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Using Web Images to Teach Biology

by Malcolm Campbell

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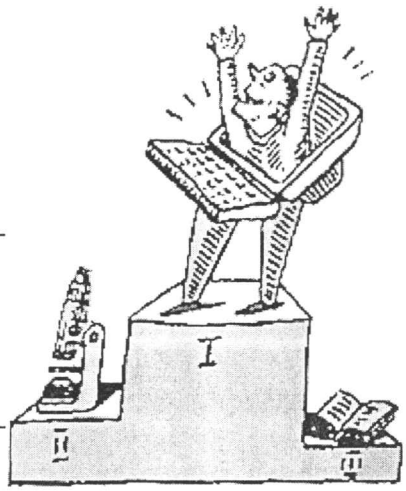

Abstract

Web renditions of biological material are a boon to teacher and student, offering advantages such as three-dimensionality and motion.

Teachers have long recognized the importance of visual information when describing biological concepts.

This may be the best era in which to teach biology since Robert Hooke first observed cells through a microscope. Perhaps more than any other scientific discipline, advances in biology have depended upon the visualization of processes and structures, such as the discovery of the Golgi body one hundred years ago, or the characterization of clathrin-coated pits. And teachers have long recognized the importance of visual information when describing biological concepts to students: we've used transparencies and slides in the classroom, and microscopes and dissections in the lab. Computers were a revolutionary new tool that teachers embraced. With the addition of the World Wide Web, educational resources increased exponentially, providing teachers with myriad new sources of information and new ways to help students comprehend biological processes.

Seeing Is Believing

Most students have trouble visualizing molecules as real, three-dimensional objects. To address this problem, I have used the huge searchable database of crystallographic structures and the data file that one can download from the Structure Group at the National Center for Biotechnology Information. RasMol and Cn3D are freeware programs that convert a data file into a model that can be viewed from many angles (figure 1); one can rotate the molecule in space, and zoom in or out for different perspectives (figure 2). These programs are useful in demonstrating molecular processes such as protein-protein interaction, and since many of the molecules studied in the classroom have been crystallized, the instructor can choose which molecules to emphasize with computer graphics.

Figure 1

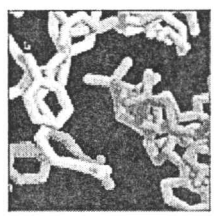

Figure 2

QuickTime movies can show students that biology is more than dead cells.

Many students perceive biology as nothing but dead cells, because the images they see are usually either static textbook photographs or of cells that have been fixed, rather than showing the dynamic interactions of living cells. QuickTime movies, using time-lapse photography, can show students how cells function and behave. For example, recent work utilized green fluorescent protein and a method called Fluorescence Recovery After Photobleaching (FRAP) to reveal the dynamic flow of molecules in the endoplasmic reticulum and Golgi (figure 3) [1]. These and other such images are superb illustrations of vesicular movement and the fluid mosaic model of membrane structure. Another outstanding QuickTime movie shows a calcium wave sweeping across a fertilized egg, while simultaneously showing the vitelline envelope rising due to the cortical reaction. This process is impossible to draw, photocopy, or otherwise demonstrate (figure 4).

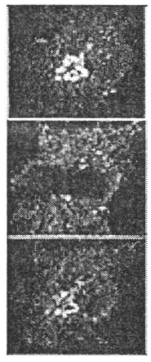

Figure 3

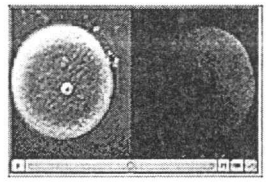

Figure 4

Another moving image can be produced by GIF animation. Unlike QuickTime files, which can be very large and may take minutes to download, GIF animations are small files that can illustrate simple movements using the same method as old-fashioned flip books. A typical GIF animation uses a series of drawings presented in rapid succession, creating the illusion of movement. It's a good way to illustrate, for example, a metabolic pathway or the enzymatic cycle of a protein. A GIF animation can be created from any series of pictures with the aid of freeware such as GifBuilder.

Students often explore related Web material in addition to class assignments.

Almost every medical school has its collection of histology slides online, so medical students can use them for class (e.g., the WebPath resource of the Internet Pathology Laboratory for Medical Education). Likewise, when discussing a particular tissue in an undergraduate course, students can be directed to the appropriate medical school Web site for the pertinent images. Once at the assigned site, students often become engrossed, and generally take the opportunity to explore related material in addition to that assigned in class.

One research area that changes rapidly, and is covered in many courses, is HIV/AIDS. Few textbooks can present all that we have learned recently about the role chemokine receptors play in HIV infection, resistance, and possible therapy. To address this shortcoming, I have added related text and figures to the Web for student viewing. This is just one example of how very recent findings can be presented on the Web to update older information. It also helps generate excitement in students when they realize that this information is so new that it hasn't yet appeared in texts.

Discussion

Dynamic images are available on the Web at any hour of the day or night.

Many biological processes and concepts are difficult to explain without visual aids. Slide and overhead projectors have been the preferred tools of biology teachers for many years; now the Web allows instructors to explore new dimensions in visual presentations. We can present 3-D, maneuverable models of molecules; we can use movies and animations to observe the progress of complex processes over time. Histological images have also broadened the range of images one can present to students. Many teachers have slide libraries of normal tissue stained with traditional histological stains; from the Web we can acquire specialized images, such as immunofluorescence and electron micrographs, that cannot be viewed with traditional media. Furthermore, the Web provides students with access to these dynamic images at all hours of the day or night, even when the instructor is not available.

I have been using the Web in class for two years, and have collected a number of useful resources. One page, for example, provides links to relevant QuickTime movies; another lists RasMol images under headings such as *proteins* , *nucleic acids* , and *proteins bound to other molecules* . As teachers develop new Web-based teaching resources, we will be able to utilize our combined efforts to build a synergistic collection of exciting teaching tools. As the price of computers goes down, and more Web software becomes available, increasing numbers of teachers will be able to design their own visual aids on the Web. The limiting factor, then, is creativity and imagination, which teachers have relied upon since before Robert

Hooke.

A. Malcolm Campbell is an assistant professor of biology at Davidson College. He has made numerous presentations about teaching as an "alternative" career option, and has written How to Get a Teaching Job at a Primarily Undergraduate Institution.

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Endlinks

Beyond Bio 101: The Transformation of Undergraduate Biology Education - a report from the Howard Hughes Medical Institute includes an extensive collection of Web resources.

Cornell Theory Center Math/Science Gateway: Biology - links to resources in mathematics and science for educators and students in grades 9-12. Teachers of other levels may find these materials helpful.

The Biology Project - an online interactive resource for learning biology. From the University of Arizona.

Access Excellence - an excellent resource for biology teachers and students that contains online mysteries, interactive resources, lesson plans, and general information related to biology. Since the site is maintained by Genentech, it emphasizes genetics and biotechnology.

Biology Education Software Taskforce - publishes reviews of biology education software and provides links to software providers.

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