Discovering how microbes cooperate

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Ever wonder what microorganisms do on a Saturday night? In professor Derek Lovley's lab at the University of Massachusetts, Amherst, doctoral candidate Zarath Summers and her colleagues made a point to find out. In the process, Summers discovered a new cooperative behavior in bacteria.

"Interspecies electron transfer" entails one microorganism forming a direct electrical connection to another.

Scientists have known since the 1960s that microorganisms can indirectly exchange electrons through a process called hydrogen transfer, in which one microbe produces hydrogen and then another microbe consumes it. But this discovery takes hydrogen transfer and goes a step further. Rather than a baton pass of sorts, it is two species directly plugging into each other.

The microbes Summers and her colleagues are studying - Geobacter - are of particular interest because of their role in environmental restoration. For example, the organisms can destroy petroleum contaminants and remove radioactive metal from polluted groundwater.

Summers recently talked with the Los Angeles Times about her lab work:

Question: What were you originally testing in the lab?

Answer: In the natural environment, there are all sorts of species everywhere, so we wanted to get a handle on what microbes are doing with their friends in the dirt.

We know that the microorganisms living in soil and water are essential for a healthy environment, but we have very little information on how different microbes live together. We wanted to learn more about how they cooperate. What we discovered is that different types of microbes can make electrical connections and pass electricity from one microbe to the other. This allows them to share energy in a highly efficient way that no one has ever seen before.

Q: You essentially placed the microbes in conditions that forced them to work together to survive, using alcohol as an energy source. What is their process?

A: We took two different microbes - Geobacter sulfurreducens and Geobacter metallireducens. They are different species, and only one of them - G. metallireducens - can consume ethanol for energy. They grow in clumps. So the second microbe attaches to the first and, rather than transfer substrates between each other, they are "wired" together and transfer electrons directly. In order to live, the G. sulfurreducens are sucking electrons off of the G. metallireducens.

We essentially put them in a position where they either adapt to work together or they both die. How they are working together has never been seen before in microbiology.

Q: What do they look like?

A: In order to grow and transfer energy, they have to be in these huge clumps together. They are the size of Nerds candy and they're pink, so they look like strawberry Nerds. The clumps are a millimeter or two, which is surprisingly large. You no longer need a microscope to see them. It's microbiology that turned into macrobiology.

Q: You've called these two "the ultimate drinking buddies." Why?

A: Because they have to work together or there's no ethanol consumed.

Q: What are the implications for renewable energy sources?

A: This is a new way to look at how microbe species can live together. Until now people have assumed that when microbes are working together they are transferring substrates between them. What we're saying is direct transfer through "wired" connections is also a possibility. This way of transfer is a much more streamlined way to transfer electrons between microbes. It's like taking an extension cord and plugging it into a neighbor.

Say you want to make a better wastewater treatment reactor. With this new information in hand, now we can possibly help to optimize these systems for faster waste degradation, and more effectively produce valuable biofuels from that waste, thanks to our microbe friends.

Q: What will you test next?

A: There are lots of cases all over the world where there are naturally occurring communities of bacteria that are in close contact, where multiple microbial species are touching - the touching is key for this type of electron transfer. For example, in microbial mats that are as thick as a doormat, or thicker, which grow in temperate climates along coastal regions (such as along the coasts of L.A., San Diego and Mexico), this type of transfer could also be happening.

With the mats, every millimeter you go down within it, there is something different going on - one of the microbes might consume something else that another does not like. There is probably some direct electron transfer going on there.

In wastewater treatment plants, we can take what we know and test different reactors processing all types of waste around the world, to see if there is a direct form of electron transfer happening.