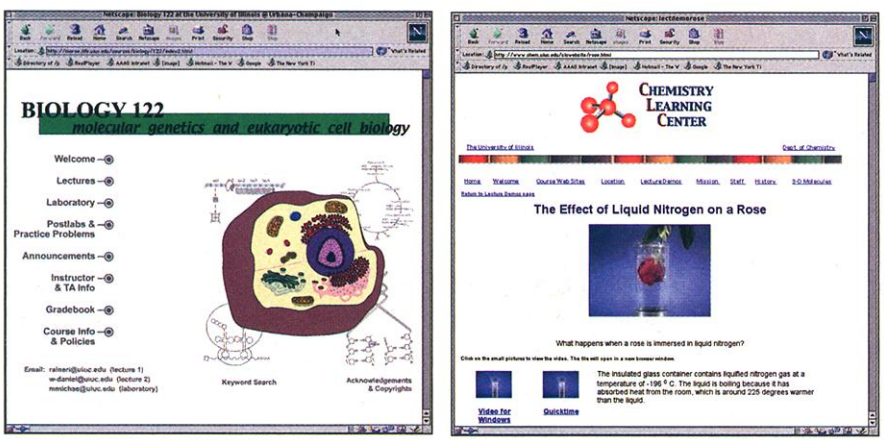
Online, On Campus: Proceed With Caution

Faculty members who have taken their courses online report a net gain in student achievement. But online instruction isn't cheap or easy, and those without tenure may want to think twice before taking the plunge

There are pleasant ways to start the day. Then there's organic chemistry (o-chem). Even worse, there's the o-chem that so many students know: complex calculations at 8 a.m., in an auditorium with 200 other students, three times a week. "It's a horrible class," admits Patricia Shapley, a chemist at the University of Illinois, Urbana-Champaign (UIUC).

So Shapley has developed another way to teach o-chem: online. The morning routine has been replaced with a more student-friendly schedule—one evening lecture, which students can attend either in person or online, and a weekly meeting with a teaching assistant, also in person or in cyberspace. The course, last offered in the fall of 2000, is as rigorous as ever: It still consists of three lessons and a quiz each week. But hypertext links offer background material for the perplexed and advanced texts for the quick learners, and course-management software lets Shapley track who logs on for lectures and homework sessions. Fewer students dropped the class in midstream than in previous years, she noted, and test scores improved considerably. "I think the students learned more and retained it better," she says.



What lecture hall? Some University of Illinois undergraduates can point and click their way through biology and chemistry classes by going online.

Despite all the buzz over online education, courses like Shapley's are still avant-garde. E-companies have yet to conquer the traditional ivory tower, and in the world of undergraduate science, in particular, the true Internet pioneers are likely to be veteran faculty members like Shapley who have turned to technology to improve the educational experience for their students on campus. For those who do take the plunge, the results can be rewarding: The students gain flexibility, in-depth lessons, and sometimes even more interaction.

But the Net is not for every class, nor every instructor. Web-based courses take time and money to develop. Labs are another problem. Future scientists need to gain experience at the bench, not just on the computer. And many instructors, particularly those on the tenure track, often lack the time to redesign classes with Net content. "There's a big gap between the hype over online education and the reluctance of many faculty members to adopt it," remarks David Passmore, an education professor at Pennsylvania State University, University Park, who helps direct multimedia technology development.

Late-night lab work

Debate over Internet-based instruction is nothing new. Physicist Michael Thoennessen of Michigan State University (MSU) in East Lansing and colleagues were criticized for proposing an online homework system in the early 1990s. "Some thought students would lose out on personalized instruction if a computer even offered homework problems," Thoennessen recalls. In fact, he notes, the opposite happened. MSU's "computer-assisted personal approach" allowed teaching assistants to spend less time grading assignments and more time working with students face-to-face at the physics help center.

Today, most faculty members still use the Net mostly as a dressed-up handout for homework problems, a reading list, or course schedules. But an increasing number are getting more ambitious. Deanna Raineri, a molecular biologist at UIUC, saw the Internet as a way to breathe life into her undergraduate biology class. "Here I was standing in front of this big class with static overheads and hand signals," recalls Raineri. "My premeds were cruising, but a lot of the class was really struggling. Wouldn't it be better if kids could visualize all this biology?"

With the help of a student programmer, she began developing animations of interacting molecules, first off-line and then online. The student response was "overwhelmingly positive," she says, and the animations also seemed to help them grasp lecture ideas better. "It took me by surprise to see what a difference it made," Raineri says.

