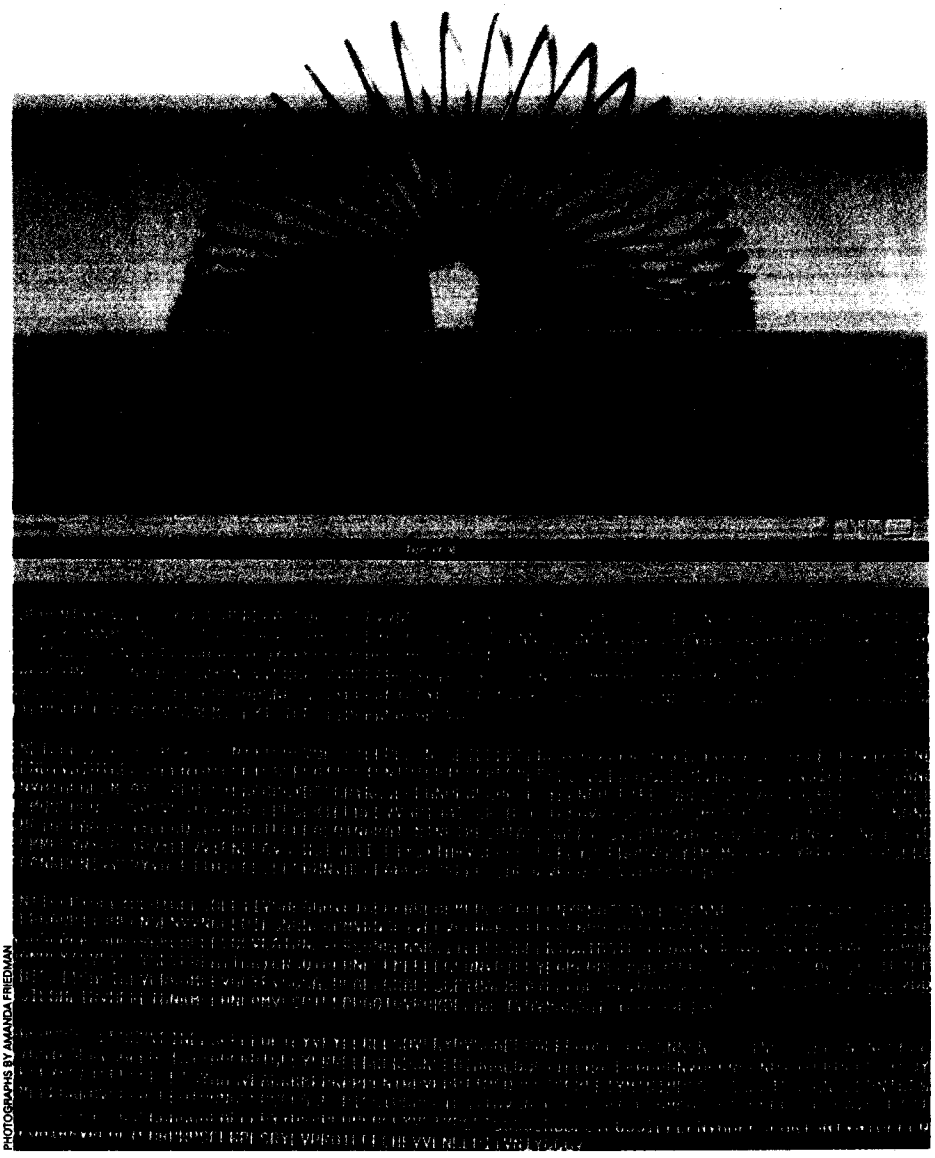
Jobs of the Future

To build better drugs, the exploding field of bioinformatics is looking for highly trained workers comfortable with supercomputing and biology. By Brad Stone

