Could electricity-producing bacteria help power future space missions?

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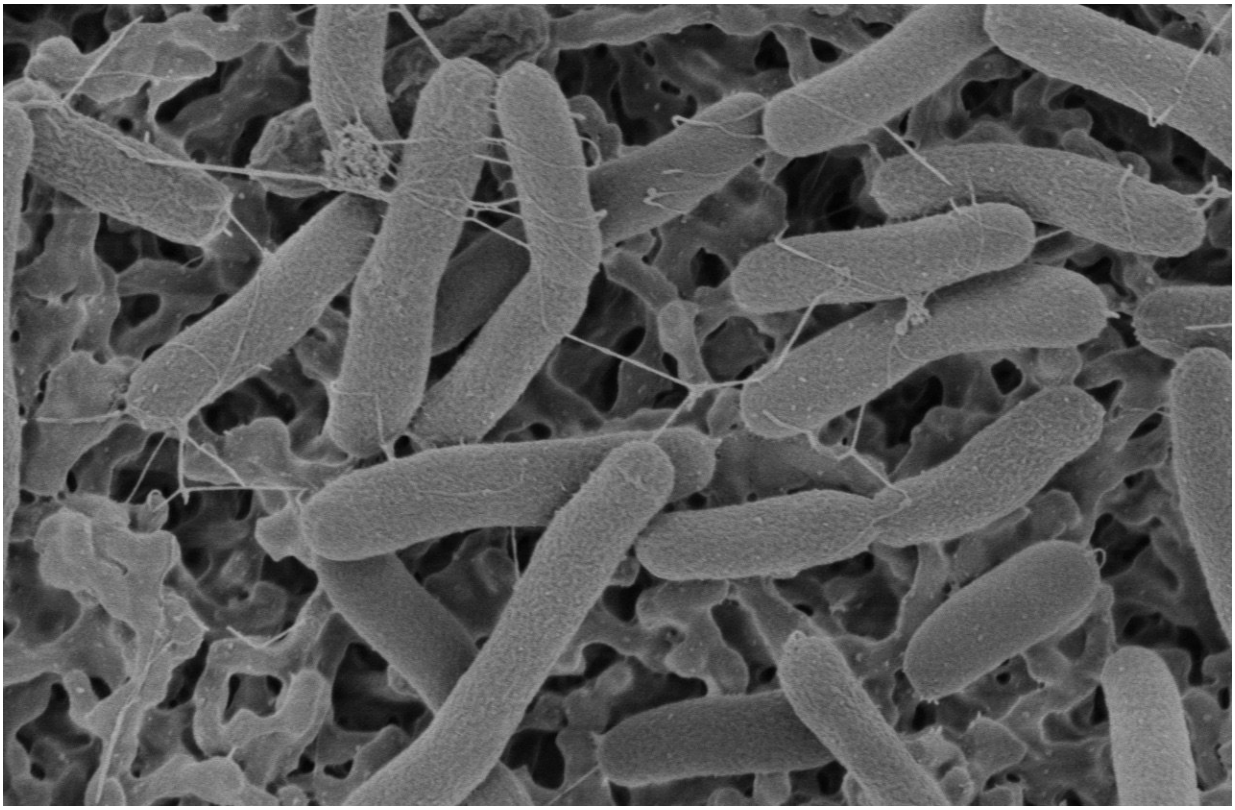

This scanning electron microscope image shows Shewanella oneidensis MR-1 bacteria. These bacteria are able to generate electric currents that can be conducted along nanowires extending from their cell membranes. NASA scientists are exploring this phenomenon to see if they can make use of these special microbes to perform essential functions on future space missions. Credit: NASA

Humans aren't the only ones who have harnessed the power of electricity. Some bacteria do this, too, by producing structures that extend from their surface like wires to transfer electrons over distances. Now, scientists at NASA's Ames Research Center in California's Silicon Valley are exploring this phenomenon to see if they can make use of these special microbes to perform essential functions on future space missions—from generating electricity to treating wastewater or producing medicines. With an experiment launching to the International Space Station, researchers will see whether the microbes work the same in space as they do on Earth.

To appreciate the rare abilities of the bacterium in question, called Shewanella oneidensis MR-1, you have to know what moving electrons around has to do with life. The transfer of electrons from one molecule to another is essential to all organisms, because it allows for the production of energy they need to survive. One reason that humans depend on oxygen is that this energy-producing chain reaction inside our cells is powered by transferring electrons to molecules of oxygen. The same goes for anything else that breathes oxygen, including Shewanella. But what makes this microorganism special is that it also has a back-up system that kicks in when the environment is low on oxygen. Shewanella keeps calm and carries on producing energy by using metals, like iron and manganese, instead.

A team from the Space Biosciences division at Ames, led by John Hogan and Michael Dougherty, has been studying Shewanella to understand better how it pulls off this electron-shuffling feat. One way is through the formation of biofilms. In a biofilm, many individual bacteria stick together, forming a thin film along a surface. Common examples of biofilms are the plaque the dentist cleans off your teeth and soap scum in your bathroom.

Shewanella generally forms biofilms on metal-containing surfaces, such

as rocks. The bacteria can make direct contact with molecules of metal in the rock using very thin appendages, known as bacterial nanowires, that extend from their outer surface. These are incredibly thin—about 10 nanometers, which is about 10,000 times thinner than a human hair. Much like an electrical cord carries electricity from the socket to recharge your phone, they transport electrons a long distance, from the bacterial point of view. Scientists think that these organisms can also connect to each other using nanowires to pass electrons to other members of the community.

These remarkable abilities have inspired researchers to see how they could be put to use. As humans venture farther into the solar system, astronaut crews will need ways to produce their own resources for longer periods of time. Potential applications for bacteria like Shewanella include development of technology like microbial fuel cells for use in space and on Earth. In wastewater treatment, for example, these fuel cells use microorganisms like Shewanella to consume organic waste in used water, while harvesting the electricity they produce to help power the treatment system itself.

As a first step, the Ames team is launching an experiment named Micro-12 aboard the 15th SpaceX cargo resupply mission to the space station to study how Shewanella may change in the reduced gravity of space. They'll check if it is able to transfer electrons at the same rate as on Earth and whether the way it forms biofilms is affected. The data collected will help NASA learn what these organisms need to thrive up there and how we might be able to use them in space, laying the groundwork for future life-support systems and long-duration human missions into the solar system.

Provided by NASA