

# Better Learners

*Educators are counting on the Web to help students tackle science's tougher concepts.*

When Bethany Lye's suitemate at Ohio's Kenyon College was diagnosed with a brain tumor, Lye vowed to help. She attended her friend's introductory biology class and took voluminous notes, complete with detailed diagrams and sketches of molecules, cell division, cellular structure, enzymatic reactions and the mechanics of metabolic energy production.

Thanks to surgery and radiation therapy, Lye's friend, Marissa Boyan, recovered, returning to Kenyon after a six-month absence, although she never did complete that biology course. And Lye, now a senior majoring in biology and English, ended up helping more than her friend.

Encouraged by Kenyon professor Chris Gillen to share her material with other students, Lye adapted her notes and drawings for a new Web page. Her "Success in Intro Biology: A Student's Guide" debuted in fall 2001. Initial student feedback says it's a hit. "Some people get bored" reading textbooks or printed handouts, Lye says. "This is something different. This could be someone's ticket to finally getting it."

Helping students "get it" online is the aim of "Courses on the Web," a multisection Kenyon Web site that includes lecture materials, supplementary information and links, as well as exercises and interactive quizzes. Supported by HHMI grants, the site contains three Web-based Kenyon courses for biology majors and two for nonmajors.

Kenyon's site is part of a trend at colleges and universities to use online tools in support of learning. At one extreme is the Massachusetts Institute of Technology, which turned heads last year when it announced its

plans to make available on the Web, at no cost, the contents of every university course—some 2,000 in all—by 2007. Other institutions, such as Columbia University, make proprietary course materials available to the public for a fee.

Kenyon's Web focus is its own students, hoping to make them better learners through online access to syllabi, course content, tutorials and links to "external" knowledge-rich sites such as the National Institutes of Health and the Library of Congress.

## NET ENHANCEMENTS

David Lampe, an assistant professor in biological sciences at Duquesne University, runs a portion of a Web-based course called SuperLab I that gives students their first experiences in the techniques of molecular biology. Lampe's students have spent the past three years cloning and sequencing human DNA and using the Internet to analyze their samples.

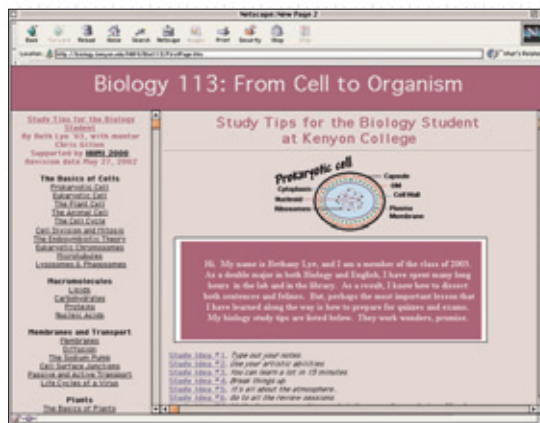
"When you're dealing with DNA sequences, the Web is indispensable; that's where all the [sequence] data is located," Lampe says. In the process, he says, his students "realize how much stuff they can figure out": Did they get a gene, or is their sequence near a known gene? Are there any diseases associated with the gene?

What's the structure of the gene, and what is its protein like? Are there any homologs in the human or other genomes? In fact, Lampe adds, students "get pretty revved up about the process, because they don't know what they're going to get, and neither do I. That level of uncertainty, which is eventually resolved by using the Internet, is something that gets them very involved and something that they like a lot."

Paul Beam, a professor of English at the University of Waterloo in Ontario, Canada, has written about the Web's potential to transform learning. What the Internet adds, he says, is around-the-clock accessibility to

course materials for both students and teachers, the capacity to make instant updates on assignments or schedules and the introduction of the interactive communication tools that have become ubiquitous over the past decade: e-mail, private chat rooms and Web bulletin boards.

Ed Dole, coordinator of the introductory biology course at the University of Illinois,



Web sites like these at Kenyon College enable students to study science at their own pace, and may help them become better learners.

Urbana-Champaign, weaves Web-based features into the curriculum "not as a replacement, but rather an enhancement." Students taking the course are required to participate in two "Web Crossing" lab assignments, in which they use a restricted, password-accessible space on the Internet to exchange ideas and critique each other's work. University teachers who advocate integration of the Web often point out that this sort of peer exchange opens lines of

communication that might never have been established otherwise between students and teachers and among students themselves.