Wanted: Hot Industry Seeks Supergeeks

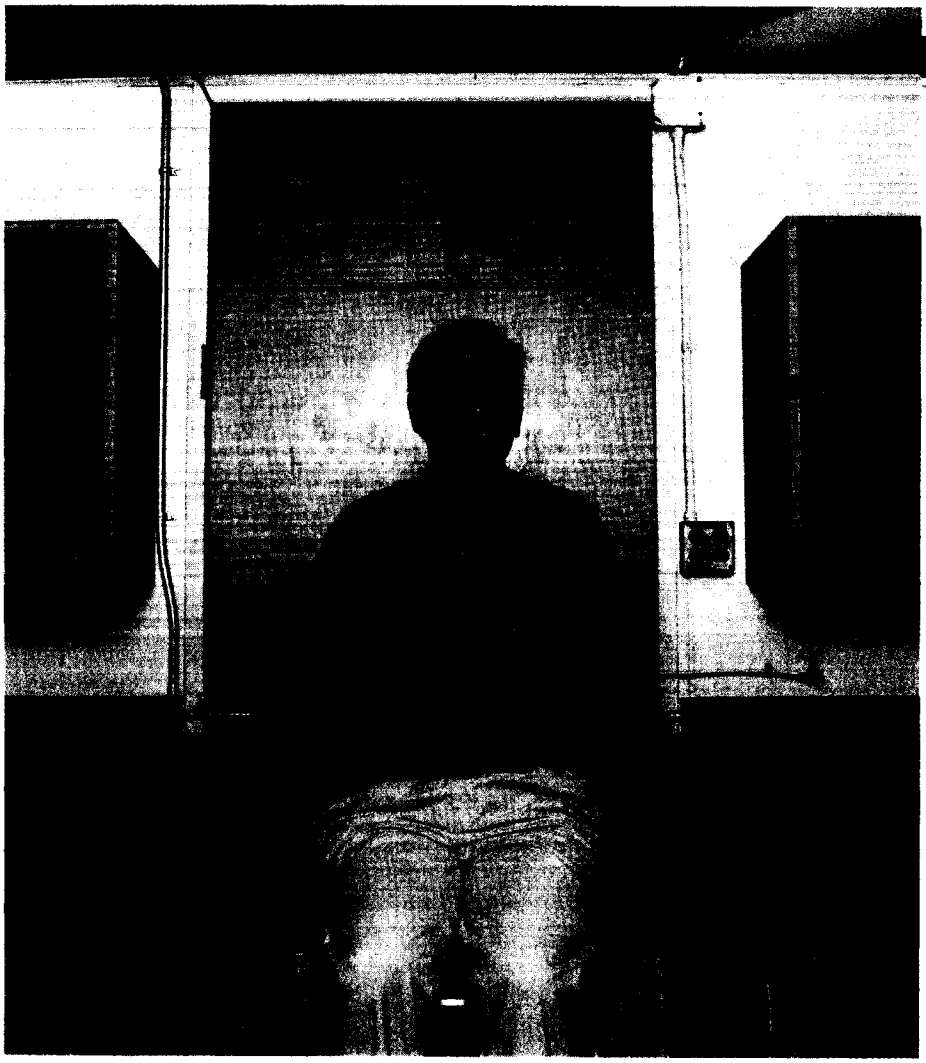
CRAIG BENHAM HAS A problem. As a professor at Mount Sinai School of Medicine in New York, he trains students in the exploding new field of bioinformatics—the fusion of high-powered computing and biology that is aimed at revolutionizing the health-care industry. But Benham can't keep a postdoctorate researcher for more than a year. They keep leaving for jobs that pay up to $100,000 at bioinformatics start-ups, giant pharmaceutical companies or technology giants like Motorola and IBM that are targeting the rapidly growing life-sciences field. "These companies need a whole new class of biologists who have training in the computational and mathematical methods," Benham says. "I've got one former student who has been hired four times in three years, increasing his salary 30 percent each time. There's huge demand for these skills." Benham knows of what he speaks: this summer he will join the University of California, Davis, heading up its new $95 million bioinformatics program.

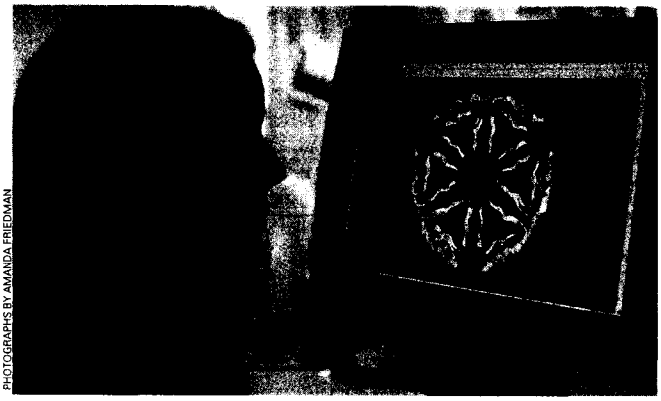
Bioinformatics encompasses its more widely known offspring, genomics, the study of genes and their function. It involves the use of supercomputers, vast databases and complex software to analyze the mountain of data that has emerged from the sequencing of the human genome, whose mapping was completed last summer. The Human Genome Project was a decadelong effort that cataloged 3 billion DNA base pairs—the chemical components that together spell out the genes that make us who we are. But the data that were supposed to change the world are merely three gigabytes of raw letters, a jumble of A's, T's, G's and C's (which stand for the chemical ingredients



