Research highlights how bacteria produce energy

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The world's smallest life forms could be the answer to one of today's biggest problems: providing sustainable, renewable energy for the future. Using a variety of natural food sources, bacteria can be used to create electricity, produce alternative fuels like ethanol and even boost the output of existing oil wells, according to research being presented this week at the 106th General Meeting of the (ASM) American Society for Microbiology in Orlando, Florida.

"Microbial fuel cells show promise for conversion of organic wastes and renewable biomass to electricity, but further optimization is required for most applications," says Derek Lovley of the University of Massachusetts in Amherst. Earlier this month, Lovley announced at a meeting that he and his colleagues were able to achieve a 10-fold increase in electrical output by allowing the bacteria in microbial fuel cells to grow on biofilms on the electrodes of a fuel cell.

This week, Gemma Reguera, a researcher in Lovley's lab will present data identifying for the first time how these bacteria are able to transfer electrons through the biofilms to the electrodes.

"Cells at a distance from the anode remained viable with no decrease in the efficiency of current production as the thickness of the biofilm increased. These results are surprising because Geobacter bacteria do not produce soluble molecules or 'shuttles' that could diffuse through the biofilm and transfer electrons from cells onto the anode," says Reguera.

She and her colleagues discovered that the bacteria produce conductive protein filaments, or pili 'nanowires,' to transfer electrons. The finding that pili can extend the distance over which electrons can be transferred suggests additional avenues for genetically engineering the bacteria to further enhance power production.

Researchers from the Universidad Nacional Autonoma de Mexico announce that they have genetically engineered the bacterium Bacillus subtilis to directly ferment glucose sugar to ethanol with a high (86%) yield. This is the first step in a quest to develop bacteria that can breakdown and ferment cellulose biomass directly to ethanol.

"Currently ethanol is produced primarily from sugarcane or cornstarch, but much more biomass in the whole plant, including stems and leaves, can be converted to ethanol using clean technology," says Aida-Romero Garcia, one of the researchers on the study. The next step is to engineer the bacteria to produce the enzymes, known as cellulases, to break the stems and leaves down into the simple carbohydrates for fermentation.

Bacteria can not only produce alternative fuels, but could also aid in oil production by boosting output of existing wells. Michael McInerney and his colleagues at the University of Oklahoma will present research demonstrating the technical feasibility of using detergent-producing microorganisms to recover entrapped oil from oil reservoirs.

"Our approach is to use microorganisms that make detergent-like molecules (biosurfactants) to clean oil off of rock surfaces and mobilize oil stuck in small cavities. However, up till now, it is not clear whether microorganisms injected into an oil reservoir will be active and whether they will make enough biosurfactant to mobilize entrapped oil," says McInerney.

He and his colleagues were able to inoculate an oil reservoir with

specific strains of bacteria and have these bacteria make biosurfactants in amounts needed for substantial oil recovery.

"We now know that the microorganisms will work as intended in the oil reservoir. The next important question is whether our approach will recover entrapped oil economically. We saw an increase in oil production after our test, but we need to measure oil production more precisely to be certain," says McInerney.

Source: American Society for Microbiology