Just One Word: Plastics

SIGHTINGS

In the 1960s hit movie "The Graduate," there is a classic line about a possible career choice for a young college graduate. The student is given the following advice: "Plastics." Now in the 1990s, this may refer to the laboratory options for a new breed of enzymologists as well. Indeed, the immobilization of catalytic enzymes in polymer matrices is an area of intense research, with applications for the food, chemical, pharmaceutical, and agricultural industries.

Many methods have been developed for the incorporation of enzymes into an insoluble matrix that houses a local aqueous environment. These consist of entrapment, covalent attachment, and adsorption. There are instances, however, when the enzyme is needed to function in nonaqueous, organic solvents as well. Wang *et al.* have just reported a method for incorporating enzymes into plastics so that they retain activity in organic solvents (*1*). Others have previously linked enzymes to acrylic polymers by covalent attachment of amphiphilic polyethylene glycol molecules to the enzyme (*2*). These biocatalytic plastics had activity both in aqueous and organic environments, but the activity of the enzyme was significantly decreased when immobilized in this matrix. The approach of Wang *et al.* remarkably yields enzymatic activity close to the activity of the enzyme in its native state.

The enzyme (chymotrypsin or subtilisin) was first chemically acryloylated by treatment with acryloyl chloride. This covalent modification generates polymerizable functionalities on the protein. Native enzymes are insoluble in organic solvents, so the team next mixed the protein with a surfactant. Noncovalent ionic bonds are then formed between the enzyme and the surfactant, producing an enzyme preparation soluble in an organic solvent (such as hexane or toluene). To this reaction, they added vinyl monomers with polymerization achieved by free-radical initiation. In the end, the team created a plastic material with an active enzyme embedded in it. The resultant catalytic activity is about 10 times less than the activity of the native enzyme in aqueous environment. The real breakthrough, however, was that the activity in an organic solvent is similar to the activity of the free enzyme in the ion-paired form in the presence of surfactant. These biocatalytic plastics are highly stable in organic solvents such as hexane. They can be left at room temperature for several months (*3*) without much loss of activity.

While scientists continue to find new ways to increase the activity and stability of such biocatalytic plastics, several future applications can be imagined. The use of enzyme-containing plastics for nonaqueous biotransformations could include peptide synthesis and acylation of sugar-containing compounds like carbohydrates and (deoxy)nucleosides. They could also include the incorporation of proteases into the coating of containers or ultrafiltration membranes to prevent the adhesion of proteins on the surface of such devices; self-cleaning house paints, where an enzyme hydrolyzes the resins that fall down from trees; or ship hull coatings to prevent the adhesion of particles to boats. The applications seem limitless.

–Richard Peters and Robert Sikorski

References

1. P. Wang *et al.*, *Nature Biotechnol.* **15**, 789 (1997).
2. Z. Yang *et al.*, *J. Am. Chem. Soc.* **117**, 4843 (1995).
3. J. S. Dordick, personal communication.

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Tech Traps

NET TIPS

The community of science is one of the best wired groups, with Internet access available to most researchers in their labs. However, if you work for a university, a company, or government there are usually rules specifying the nature of the content that can be viewed over the Net. There may be free speech on the Net, but not free listening.

If you use the Net for checking out lab Web sites, databases, science news, and other work-related sites, don't worry, you are fine. If you deviate (pun intended) from these areas, you may be setting yourself up for some trouble. Individuals have been fired or reprimanded for surfing in nonscientific sites. How do they get caught? Easy. We all leave digital trails on our computer and in cyberspace. There are obvious ones such as URL bookmarks, but the Net technology itself also keeps clues. Here are three.

Every time you go to a Web site, files are transferred to your hard drive where they are stored in a file called a cache. This is used by the browser when you return to a site; you don't actually go to the Net again, you get the document from your local cache. The cache can be found with the other preference and helper files that a browser uses. Almost every picture or piece of text that is displayed on your browser screen ends up in the cache. When you

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shut down the computer, the files remain. You can open them easily with the browser and see their contents—good, bad, or ugly. A browser's cache can be emptied by selecting a menu option from the browser.

You probably have noticed that the browser seems to "know" that you have visited a site sometime in the past. Usually, the color of the hypertext links appear different. This memory is possible because the browser actually keeps an internal record of every site you have ever visited. This running list, called a Global History on Navigator and History on Explorer, is stored on your machine in a special file. In Netscape, type "about:globalhistory" in the "Location" box at the top. Interestingly, if you are on a Local Area Network, the systems administrator could, in theory, log on to your computer and read your History file remotely. You can delete the History file, and a new, blank one will be automatically generated.

Finally, your browser sends out a unique code, called an IP address, each time you get information from the Web. Depending on your access configuration, this unique address may be traced back unambiguously to your personal computer. That means that every transmission (Web site, FTP, and so on) coming from your machine can be linked to you. If the systems administrator keeps logs of the network traffic, he knows where (and when) you were surfing.

For more information on browser technology, security, and safe surfing, we've put some resources online at www.medsitenavigator.com/tips

–Robert Sikorski and Richard Peters

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The following is reader feedback received through the online Digital Mailboxes for the Tech.Sight Sightings and Net Tips in June and July. Readers can leave comments by going to the URL listed at the end of each item in Tech.Sight.

From: Roger Akers
<akers@synthecon.com>
Subject: Xenotransplanters Turn Xenobiologists, *Science* 276, 1893 (1997)

Does the FDA care if all of the viruses are not located as long as most viruses in the donor tissue have been screened? How can the FDA allow pig tissue to be used in humans? Is the FDA aware of your findings, and what is their response?

Reply: The staff at the U.S. Food and Drug Administration (FDA) is watching the issue of xenotransplantation and its side effects very closely, and they are trying to weigh the advantages of using animals as organ donors versus the risks such as those alluded to in the column. You can read more about FDA guidelines, rulings, and so forth, by going to the following URL: www.fda.gov/veritysearch.html—search for documents containing the word "pig," for instance.

From: Richard J. Hughes
<rhughes@ucsd.edu>
Subject: Browser Half-Life, *Science* 277, 399 (1997)

Despite your enthusiasm for constantly updating browsers, this is a time- and disk-space-consuming process. It's humbug, in other

words. If we were to keep up to date all the software on our computers, we'd never get any work done! There's no need for browser software that consumes 10+ megabytes of disk space. Sure, the space is cheap but the code is bloated.

From: Cornelius Krasel <krasel@wpxx02.toxi.uni-wuerzburg.de>
Subject: Browser Half-Life, *Science* 277, 399 (1997)

I disagree with a number of points made in your column. (i) 3.x versions of Netscape are not running reliably on either Mac or Linux platforms. (ii) 2.x versions of Netscape are more stable and sufficient for any site I encountered on the Web so far. (iii) Microsoft's Internet Explorer is only available for a subset of operating systems. (iv) For about 90% of all Web sites, a text-oriented browser like Lynx is sufficient.

Reply: These comments underline a common user complaint that software upgrades are too fast as far as browsers are concerned. We agree and recommended that you wait until the "bugs" have been fixed before upgrading. In the column, we indicated that "Adventuresome users who want to be at the cutting edge," when perhaps we should have said "bleeding edge." In fact, on 20 August, Netscape made an interesting announcement that it was going to "unbundle" the Netscape browser from Communicator 4.0, for users who only want basic browsing capabilities. Bigger may not always be better.

–Richard Peters and Robert Sikorski

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