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NEWS AND VIEWS

Geobacter: The Electric Microbe! Efficient Microbial Fuel Cells to Generate Clean, Cheap Electricity

Sushmita Poddar · Surbhi Khurana

In recent years, major research has been focused on alternative and renewable energy sources to replace our current reliance on fossil fuels. Some microorganisms can convert chemical energy from a wide range of organic substances directly into electric current. This catalytic ability of microorganisms laid the foundation of microbial fuel cell (MFC) research [3]. A typical MFC comprises of a cathode, an anode, a cation or proton exchange membrane and an electrical circuit.

Amongst many known bacteria which can produce electricity, the most successful as of today are the *Geobacter species*. Discovered by *Dr. Derek R Lovley* and co-workers in 1987; this organism not only has the potential for bioremediation, but can also produce electricity!

Interestingly, *Geobacter sulfurreducens* also called, "electricigens" [1] can form metabolically active biofilms greater than 50 μm thick which help in converting acetate to electricity [2]. Its property as microbial nanowires is important for long-range electron transfer through the biofilms. Cells at a distance from the anode remain viable and the electrically conductive 'pili' increase the thickness of the biofilm without reducing the efficiency, sometimes increases electricity production by 10-fold [2].

A recently discovered mutant strain, *G. sulfurreducens* KN400 [3, 4] can produce the highest known current densities in pure cultures. The possibilities of adapting this organism to produce even higher current densities are being evaluated. How geo batteries are more efficient than earlier MFCs has been shown in Table 1.

S. Poddar (✉) · S. Khurana
Department of Zoology, University of Delhi,
Delhi 110007, India
e-mail: sushmita1988@gmail.com

Recently, a lot of effort has been made in using MFC sediments of the marine environment as a source of light and remote sensing. Powering of electronic devices from renewable energy sources and production of "Gastrobots" (robots fueled from food or organic waste) are on its way. Also capability of MFC to convert waste organic matter to electricity instead of methane and ethanol can prove to be a boon.

In fact, the World Bank has provided funding to start trials of MFCs that run on waste and provide electricity for lights and to charge batteries in rural areas of Tanzania and Namibia [1].

With so much still to be discovered regarding the electron transfer process, the ecology of extracellular electron transfer and microbial limits to power production [1], this is a field that will continue to grow in upcoming years.

Table 1 Comparison of geo batteries with previous microbial fuel cells

	Previous microbial fuel cells	Geo battery
Oxidation of organic fuel	Incomplete	Complete to carbon dioxide
Requirement for toxic electron shuttles to function	Yes	No
Recovery of electrons as electricity	1–50%	80–95%
Long-term stability	Poor	Excellent
Ability to function in "open" environments	No	Yes

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