BIOREMEDIATION

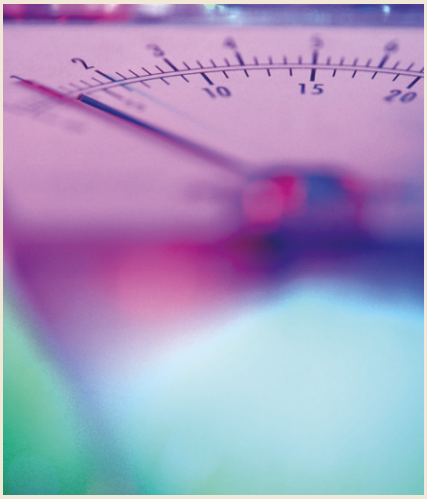
Boost for bacterial batteries

The idea of using microorganisms to unlock the energy present in waste products has been around since the 1980s, but its application has been held back by problems such as the inefficiency of the bacteria used at converting waste sugars to electricity. Now, all that could change in the light of work published in *Nature Biotechnology* describing an efficient biofuel cell that uses the recently isolated bacterium *Rhodoferax ferrireducens*.

Biofuel cells harness the ability of bacteria to remove electrons from organic compounds and transfer them to an electron acceptor. In the case of biofuel cells, the acceptor is a graphite anode and the electrons that are transferred produce an electric current that can power a so-called 'bacterial battery'. But the bacteria tested so far for this application have had drawbacks, such as inefficiency in using the electrons available from their substrates or a requirement for unstable electron-shuttling compounds to transfer electrons to the anode, reducing the useful life of the fuel cell. Now, Derek Lovley and his colleague Swades Chaudhuri have overcome these problems using an *R. ferrireducens* biofuel cell with glucose as a substrate. They obtained an electron-transfer efficiency of over 80% — a substantial improvement on the average efficiency of ~10% using other bacteria. *R. ferrireducens* can also transfer electrons directly to the anode, bypassing the need for electron-shuttling compounds, which cuts costs and enables a longer-term use of the fuel cell.

Another advantage of using *R. ferrireducens* in biofuel cells is its ability to produce electricity from a range of substrates — as well as glucose, it can strip electrons from other carbohydrates such as xylose, which is generated in large quantities in the production of paper.

The amount of current that Lovley and Chaudhuri generated from the *R. ferrireducens* fuel cell was too small to have a practical use at the moment, and modifications to the design are needed to improve on this. Steps such as changing the material used to make the anode and increasing its surface area should increase the power generated, bringing us one step closer to using bacterial batteries as an efficient way of disposing of waste biomass.



Louisa Flintoft

References and links

ORIGINAL RESEARCH PAPER Chaudhuri, S. K. & Lovley, D. R. Electricity generation by direct oxidation of glucose in mediatorless microbial fuel cells. *Nature Biotechnol.* **21**, 1229-1232 (2003)

WEB SITE

Derek R. Lovley's laboratory: http://www.geobacter.org/

ANTI-INFECTIVES

Chemical warfare

The production and secretion of antibiotics creates a protective environment for the producing microorganism, and an inhospitable environment for invading microorganisms — a microbial form of chemical warfare. But how do the producers avoid committing suicide? One answer to this question has recently been provided by a team at the University of Wisconsin. Reporting in *Science*, Jon Thorson and colleagues have elucidated the mechanism by which actinomycetes are self-resistant to the antibiotic calicheamicin γ_1 — an enediyne that acts as a DNA-cleaving agent — in which the CalC protein is sacrificed.

It had previously been shown that the *calC* gene is required to confer resistance to calicheamicin γ_1, and that CalC is involved in inhibition of calicheamicin γ_1-induced DNA scission. However, the mechanism by which this resistance is conferred was unknown.

Using a molecular break-light assay to monitor enediyne-induced DNA scission, the authors established that CalC is specific for calicheamicin γ_1; it does not inhibit the action of all enediynes and it does not simply prevent the cleavage of DNA. Furthermore, tryptophan fluorescence in the presence of dithiothreitol was used to detect the calicheamicin γ_1–CalC interaction, and susbsequent SDS–PAGE analysis showed that, on binding, the CalC protein is cleaved at Gly113, generating two peptides.

The authors postulated that this self-resistance mechanism proceeds by hydrogen abstraction at Gly113 of CalC, and the results of site-directed mutants of Gly113 and liquid chromatography–mass spectroscopy analysis confirm this view. In the absence of CalC, the active form of calicheamicin γ_1 removes hydrogen from both the sense and antisense strands of double-stranded DNA. However, the presence of CalC provides an alternative and competing substrate, and therefore mechanism, for this active form of calicheamicin γ_1, which removes a hydrogen from Gly113 of CalC to generate a hydrogen backbone C-α radical species.

Like other self-resistance mechanisms, the CalC self-sacrifice mechanism could be common among bacteria, and its elucidation could aid in the battle against multi-drug resistance pathogenic microorganisms.

Jane Saunders

References and links

ORIGINAL RESEARCH PAPER Biggins, J. B., Onwueme, K.C. & Thorson J.S. Resistance to enediyne antitumor antibiotics by CalC self-sacrifice. *Science* **301**, 1537–1541 (2003)

FURTHER READING Whitwam, R. E. *et al*. The gene *calC* encodes for a non-heme iron metalloprotein responsible for calicheamicin self-resistance in *Micromonospora*. *J. Am. Chem. Soc.* **122**, 1556–1557 (2000)