The next step for Raineri was virtual labs. They typically follow a similar lab done live and allow her to reinforce the lesson. For instance, in a campus lab, students use restriction enzymes and run gels to characterize DNA. Later, online, they use similar techniques to diagnose a hypothetical disease and explore the issue of genetic testing. "They get a lot of practice at data interpretation, which is something the class lacked before," Raineri says. Today's students also score better than their predecessors on quizzes covering applied questions, she adds.

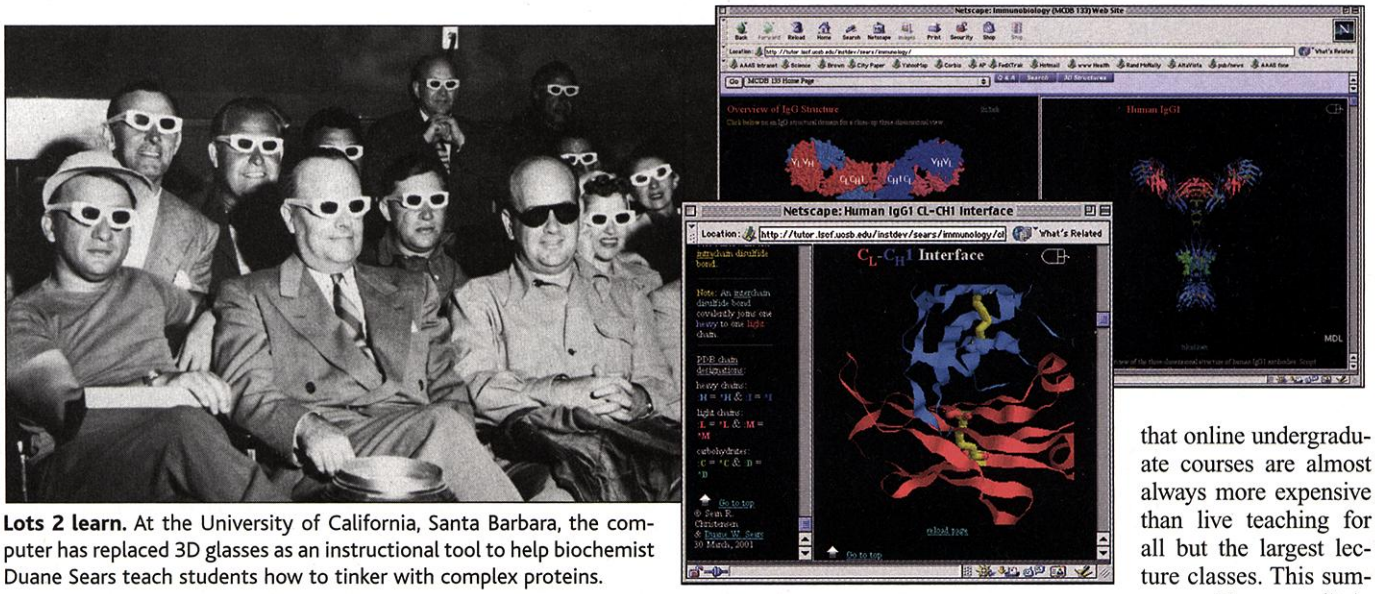
Others, too, are discovering the value of the Internet as a dry lab. Years ago, Duane Sears, a tenured professor of biochemistry at the University of California, Santa Barbara, used to pass around 3D glasses to his students before firing up the slide projector for shots of molecules. When a better view of the 3D structures emerged, he designed a computer lab that allows students to log on, day or night, to manipulate and study them.

"I've always tried to give students new problems, new situations that require them to really apply what they've learned," Sears says. "It's not practical to have all these undergraduates in the lab, trying to solve the 3D structures of proteins or the kinetic analysis of enzymes. The Internet allows us to duplicate the thought process behind this kind of work."

Developing the new lab did steal from time for research, Sears admits, but he thinks the benefit to students is worth the sacrifice. "I feel that students are being shortchanged when they don't understand how science works," he says. "And in biology, there simply aren't enough resources to provide the experience our students need to gain that appreciation."

Online limits

Finding the time for such trade-offs isn't easy, however, and professors are divided



Lots 2 learn. At the University of California, Santa Barbara, the computer has replaced 3D glasses as an instructional tool to help biochemist Duane Sears teach students how to tinker with complex proteins.

on who should lead the way. "I would never recommend that assistant professors try to do this, because they need to be publishing," says Shapley, who received tenure in 1991. "If you're tenured, you can afford to spend a little more time." Raineri, a non–tenure track employee whose job includes curriculum development, echoes that sentiment: "My suggestion to tenure-track faculty is not to do this right now, but to concentrate on research and teaching."

But Sears doesn't like the fact that junior faculty members "are highly discouraged from developing online teaching tools because of the time involved." He favors incentives for all faculty members to explore the value of the Internet in teaching.

