Economist.com SCIENCE & TECHNOLOGY

Synthetic biology

Gassed up

May 24th 2007
From The Economist print edition

A new, green way to make hydrogen

THE problem with living things is that they do insist on growing. They also insist on metabolising. The reason this is a problem, at least from the point of view of the new science of synthetic biology, is that all this growing and metabolising is a dissipation of effort from the task you want your souped-up bug to do.

Synthetic biology works by taking enzymes from a range of organisms (and sometimes other enzymes that have been tweaked so much that they no longer resemble anything natural), and assembling them into novel biochemical pathways in tame microbes. That allows synthetic biologists to turn out things like drugs and precursor-molecules for plastics more efficiently than traditional chemists can.

But the process would be even more efficient if it separated the pathway from the microbe. And that is what Percival Zhang, of Virginia Tech, has managed. He and his colleagues have taken 13 enzymes, derived from five different organisms ranging from spinach to rabbits via yeast and bacteria, and assembled a pathway that converts starch into hydrogen. No living organism can perform that feat, but it is a trick that might, if commercialised, provide hydrogen for fuel cells cheaply and easily.

To do this sort of thing, you really have to know your enzymes. Most enzymes can perform only one chemical transformation. The art, therefore, is to create a chain in which the output of one provides the input of the next. It is rather like a puzzle in which one word is transformed into another by altering one letter at a time, while always making the result a legitimate word. Except, in this puzzle, the length of the word can change, too. To turn starch (a polymer composed of glucose molecules) into hydrogen (an elemental gas composed of two hydrogen atoms) in this way is no easy task. To complicate things still more, the enzymes in question all have to like the same conditions of temperature and acidity, otherwise they will not be able to work simultaneously.

By diligent searching of the databases, and by including a 14th component known as a co-enzyme, which helps some enzymes to function properly, Dr Zhang has managed this. As he and his team report in the *Public Library of Science*, they then built a reactor that stirred their enzyme mixture up with some starch. Lo and behold, hydrogen bubbled out of it.

At the moment, the cheapest way to make hydrogen is by reacting methane with steam. The methane in question, though, usually comes from natural gas—and that is a problem if the motivation for using hydrogen in the first place is to avoid relying on fossil fuels. This is the goal of those who talk of a “hydrogen economy”, in which that gas would become the fuel of choice. They worry both that fossil fuels are a finite resource and that burning them contributes to global warming.

The goal, therefore, is to make the hydrogen from plants. Dr Zhang's method is a step towards that goal. Though starch is a refined and relatively expensive starting point, his method is more efficient than any of the alternatives that begin with plant matter. It is also a proof of principle. Now, he and his team are working on a still longer chain that starts with cellulose. This is a much more abundant glucose polymer than starch, but is also much harder to break down. If he can get his enzymes to turn cellulose into hydrogen, the dreams of the hydrogen economists really will be a step closer to realisation.