—DKC

In response to the changing job market, several universities have introduced programs that assist postdoctoral fellows with career development.

employ the majority of life scientists, the number of academic positions has not grown enough to absorb the flood of Ph.D.s. The biotech industry, meanwhile, has been booming, fueled in part by the overflow of life scientist Ph.D.s, according to the NRC report. During this period, Ph.D.s also began to explore alternative science-related careers—in law, writing and secondary or undergraduate teaching.

Among scientists, the changes are spurring a cultural shift. "Twenty-five years ago, jobs in industry were thought not to be very interesting or very prestigious," Tilghman says. Now, however, she notes, "younger scientists see it as a place for exciting careers" and adds that "one of the largest problems today is a disconnect between the attitudes of the current generation and their advisers."

The attitudes of younger scientists about biotech are shaped not so much by the appeal of higher salaries as by the prospect of doing cutting-edge science. Celera's pioneering use of EST clustering and whole genome data mining, Affymetrix's GeneChip expression monitoring probe arrays and Genzyme's innovations in tissue repair are a few examples. "When I visit companies like these, they strike me as places of great energy and enthusiasm," says David A. Clayton, HHMI's vice president for science development. "A lot of very exciting science is being done there." Clayton says the Institute will continue focusing its scientific and educational activities in nonprofit settings, and he emphasizes the importance of academic training even for researchers who enter industry. But, he's quick to add, "I believe the essence of doing science is the same no matter where you end up."

In response to the changing job market, several universities have introduced programs that assist postdoctoral fellows with career development. In 1997, the University of Pennsylvania School of Medicine created an office to do just that. Its director, Trevor Penning, who has mentored many postdocs over the years, tells those now entering the program to prepare from the start of their fellowships for their intended permanent positions. To some, this comes as a shock. "Many have been in a protected environment and were not exposed to career options in their graduate programs," he says.

Penning's office holds career workshops that bring together academic scientists and those in nontraditional careers to speak about their experiences and career paths. Penning has also established a link with the career services office, which, at Penn as at most other universities, ordinarily serves only students and employees. Now, postdocs can turn to career specialists to learn effective job search skills, participate in mock interviews and get feedback on their CVs and cover letters.

Many scientists applying for biotech jobs are eager for career counseling. At the *Science* career fair, a résumé expert runs a very popular booth, with a long line spilling out into the hallway. At no charge, he will scan a CV and offer a few tips, all within five minutes or so.

Aside from the résumé expert, there are

Scientists attending a job fair meet with representatives from biotechnology firms and other employers.

One job seeker says, "It will depend on who gives me the better offer—grants, fellowships, salary. I'm really on the fence."

only three nonbiotech exhibitors at the fair. The National Cancer Institute and U.S. Food and Drug Administration have each set up booths, which draw few applicants. The booth for St. Jude Children's Research Hospital isn't hopping either. William S. Walker, vice chair of the department of immunology and associate director of academic programs, who is staffing the St. Jude exhibit, says his presence among the biotech companies provides an excellent chance to meet postdoctoral scientists of the highest caliber, given the proximity of nearby universities like Harvard and MIT. He hopes to hook some undecideds, if only a few—and sell them on working at St. Jude.

Among those exhibiting at the job fair are pharmaceutical companies, government agencies and research institutions.

At the moment, the lone job seeker at the St. Jude booth is Paul Beresford, who is nearing completion of his postdoctoral fellowship at the Center for Blood Research at Harvard Medical School and whose wife anticipates the birth of their first child in March. Beresford, 32, feels uncertain about his prospects in academia and worries about supporting a family. His friends, who are his age and work outside academia and science, are farther along in their careers, he observes. He might not consider leaving the university world if he had a better idea of how long it will take his career and salary to progress. "It can take five to 10 years to establish a lab," Beresford says. "That really takes its toll psychologically and financially." Still, while higher-paying biotech jobs may beckon, it was his heart that lured him to the St. Jude booth.

Walker talks to Beresford at length about the hospital's start-up package and core facilities. Beresford likes what he hears, but St. Jude is in Memphis and he and his wife have family ties in Boston. In the end, however, location will not be the deciding factor. "It will depend on who gives me the better offer—grants, fellowships, salary," Beresford says. "I'm really on the fence."