The Internet brings other challenges as well, notably intellectual property questions, software headaches, and, at the most basic level, cost. A guidebook released in April by the National Education Association warns that online undergraduate courses are almost always more expensive than live teaching for all but the largest lecture classes. This summer, with no profit in sight, Temple University shut down Virtual Temple, a spin-off company created 2 years ago. In his published agenda for Temple, president David Adamany noted that "no one has yet found a way for online learning to be economically viable." Adds Thoennessen, "the main motivation for using the Net should be to improve education, not to make it cheaper or easier on the instructor. Even if you use the Internet, instructors are still critical, particularly to explain advanced material."

Educators are also trying to figure out what works online. Some students flock to online chat rooms, for instance, whereas others prefer the somewhat more private form of ordinary e-mail. Moreover, not all students are comfortable learning online. "Even when I'm teaching online, I give the students a choice to attend lectures live," Raineri notes. She and others believe that large lecture classes may offer the richest rewards for Net-based learning, because smaller courses already offer more chances for one-on-one communication.

If there is one domain in which the Internet has barely made inroads, it's the classic undergraduate lab. Dissecting a worm, running a gel, squinting at a color reaction—these workaday tasks are the stuff of science majors. And although online labs can share the basics of science, computers can't teach you how to brew uncontaminated media or finger a pipette just so.

It's the here-and-now nature of experiments that makes science classes so hard to teach online, says Frank Mayadas, a program director with the Sloan Consortium, a group of higher education institutions offering online programs that are funded by the New York City–based Alfred P. Sloan Foundation. "You can't transfer the whole physical lab experience to the

MIT Offers World-Class Courses, for Free

Major universities may hesitate to teach undergraduate science online, but they seem ready to cash in on continuing education. A growing number of schools—including Columbia, Duke, Stanford, and New York University—hope to profit from online courses, typically targeted to working adults. Businesses such as the University of Phoenix Online and eCollege also contribute to the estimated $4 billion e-learning market. Now, in the midst of all this enriching education, one school has announced plans to teach the world—for free.

This spring, the Massachusetts Institute of Technology (MIT) announced that it would post lecture notes, course outlines, or other teaching material for virtually every class offered, free of charge. MIT's so-called "OpenCourseWare" Web site could debut within 2 years, including content from 500 classes. Within a decade, MIT officials say, over 2000 courses could be posted online. The effort is the first of its kind for a university.

"There's a sense that universities are losing their direction by getting too involved in e-commerce," says Harold Abelson, an MIT computer scientist helping to develop OpenCourseWare. "The Web was invented for the sharing of scientific research, and this initiative is really about sharing. MIT plans to use the Internet as a way to disseminate the stuff from which our courses are made."

OpenCourseWare is the brainchild of an MIT council on education technology that wanted to use the Net to enhance teaching. Abelson, part of the council, compares the future Web site to a monograph series or expanded course catalog. The site will not offer actual courses or class credit; instead, it will provide raw information for anyone with an urge to click and learn. "Undergraduate education really draws on a collaborative enterprise, and our hope is that students and faculty can learn from each other," Abelson says. Perhaps other schools will follow suit, he adds, building a new way to communicate science and teaching.

That wouldn't surprise Frank Mayadas, a program director at the Sloan Consortium. "Over time, we'll see significant progress," Mayadas says. "There's a lot of room to grow."

–K.B.

CREDIT: (LEFT) BETTMANN/CORBIS

online environment," Mayadas says. "The labs are difficult."

Members of the consortium are trying to solve that problem. Electrical engineer John Bourne of Olin College in Needham, Massachusetts, who is principal investigator for the group, says one idea is to have students log on to remotely controlled instruments that allow them to build a circuit, say, or mix a solvent. This kind of chemical engineering course is already under development at Illinois. At the University of Washington, Seattle, Robert Franza, director of the Cell Systems Initiative, leads an information technology team that hopes to produce a wireless tablet PC. It will be somewhat like a personal digital assistant, on which students can build digital proteins, jot down notes in class lectures, or brainstorm with others —anytime, anywhere. "Most people think of 'online' as tethering people to a box and a seat," Franza says. "We think the future looks different."

No matter how the future unfolds, tech-savvy students are likely to insist on being plugged into the Internet. After Raineri added virtual labs to her molecular biology course 3 years ago, her scores on student course evaluations skyrocketed. "They want more of this, and in the years to come, they may demand it," she says. For Sears and other Internet pioneers, that means feeding a grassroots movement until it spreads like the Internet itself.