PHOTOGRAPHS BY AMANDA FRIEDMAN

FLY WITH SLINKY: Genetic code of the fruit fly on the computer of a bioinformatics student





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COMPUTER LAB: UCSF's Cohen (left), student imaging a protein unaffected by mad-cow disease

of DNA). The pairs of letters offer few hints about the genes they describe or what those genes actually do in each of the billions of cells in the human body.

That's where bioinformatics comes in: making sense of the genome by offering the tools to mine the data and match the DNA info with the genes. Venture capitalists invested more than $700 million in the field last year, according to the tracking firm VentureOne. Dozens of schools, including UCLA, have started bioinformatics centers in the past few years, and tech giants are targeting it as one of the few growth sectors in today's economy. IBM in particular recently estimated that selling computer equipment to the life-sciences industry over the next three years is a $43 billion opportunity. Eventually, the proponents of bioinformatics claim, the new field will change health care by allowing pharmaceutical companies to shave years off the drug-discovery process, and letting doctors tailor medicines to an individual's genetic makeup. "This is as big an opportunity as the computer industry itself," says Nathan Myhrvold, once the chief technology officer at Microsoft and now a Seattle-based investor who concentrates on biotechnology. "In order to understand how our bodies work, we need to process enormous amounts of information."

But the fledgling field first must find the right people to build, deploy and manage such complex systems. One study estimates the industry will need 20,000 highly trained workers by 2005—a new brand of supergeek who understands the complex tongues of both biology and computer science. That person will look a lot like 26-year-old Marcin Joachimiak. The fourth-year Ph.D. candidate at UC, San Francisco, has bounced from a mathematics undergraduate program to a biomolecular lab and ended up pursuing his doctorate in biophysics. He spends his days peering into a computer screen at the cellular and molecular pharmacology lab of Prof. Fred Cohen, analyzing the DNA of the deadly parasite that causes malaria. The ultimate goal: identifying which sequences are most vulnerable to attack by drugs, and then sending those new, promising targets into the lab. "This is not computation in a vacuum," says Cohen. "Analyzing the data leads to more focused experiments," which have a better chance of success than trial-and-error tests on animals. But the interdisciplinary work is so new that Joachimiak says, "I don't feel like I have a good name for what I do."

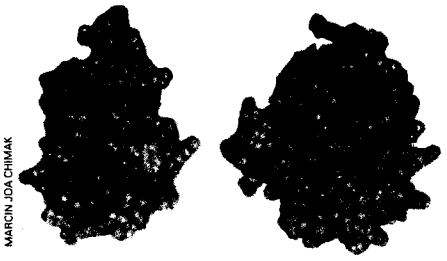
Despite the difficulty of describing the job at cocktail parties, the industry will have a lot more openings for graduates with that kind of specialized education. "Most people trained classically in biology don't have the quantitative skills that are required," says Bruno Sobral of Virginia Polytechnic Institute. "And most people trained in computer science or statistics don't understand enough biology to know what the important problems are." Sobral's university is one of the many around the country rushing to produce the workers to fill that gap. The new Virginia Bioinformatics Institute will cost $100 million and occupy three new buildings. Other schools, like the University of Florida at Gainesville, the University of the Sciences in Philadelphia and George Mason University in Virginia, have all recently formed departments of their own. UC, Berkeley, and Cornell also plan to start centers.

Despite the sudden burst of interest, bioinformatics has actually been around in some form for two decades. In the '80s it was called computational biology. Back then researchers checked the DNA sequences they discovered in the lab with GenBank, a free database hosted inside the Department of Energy and later the National Institutes of Health, to see if there were any related discoveries. Since then the movement to classify the genetic ingredients of human beings has been picking up steam and yielding copious amounts of data. In 1985 GenBank contained about 5,700 DNA sequences. With the sequencing of the

genome, that number has ballooned to more than 10 million today. Some well-known genome companies, like Human Genome Sciences and Celera, have bioinformatics divisions that offer their own databases of DNA information. Scientists who use them are required to give the company royalties on any resulting drug.

