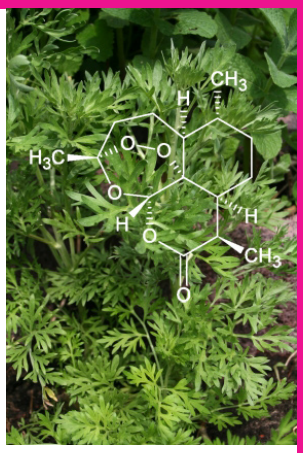
S1 Cheaper Drugs for Malaria?



Malaria is one of the three biggest killer diseases worldwide. A current treatment uses a natural chemical artemisinin, taken from the plant *Artemisia annua*. Its benefits have long been known in Asia, but it costs too much to extract enough to treat the world's malaria sufferers. Synthetic biologists found out how the plant makes artemisinin, and have engineered this ability into *E.coli* bacteria and yeast. This makes them produce a chemical which can be turned into artemisinin cheaply, in large quantities. But this could undercut traditional ways of making the drug in developing countries. Does that matter if it means we can now make enough? And who should control the rights to this development?

S2 Dr Smart and the Funding Council

Nitrogen fertilisers can greatly improve crop plant growth but they're expensive and polluting. Some plants host special bacteria which are able to 'fix' nitrogen for them through the plant roots. But most food crops can't do this. Biochemist Dr Peter Smart has been trying for 30 years to work out how bugs do it, and transfer their ability into cereal crops. He thinks synthetic biology could now do the precise multiple genetic changes to make the breakthrough! He applies for a government research grant.

With a limited budget, the funding committee has a dilemma. How important is this compared with other scientific topics? Nitrogen fixation is an ambitious goal but it hasn't worked after many years. Does 'nature know best' after all, or should he get his grant?

S3 Pioneers and Patents

Controversial genome pioneer Craig Venter has a flair for innovation and big ideas. He aims to strip down a microbe to the smallest viable amount of DNA it needs to live – a 'minimal genome'. He wants to use this as a backbone or 'chassis' to which he adds different biological parts which do specific functions.
One idea is to produce hydrogen to replace oil. He's also been sailing the oceans, trawling marine bugs which might have useful 'parts'.

But he's also been applying for patents on his findings. This worries some people. They say we shouldn't patent life forms, or give monopolies to anyone on basic technology which may provide our future transport fuel. Should one company corner the global market, as we've seen with software? On the other hand how should we reward inventors for their innovation?

S4 The Science Festival Debate

There's a debate at the Science Festival. Synthetic biologist Jean Bold argues that humans have always altered nature. We've greatly changed animals and plants by selective breeding. Synthetic biology gives us ways to reshape living organisms to our own design, or make new ones, for energy and medical uses.

Ethicist Joe Zen says it's one thing to understand how living things work, but it's 'playing God' to rearrange them like a biological Lego-set. Do we know *enough* to make such radical changes, or to design new bacteria safely?

'Let's press ahead with innovation!' Jean concludes. *'But aren't there moral limits in any innovation?'* Joe replies.

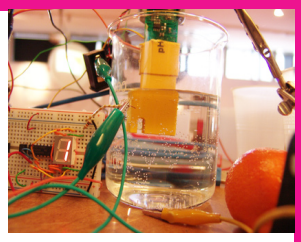
... so, who's right ...?

S5 A Probe to test Water for Poisons

An Edinburgh research team has links to Bangladesh, where arsenic can contaminate drinking water. Could they make a simple, cheap and sensitive test for arsenic in local wells? Back in Edinburgh, they put together genes and proteins from different organisms (Bio-Bricks) to make up a tiny biological sensing device inside the cell of a microbe. Genes are added to the cell that respond when arsenic is present, causing a colour change.

It shows the basic idea of synthetic biology: of putting biological parts together to make bacteria do new things. But it needs lots of development, to turn this first research result into a reliable probe. And if it's not for the western consumer market, who is going to fund it all?

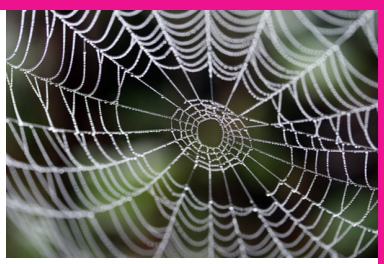
S6 Rick: DIY DNA



Rick just graduated in molecular biology in California. He's brilliant in the lab, but potential jobs all want experience. In his final year project, his class got bacteria to make a new chemical flavouring in yoghurt. They won third prize in a global synthetic biology competition called iGEM. It didn't work completely, but he can see how to improve it. He's got a bit of money to order DNA sections, and get secondhand equipment. Could he do it in his garage?

His girlfriend is getting worried. She read that scientists reconstructed a deadly virus, by ordering small sections of DNA from different companies, then splicing them all together. Rick says it was legal and it was to combat pandemic flu viruses. 'That's not the point,' she says, 'It could be really dangerous. Shouldn't all this be regulated somehow?'

S7 Rhoda Jameson, Entrepreneur



Rhoda discovered how to modify bacteria to make spider silk protein. Spider genes were added to bacteria to make the protein. Then a tiny biological device like a needle was made to extract the protein. It seems to work, with no apparent negative effects. It could make a strong, lightweight engineering material, so Rhoda set up a small biotech company to commercialise her results.

But it will take several years to scale up to make the silk protein industrially in vats. Venture capital is running low. She needs more money. The military approach her with a big contract to develop the silk for bulletproof vests. The extra cash would enable her to bring medical applications of her silk to market much quicker. But it could tarnish the image of her company. Should she accept?