–KATHRYN BROWN

NEWS

Are We Having Fun Yet? Joys and Sorrows of Learning Online

Web classes offer students and instructors great flexibility and a chance for more focused interaction. But cyberspace can also be a lonely place

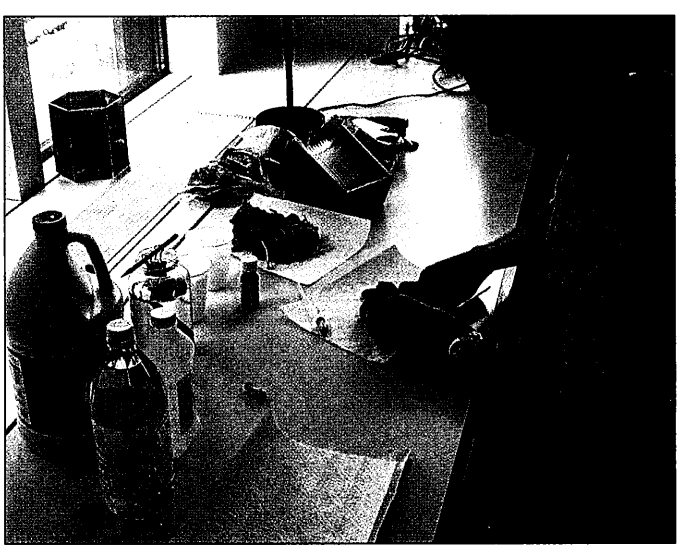
WASHINGTON, D.C.—Wrist deep in ground-up spinach leaves and rubbing alcohol, I'm wondering if some of my fellow online students have ignored the instructions not to directly mix vinegar and bleach. The hands-on lab—and the potential for disaster—enlivens an otherwise lonely and at times frustrating online introductory biology course. I'm learning on the Web, but I'm not loving it.

In May, my editors asked me to write a first-person account of taking an online undergraduate science course with a lab component. Finding one isn't as easy as it sounds (see sidebar on p. 1620). But eventually I settled on one offered by the University of California, Berkeley, Extension program.

Within minutes, I had charged the $475 tuition and $50 "fee" on my credit card and enrolled in the four-credit semester-long X19 Introductory Biology with Lab. A link to an online bookstore soon made me the electronic owner of a textbook, two CD-ROM virtual laboratories, and a lab kit —and drained me of another $236. That's about par for costs per unit for an in-state Berkeley undergrad, but substantially less than for a nonresident. Just 3 days later the book and CDs arrived, although the lab kit was on back order.

Eager to get started, I went to the course Web site. There I was greeted by a written introduction to the class and the friendly (virtual) face of my Harvard-trained instructor, Monica Ranes-Goldberg. She was available via e-mail, as well as through a message board and chat room where we could post assignments and communicate with our peers. (Although the course was billed as cooperative and interactive, I would end up communicating much more frequently with my instructor than with other students. Indeed, I spent 3 days diligently checking the chat room without hearing from a single classmate.)

With 6 months to complete the one-semester course, I set to work. My first "assignment" was to post an autobiography. Although I hid my true intentions for taking the class, others spoke freely of their motives. A Wyoming high school student felt ready for college material. A premed student needed one more lab class. An investor wanted the scientific dope on biotech stocks. And a surface warfare officer in the U.S. Navy had decided to cram biology into a busy schedule.



Hands-on at home. Virtual learning gets real with use of lab kits.

CREDIT: A. STONEBRAKER

The course was divided into 14 units emphasizing biology at the cellular level: basic biochemistry, cell structure, metabolism, genetics, cell division, and molecular biology. Assignments for each unit included posting a brief review or summary of a Web site related to the topic at hand; "wet" and virtual labs, reports of which I would e-mail to the instructor; and quizzes and problem sets. The core knowledge for each unit was contained in the textbook and lecture notes written by the instructor. Chapter quizzes written by the textbook publisher offered a convenient way to test my progress—after a week's worth of calls to get a Web site password that should have come with the book.

CD-ROM activities brought alive the concepts presented in the textbook and notes. Some of the exercises were informative, such as changing the size and shape of a virtual cell to learn about surface area and volume or studying the effect of changing adenosine triphosphate concentration and food supply on a computer model and animation of cellular respiration. But one lab was an exercise in dull repetition: Using a virtual spectrophotometer and a selection of five indicator dyes, I was supposed to test more than 10 compounds. And each of the more than 50 trials subjected me to animation that lasted several seconds.

Boredom wasn't the only challenge. The spectrophotometer lab produced reams of data that resisted export for analysis. Other exercises didn't allow me to manipulate parameters necessary to answer the questions, and the instructions for the simulations were overly vague. Subtle flaws in the resources became incredibly frustrating: One CD-ROM listed questions in such a way that you couldn't read them while doing the "experiment" and you couldn't cut and paste them into a word processing document to answer them.

But learning on the Web does have its advantages. I could set my own pace, delving into harder or more interesting topics and