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Overcoming the "yuk" factor

It sometimes seems like people have an inherent ("genetic?") distaste for any advance widely perceived as "unnatural." This distaste is an instinctual, primal response that implies that "natural" stuff (e.g., an organic potato) has a special moral status compared with unnatural stuff (e.g., a "Pusztai" concanavalin-containing GM potato). History provides us with many examples of yucky biotechnology: GM crops containing insecticidal bacterial genes; mice engrafted with human ears on their backs; baboons with transgenic pig hearts transplanted into their necks; and GM super-salmon that grow twice as fast as their wild relatives.

Whether we like it or not, this perception is a potent force that has potentially disastrous consequences if ignored. (Look no further than the plummeting fortunes of agbiotech following European rejection of its products.) Life-giving biomedicines are generally well accepted, the benefits clearly outweighing the risks. But even here, there have recently been public protests over the testing of medicines in animals. In February, these were so extreme that an executive at Huntingdon Life Sciences in the United Kingdom was physically assaulted with baseball bats (see p. 495).

But not all biotechnologies elicit irrational overreaction. A report released last month by the OECD entitled "The Application of Biotechnology to Industrial Sustainability" (see p. 493) provides some real-world examples of biotechnology at its most publicly "acceptable." Overall, it details 21 instances from around the world in which living organisms have been harnessed to produce pharmaceuticals, fine and bulk chemicals, food and feed, textiles, pulp and paper, minerals, and energy. And all these processes provide cheaper, cleaner, more flexible, and less wasteful options than those presently used by the chemical industries.

The report is timely because it clearly demonstrates that advances in biotechnology research have improved the efficiencies of bioprocesses to the stage where they can now compete with other conventional technologies. Many of these advances have been covered in our pages: novel enzymes capable of withstanding hostile industrial environments isolated from extremophiles or evolved in recombinant organisms using directed evolution and/or DNA-shuffling approaches; encapsulation technologies using viral cages or synthetic polymers for enzyme protection and chiral separations; studies on the formation of hierarchical architectures in seashells, bone, and skin for research on adhesives and composite materials; increased understanding of metabolic fluxes and its application to the engineering of organisms that synthesize a wide range of biodegradable materials, bioplastics, fibers, and even timbers. Industrial bioengineering can supplement traditional chemistry; chemists are very adapt at designing reactions for simple syntheses; bioengineering excels at creating complex compounds by exploiting the incredible metabolic capacity of living organisms.

The implications of these developments for biotechnology PR are plain. Green biotechnologies promise industrial products that can be "grown" rather than manufactured; fabricated with far less damage to the environment; and ultimately (although this one is a bit of a stretch) produced in areas of the world that presently have most of the human population, but least of the riches. What's more, similar to developments in health care, bioprocesses promise to shift the emphasis away from remediation to prevention of destruction.

With all this going for it, why has adoption of green biotechnology been so slow? One reason may be that in the current genome-obsessed environment, it is rather unexciting or untrendy. It certainly has been poorly funded. According to the US Department of Energy, since 1983, funding for biofuels has never exceeded $4.7 million per annum. Figures for European funding of recyclable energy research since 1985 are similar. That said, in the United States at least, this situation may be changing. At the beginning of the year, the government allocated $250 million for bioprocessing and bioengineering research. In addition, US Vice President Dick Cheney announced last month a biomass-refining initiative that will inject million of dollars of research spending and tax incentives.

Regardless of public funding, green biotechnologies must demonstrate that they are economically viable alternatives to conventional processes. Because biotechnologies are new and unfamiliar, industrialists often assume that the costs and risks are too high and the scale of operation too restrictive. These individuals should take stock of the OECD report, however. It provides clear examples of processes in which operating costs were lowered (in some cases by as much as 90%) and energy savings were achieved. In fact, biotechnological processes can often be easily incorporated into existing manufacturing facilities without the need for extensive retooling; the problem is reeducating engineers and industrial designers to adopt the technology.

The move to industrial bioprocessing clearly goes hand in hand with the public desire for a cleaner environment. It is in tune with increasing public enthusiasm for more sustainable lifestyles and the demand for cleaner products. What's more, unlike fields such as genomics, these technologies are at a stage of development where they can immediately produce tangible products for use in industrial applications. As many of the founders of biotechnology were fond of saying in their youth, "Seize the Time."

Brief comment on a final Commentary

In the days when *Nature Biotechnology* was *Bio/Technology*, we used to run a regular feature page entitled "Last Word." In this issue, we resurrect this tradition, metaphorically and with profound sadness, by publishing what turns out to be the last printed words of Professor James E. Bailey. On April 28, Dr. Bailey sent us the Commentary that appears on pages 503–504. In his words, it attempts to outline "mathematical tools available that bypass the need for systems parameters and achieve strong results, including some remarks on their limitations and where we might try to go in the future." Just 11 days later, he succumbed to metastatic cancer in the early morning of May 9, 2001 in Zurich, Switzerland. He is, and will be, deeply missed.