The Internet is also credited for its capacity to convey visual information in compelling ways; complexity can be rendered vividly in three-dimensional visuals. Tom Susman, a junior at Kenyon majoring in molecular biology and political science, elected to take a hands-on lab class that included examination of cat anatomy. During and after dissection, Susman and his fellow students used workstations in the lab to access Kenyon's "Cat Anatomy Tutorial," authored by biology professor Patricia Heithaus, which displays detailed pictures of feline physiology and provides arrows and other markers identifying organs, muscles and bones. "I thought it was very helpful," Susman says. "It was easier and clearer to see the actual anatomical structures and know what they were. It was also a good way to quiz yourself outside the lab."

Indeed, working on their own, students can digest information at their own pace—another of the Web's potential advantages. "You actually benefit from your mistakes," says Joan Slonczewski, a Kenyon biology professor and program director of the college's HHMI grant. "You get instant feedback. You're testing things out and getting an immediate response. It's very different from traditional quizzes."

She points to an interactive multiple-choice quiz in her introductory genetics and development course. She built the quiz by using Hot Potatoes software, which is free to nonprofit educators. If a student selects an incorrect response, a reply explains why the choice was incorrect and offers a hint toward the correct response. When the student finally selects the correct answer, he or she receives a score discounted for the number of attempts required. "They learn something every time, no matter which responses they pick," Slonczewski says.

#### BIOLOGY IN THREE DIMENSIONS

Slonczewski credits the Kenyon Web tutorial on genetics and its three-dimensional images with helping her students "learn as much Mendelian genetics and gene-product interaction in a week as I used to teach in a month in the traditional lecture-and-learn

## My Computer, My Writing Coach

Whether they're taking Biology 101 or an advanced course on genetics, students need to be able to write coherently about what they're learning. Now they can help each other improve their writing skills, with an Internet-based program for networked computers.

With support from an HHMI grant, UCLA chemistry professor Orville Chapman developed a program called Calibrated Peer Review (CPR) that teaches students to read critically for content and style and to write clearly and persuasively about science. Based on the peer-review model of modern science, CPR trains students to analyze the writing of—and to profit from being reviewed by—other students. It includes a growing library of ready-to-use assignments, although instructors can also write their own.

CPR, now being used by UCLA and more than 100 other colleges and universities nationwide, works like this: A student logs on to get an assignment, reads recommended source materials and then writes a brief essay (150–350 words) that's intended to answer a set of questions. The student then reviews and grades three sample essays on the same subject, using criteria such as "Does the text contain unexplained jargon?" The CPR program scores the reviews and gives feedback on how they compare to a model review.

When the student does well enough on test reviews, he or she gets to analyze and score three real essays submitted by other students. Finally, the writer scores his or her own essay and can access other students' reviews to see what peers thought of it.

CPR provides individual feedback, even for students in large lecture courses, without overburdening the instructors. The educational payoff of peer review can be enormous, says Chapman. "Writing about science produces a different kind of learning about science—real understanding."

—JENNIFER BOETH DONOVAN

» For more information see [cpr.molsci.ucla.edu/cpr\\_info/main.asp](http://cpr.molsci.ucla.edu/cpr_info/main.asp)

course." She also reports that Kenyon's student-authored "Biomolecules" tutorials have enabled her sophomores and juniors to accurately "recognize amino acid residues within protein model structures." Slonczewski now tests students on this material, something she "never would have thought of doing" in pre-Web days, when such knowledge, in her view, was beyond the grasp of most students. Web graphics have helped make it palpable, she says.

"Doing things in the electronic medium adds an interactive dimension that really does not exist in a medium like the standard textbook," says Ron Stevens, professor of microbiology and education at the University of California, Los Angeles, School of Medicine. Over the past decade, in part with HHMI grants, Stevens has developed a learning tool called IMMEX that has gained a

foothold in classrooms ranging from kindergarten to medical school. The med school version presents students with a series of real-world "problem sets" in immunology, microbiology, pediatrics, respiratory therapy and clinical practice.

During a two-hour session, groups of four students sit at a workstation and are presented with three patient cases, replete with symptoms, results of a physical exam and lab assays of tissue and fluid samples. As in an actual hospital or clinic, the fledgling doctors cooperate to diagnose and recommend courses of treatment. The idea is for doctors-in-training to acquire important skills before entering the clinic, where the stakes are high.

Enthusiasts like Stevens say that helping students of all ages put facts they've learned to work is "just the tip of the iceberg." Web-based learning is no replacement for classroom instruction, they say, but it can tell educators new things about how students learn and therefore help them learn more effectively.

—JAMES SCHULTZ AND PETER TARR

#### WEB-TEACHING RESOURCES

Kenyon's "Courses on the Web": [biology.kenyon.edu/HHMI](http://biology.kenyon.edu/HHMI)  
Hot Potatoes quiz-making software: [web.uvic.ca/hrd/halfbaked](http://web.uvic.ca/hrd/halfbaked)  
IMMEX: [www.immex.ucla.edu](http://www.immex.ucla.edu)