BIOLOGY BOOT CAMP

BASIC TRAINING FOR NEW RECRUITS TO THE LIFE SCIENCES

BY SALLY POBOJEWSKI

MARK HOOPER/PHOTO-ILLUSTRATION: B&G DESIGN STUDIOS

WANTED: Desperate scientist overwhelmed by data seeks graduate student trained in bioinformatics. Expertise in computational methods and statistical analysis required. Must understand genetics and molecular biology. Interdisciplinary experience is a plus.

GOAL: Long-term research collaboration.

In 2003, the Human Genome Project gave scientists an amazing research tool — the genetic code for 3 billion base pairs of DNA and the 25,000 or so genes that make us human. It may have been too much of a good thing. In their efforts to understand what these genes do, how they are regulated and what goes wrong to cause disease, scientists are drowning in a flood of information.

Interpreting all that data requires lots of computing power and people who understand advanced statistical analysis, bioengineering and computer science. University and private research laboratories are clamoring for specialists trained to work at the interface between biology and computer science.

Graduate programs in the Medical School and other U-M professional schools are training tomorrow's Ph.D.s to fill this need, says Margit Burmeister, Ph.D., a professor of human genetics and psychiatry, who directs the bioinformatics program. Burmeister says students entering these programs are smart, hard-working graduates from top-rated universities around the world. About one-third have undergraduate degrees in mathematics or statistics, one-third in engineering, and the rest in physics or computer science.

But there is one small problem. Although they know a lot about the quantitative sciences, most students know very little about the life sciences. "Some of these people haven't taken biology since high school," Burmeister says. "They don't know anything about genetics, the nomenclature of biology or simple laboratory procedures."

To communicate with the geneticists and molecular biologists they will work with in the future, the new students need a crash course in basic biology. So three years ago, Burmeister started one. It's an intensive hands-on course called "Bioinformatics 523: Basic Biology for Graduate Students with Quantitative Training." Around the Medical School, it's known as Biology Boot Camp.

Burmeister schedules the course for late August just before graduate student orientation begins. Enrollment is limited to 18 students and Burmeister accepts only those who have never taken a college-level biochemistry or molecular biology course. New graduate students spend seven days, six hours a day, covering the basics of biochemistry,

Students pick up their saliva samples and spin them in a centrifuge.

SCOTT GALVIN, U-M PHOTO SERVICES

cell biology, genetics, physiology, cell signaling and microbiology. In lab sessions, they get hands-on experience with common procedures for DNA extraction, polymerase chain reaction, plating bacteria and protein analysis.

While Burmeister and other Medical School faculty give the Boot Camp lectures, Ela Sliwerska organizes and presents the laboratory sessions. A native of Poland, Sliwerska works as a research technician in Burmeister's lab in the Molecular and Behavioral Neuroscience Institute.

Nothing is too basic for Boot Camp. Sliwerska begins with safety rules like "Gloves must be worn at all times in the lab," and "If you need to go to the bathroom, take your gloves off first." She covers elemental lab procedures like how to hold a pipette and how to grow colonies of bacteria.

Because the students are so inexperienced, Burmeister insists on having at least one faculty member or graduate student at each lab table to supervise, answer questions and keep students from contaminating a solution or breaking one of the $500 pipettes. Boot Camp instructors Michael Hortsch, Ph.D., and Jeffrey de Wet, Ph.D., often help out during lab sessions, along with graduate students from Burmeister's lab.

"The students are mystified by biology," Burmeister says. "Sometimes they are a bit scared or intimidated, but also very curious."

Biology Boot Camp is popular. There's been a waiting list for the past two years and Burmeister has received positive feedback from faculty and students. She is even considering taking the Boot Camp concept to China's Jiao Tong University, which has a joint institute with the U-M Medical School. "I've just started exploring the idea, but it would be exciting," she says, "and I have a sabbatical coming up!" [M]

A DNA OBSTACLE COURSE

The first training experience at Biology Boot Camp is a three-day DNA-extraction experiment. Students are the subjects of their own research. The goal is to determine what type of a certain gene they possess.

On the first day, Ela Sliwerska hands out small plastic containers and tells everyone to start spitting. Each student needs to collect two to four milliliters of saliva — about one-half to three-quarters of a teaspoon. That doesn't seem like much until you have to produce it on command. "It's quite a lot of spit, so it's going to take awhile," says Sliwerska encouragingly. "It helps to think about food." Several students who find it embarrassing to spit in public move down the hall to the restroom. After about 20 minutes of muffled throat-clearing and hacking, the deed is done. Nineteen containers filled with saliva are numbered, mixed with a stabilizing solution and sent to the incubator overnight.

The next day, Sliwerska (wearing a T-shirt that reads, "Got DNA?") announces that it's time for extraction. Everyone carries their saliva, which gets pretty smelly after sitting in a warm incubator for 24 hours, back to the lab bench. Transferring some of the saliva into a clean tube, the students add a purifying agent and spin the tube in a centrifuge. Five minutes later, a pellet forms at the bottom of the tube. The task now is to pipette out the clear liquid that contains the DNA without disturbing the pellet full of impurities. "Don't poke the pellet," commands Sliwerska, as she moves from table to table. Students add ethanol to the fluid and run it through the centrifuge again. And miraculously there it is — a tiny pellet of pure white DNA.

On day three, each student faces the moment of truth. They use a procedure called polymerase chain reaction to make millions of copies of one piece of their DNA. Enzymes isolate and replicate a segment of DNA containing a circadian rhythm gene called PER3. When the samples are ready, nervous students must pipette them into impossibly tiny pockets for a procedure called agarose gel electrophoresis. Advice from the instructors raises the anxiety level: "There are lots of ways to make an error here. Don't put the pipette in too far. Don't press too fast or too hard."

Sliwerska runs an electric current through the gels and prints an image of the results. The students' DNA has separated into bands of identical molecules that migrated into the gel at different speeds. The shorter version of the genes moves faster than the longer. Students with two bands on the image have inherited two different versions of the highly variable PER3 gene — one from each parent. Those with one band have inherited two identical versions.