part because of the difficulty in achieving consensus across its many fields.

Meanwhile, although the reformers are generally headed in the same direction, they don't always agree on a particular strategy. For example, there's a controversy brewing over whether computers can replace lab courses. "On a computer you can do multiple runs, it always works, and no glassware is ever broken," says biologist Charles Ralph of Colorado State University, who taught freshman biology labs on computers for half a dozen years. On the other hand, chemist and NSF officer Pine thinks there's no substitute for getting your hands wet.

However that dispute is resolved, reform efforts appear to be picking up steam. At Rensselaer, where the reform spirit has penetrated almost every department, science faculty members generally find they like the change, says Wilson. "I'm learning a lot more," says biochemist White. "I'm not using the same overheads I did 4 years ago. The students are asking me new and unexpected questions. It's exciting, dynamic." If that feeling spreads, undergraduate science classes may never be the same.

–**Elizabeth Culotta**

John Jungck: Godfather of Virtual Bio and Genetics Labs

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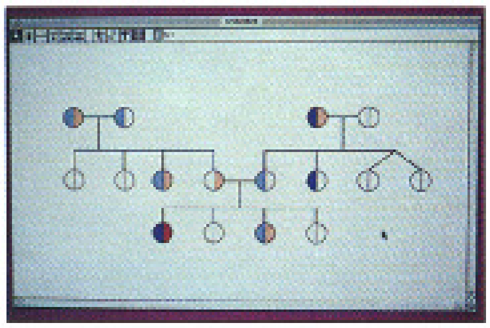

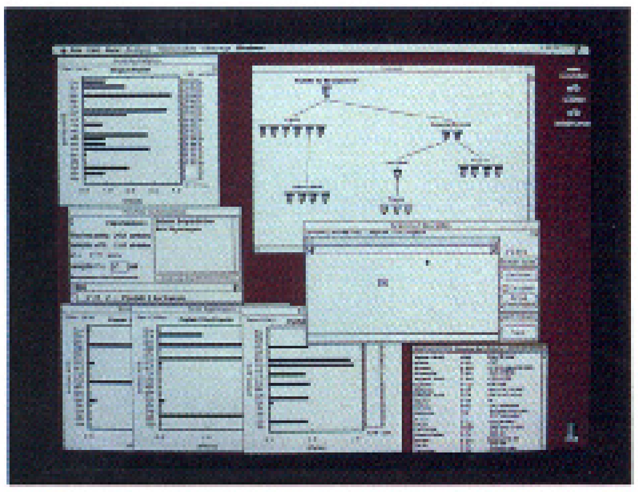

Genetic diversity. John Jungck's *(top)* growing BioQUEST computer library includes software to carry out clinical genetics case studies *(middle)* and to simulate a protein sequencing lab *(bottom)*.

Ethel Stanley, a biologist at Illinois's Millikin University, thinks something "neat" happens when she uses BioQUEST in her classroom. "Not only is the computer room busy," she marvels, "but the lounge is full of students who are actually talking about genetics." BioQUEST—a virtual lab—disproves a notion students acquire in school, Stanley says, that the lab is "a sterile place where nothing unexpected happens. Now they see it's a place where you make discoveries."

Stanley's fervent praise is not for a single commercial software package but rather a collection of 17 biology and genetics simulation programs that John Jungck, a molecular evolutionist at Beloit (Wisconsin) College, has godfathered into existence over the past 8 years. Most of the programs, such as the "Genetics Construction Kit" and "Sequence It!," mimic the long-term strategies used in the lab. Others include a heart simulation program, an environmental decision-making model, and a program to teach statistics to biologists. The idea, according to Jungck, is to give undergraduate students the experience of research—from setting up experiments to presenting a paper—without having to build additional facilities meant for undergraduates. "A lot of science teaching is poor because it doesn't let students play at the game of science," says William Sofer, a molecular geneticist at Rutgers University who uses several BioQUEST programs with his students. "This gives students a feel for the fun of research."

Jungck designed the genetics kit, his first simulated computer lab, on an Apple II. A few years later, Jungck met Nils Peterson, a Washington State University hacker who shared Jungck's goal of giving students science experience via computer simulations. With money from the Department of Education's Fund for Improvement of Post-Secondary Education (FIPSE), Peterson was then creating a computer model of the inner workings of the heart. In 1986 the two men joined forces—and simulations—and founded the BioQUEST consortium. The acronym stands for "Quality Undergraduate Educational Simulations and Tools in Biology." Jungck and Peterson next recruited 12 academicians—biologists, mathematicians, computer scientists, and educators—to develop more programs and landed a 3-year, $360,000 grant from the Annenberg Fund of the Corporation for Public Broadcasting.

Last year, after several large-scale field tests, the first edition of the BioQUEST library (including 14 different lab courses) was released on CD-ROM. It has proved a tremendous hit with professors in undergraduate—and even graduate—biology and molecular biology courses across the country, from the Massachusetts Institute of Technology (MIT) to the University of Oregon. The level of sophistication ranges from graduate level to junior high school.

The key to the software is what Jungck calls the three Ps: problem posing, problem solving, and persuasion. In the genetics kit, for example, students are given a number of "field-collected" organisms with the genetic traits of *Drosophila*. Students then mate the fruit flies and from these crosses try to explain the inheritance patterns (and thus, the genes) that they see. Students must convince their teacher and classmates that their solution is a reasonable one.

"The question students ask me the most is, 'When am I done?' " says Jungck. "And, of course, nothing is ever really finished in science. But scientists—and the students—do reach a kind of closure when they are ready to communicate their results."

Yet for all the excitement the simulated lab can generate in a classroom, Jungck warns that it was not designed to replace the real lab. "I know that there are schools that want to use it that way, that see it as a means of cutting costs; but it will never replace a wet lab," he says. "Nor will it ever replace the teacher, although it does change the way students and teachers interact."

Professors using BioQUEST agree on both points. "If you only used these programs, it'd be like looking at drawings of organisms and never looking under the microscope," says Vernon Ingram, a molecular biologist at MIT. "But what the programs are good at is teaching students how to design hypotheses and set up experiments."

The BioQUEST consortium now has more than 30 people developing programs for it and recently received a 2-year, $400,000 NSF grant. "We expect to have 13 more programs ready by the end of this summer," says Jungck. "And while those writing the programs don't get financial remuneration, they do get a lot of satisfaction from serving science and the educational community."

–**Virginia Morell**

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