Unlike Beresford, Flanagan stays away from the St. Jude booth as well as the other nonbiotech exhibitors. Yet she still debates about moving to industry. It's not that she still feels uncomfortable with entering biotech; the more she talks to people who have gone to the "other side" and taken research positions in biotech, the more conceivable the option feels. Flanagan used to question whether a job in industry would mean selling out as well as whether it would prevent her from ever returning to the academic world. That was before she began gathering information about biotech careers, however. In the end, she says, her decision will depend on finding a situation that suits her, whether in biotech or academia. "My hope for my career has always been that I continue to love what I do each day. I find the workings of the human brain fascinating, and I particularly like thinking about the intricate details of neuronal function," she says. "So from that standpoint, as long as I continue to do that research, I'll be happy."

Flanagan manages to introduce herself to all five recruiters on her list today, reciting her credentials and interests while looking each interviewer straight in the eye. Mission accomplished.

"This was useful," she says at the end of the day. "I got a couple of contacts at companies, which is good. I'm a step farther along than when I came here," she says as she leaves the now hot and airless ballroom. Will she take the leap or, like her husband, continue on an academic track? Like so many postdocs in this shifting career world, she's still undecided—but either way, she knows she'll be doing research.

Campuses Strive to Keep Pace

The boom in biotechnology and genomics is also having an impact on science education.

Colleges and universities are moving quickly to help their biology students gain the interdisciplinary skills they'll need to deal with the mountains of data churned out by enterprises such as the Human Genome Project. They're retooling their curricula, faculty and facilities, most notably with courses in computational biology, the emerging discipline that blends the life sciences with computer sciences and mathematics. At least 20 schools have launched entirely new programs in the field.

At Kenyon College in Ohio, mathematical biologist Keith Howard, with support from an HHMI grant, is helping establish math courses that emphasize computer modeling of biological problems. This year, the college hopes to fill a new faculty position with a joint appointment in the mathematics and biology departments.

The biology and mathematics faculties at Harvey Mudd College in California decided to alter their programs—and not just because the life sciences are increasingly quantitative. Professors had also noticed that students were assembling makeshift majors that combine mathematics with the sciences, says F. Sheldon Wettack, a chemistry professor and dean of the faculty. An HHMI grant will enable the college to hire a bioengineering faculty member, update computational and molecular biology facilities and free up faculty to develop a program in quantitative life sciences. In addition, a new joint major in mathematics and biology is in the planning stages.

Biology professor David H. Deheer, director of HHMI-supported education programs at Calvin College in Michigan, also cites the need to keep pace with trends in biotechnology and to prepare graduates for academia or industry. Last year, Calvin introduced an undergraduate major in biotechnology, in which life sciences courses emphasize computational biology.

At Haverford College in Pennsylvania, the quantitative skills of both faculty members and students are being brought up to speed. "This year, we have a course called Computing Across the Sciences for faculty members in the natural sciences," says biologist Philip M. Meneely, chair of the department of biology. Meneely hopes the training will help professors incorporate computational and mathematical skills into existing courses.

This past fall, Rensselaer Polytechnic Institute in New York welcomed its first group of freshmen majoring in bioinformatics, a program implemented with an HHMI grant. The students will take a variety of molecular biology courses and work in a new computer lab where they can run biological simulations during lectures. Instead of the usual introductory biology course, they're starting off with cell and molecular biology.

These and similar programs at campuses across the country appear not a moment too soon. Scientists proficient in computational biology are in great demand, as illustrated by the growing number of job announcements in the journal *Science*. According to a 1999 report in *Science and Public Policy* by economists Paula E. Stephan and Grant Black of Georgia State University (GSU), the number of announcements in *Science* for computational biology specialists doubled between 1996 and 1997. Since then, the field has gotten even hotter.

Many researchers, however, have had little formal instruction in computational biology. To get the help they need, they may hire younger scientists who gained the necessary skills informally through Web-based tutorials, commercial software and seminars. But such individuals are in short supply, and the shortage is likely to persist until colleges and universities catch up. That won't be easy with so few experts available to teach courses in computational biology and to help integrate computational biology into the broader curricula.

Certain academic realities will prolong the shortage. "There is very little cross-pollination between mathematics and biology," says Kenyon's Howard. Long-standing barriers between disciplines discourage students and faculty from crossing over, so biology students avoid taking computer science or mathematics courses, just as computer science and mathematics students are reluctant to delve into other sciences.

Another factor noted in the 1999 GSU study is that the needs of industry—while clearly pressing—have exerted less influence on life sciences departments than on departments of engineering and computer sciences, whose students traditionally go into industry. In contrast, faculty members in the life sciences tend to steer their graduates toward academia and may even be ignorant of the training students need for the biotech industry.

— DKC