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25 June 2005

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Douglas Fox

IMAGINE having 15-metre-long arms that you could use to pluck fruit off trees. Some bacteria have an equivalent ability: they can make "arms" 10 times their own length to help them process nutrients.

The *Geobacter* family of bacteria live underground. They get their energy by oxidising organic molecules such as oils, a process that involves stripping electrons from the organic molecules and dumping them onto iron oxide crystals around them. But the crystals do not dissolve in water and hence cannot be absorbed by the microbe. They can also be quite far away. So how do the bacteria make use of them?

Now Derek Lovley, Gemma Reguera and colleagues at the University of Massachusetts Amherst have found that the *Geobacter sulfurreducens* species makes "nanowires" that are 20 micrometres long, 10 times the length of the bacterium. The wires are 3 to 5 nanometres wide and conduct electricity about as well as graphite. The bacteria use these tentacles to touch the iron oxide crystals and transfer electrons. "It greatly extends the reach of the cell," says Lovley.

The wires are made of a novel form of a protein called pilin, which bacteria use to attach to surfaces. When the team engineered a strain of *G. sulfurreducens* that could not make the protein, the bacteria could no longer transfer electrons to the crystals (*Nature*, vol 435, p 1098).

"It's very exciting," says Eugene Madsen, a microbiologist at Cornell University in Ithaca. "It's so unique that I don't think it will be accepted immediately."

"The bacteria can make tentacles 10 times their own length to reach the crystals that help them process nutrients"

It is unclear how the nanowires conduct electricity, since proteins are not known to have this ability. One explanation could be that molecules called cytochromes, which can transfer electrons to metal atoms, are present in the wires. But Lovley says he did not see any when he studied the wires with an atomic force microscope, even though cytochromes are much wider than the nanowires.

The discovery could help in building biological fuel cells. It is well known that if you stick an electrode into mud, *Geobacter* bugs colonise it and generate electricity. But electron transfer to electrodes is 100-fold slower than to iron oxides, says Lovley. If the bacteria turn out to be using their nanowires to connect to the electrode, that knowledge can be used to design better electrodes.

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