But it would take researchers centuries to sift through all the raw genomic data that are out there today. So another category of bioinformatics companies focus on providing the software tools to mine that information. Companies like Informax in Bethesda, Md., and Lion Bioscience in Germany license software and offer consulting services to thousands of research organizations worldwide—small labs and giant pharmaceuticals alike—for prices up to $100 million. Other start-ups, like Silicon Genetics in Redwood City, Calif., make software that allows researchers to crunch the data from so-called gene-expression experiments, which indicate whether individual genes are active in certain kinds of tissue (for example, in cancer cells).

Computer-industry giants like Compaq, IBM and Oracle don't want to be left out of the action either. Beyond its drive to sell equipment and services to the industry,



MARCIN JOA CHIMAK

ON TARGET: Tapping computers for cures

IBM is spending $100 million to build the world's fastest supercomputer, dubbed "Blue Gene," that will model how human proteins are folded and thus what activity they perform—a spinoff field of genomics called proteomics. Software maker Oracle also recently jumped on the bandwagon, saying it would make a database capable of storing all the info coming from a new project to catalog the estimated 1 million proteins in the human body.

So how will this new, promising field actually change the world? The new tools can shorten the development cycle for new medicines, which takes 10 years and costs hundreds of millions of dollars. Failed drugs can be discarded earlier if computer searches reveal, say, that similar chemical compounds have produced toxic reactions in the past. Bioinformatics will also change the kinds of drugs that are greenlighted. Today, drugs are like Nike sneakers: mass-produced for a whole class of individuals (those who wear size 10, or victims of AIDS). Researchers envision a time when drugs abandoned because they caused harmful side effects in some people would be produced, and doctors will test patients for the genetic characteristics that would make them susceptible to a bad reaction.

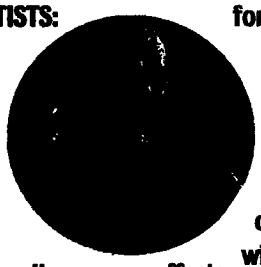
A decade down the road, proponents predict, bioinformatics advances will filter right down to the doctor's office. Routine blood tests will identify not only what's wrong with patients, but which medicines are most likely to work given their genetic makeup. Or a pediatrician will test newborns to find their propensity to a whole spectrum of illnesses, along with information about their metabolism and susceptibility to drug side effects. These doctors may not themselves be directly schooled in bioinformatics, but they'll be using a new set of tools and software that the industry will create. And standing behind those tools, in turn, will be the new generation of workers. That is, if they can stop hopping from job to job. ■

Opportunity Knocks
NEW CAREER PATHS

Gets along well with co-workers

WEB-SECURITY SPECIALIST: Lethal computer viruses and other hack attacks have made Web security a hot specialty. Rigorous background-check requirements tend to make the jobs hard to fill, however. A military background is a plus.

PROGRAMMING ARTISTS: The high-end graphics popular in Hollywood animation, computer games and virtual media require artists who are also computer programmers. The Labor Department projects employment for commercial artists to rise 25 percent by 2008, spurred in part by an increased demand for digital talent.



Unwrap new effects

ROBOTIC ENGINEERS: Engineers will be needed to build robots that do everything from assembling machinery to caring for aging parents.

TELEMATICS: Telematics is the term used for the new industry of equipping cars with e-capabilities. Analysts predict that 84 percent of new cars sold in 2005 will be telematic-ready. Jobs require a combination of telecommunications and computer-science skills.

TECH TEACHERS: As technology use increases in all industries, more adult-education teachers are needed to give workers the skills to survive. About half of all adults are currently enrolled in an adult-education class.

WIRELESS DEVELOPERS: The Internet is going wireless, and the demand for programmers and architects familiar with this somewhat arcane coding, which bears little resemblance to HTML programming, is increasing exponentially.

TECH SUPPORT: Technology isn't infallible, and skilled workers who can fix frustrating problems are always needed. Estimates show a 222 percent boost in computer-support jobs by 2008.

Teaching the grown-ups

FROM LEFT: ILM—UNIVERSAL STUDIOS, PETER MENZEL, JOSH MITCHELL—TONY STONE