Self-destructing bacteria improve renewable biofuel production

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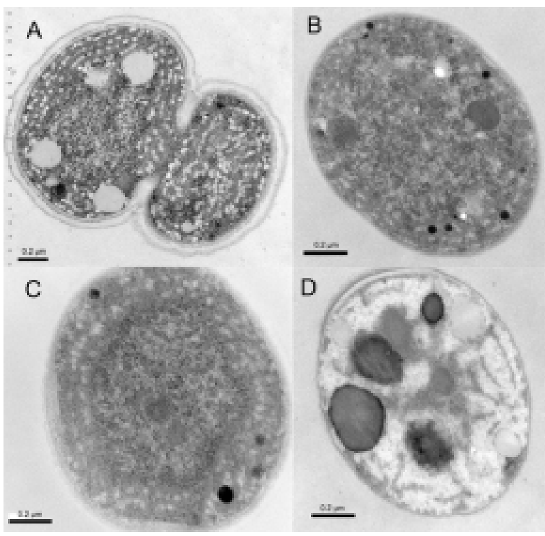

Self-destructing biofuel bacteria. Pictured are transmission electron microscopy images of the cyano SD121 cells before and after the addition of trace amounts of nickel.

(PhysOrg.com) -- An Arizona State University research team has developed a process that removes a key obstacle to producing lower-cost, renewable biofuels. The team has programmed a photosynthetic microbe to self-destruct, making the recovery of high-energy fats--and their biofuel byproducts--easier and potentially less costly.

"The real costs involved in any biofuel production are harvesting the goodies and turning them into fuel," said Roy Curtiss, director of the

Biodesign Institute's Center for Infectious Diseases and Vaccinology and professor in the School of Life Sciences. "This whole system that we have developed is a means to a green recovery of materials not requiring energy dependent physical or chemical processes."

Curtiss is part of a large, multidisciplinary ASU team that has been focusing on optimizing photosynthetic microbes, called cyanobacteria, as a source of renewable biofuels. These microbes are easy to genetically manipulate and have a potentially higher yield than any plant crops currently being used as transportation fuels.

But, until now, harvesting the fats from the microbes required many cost-intensive processing steps. Cyanobacteria have a multi-layer, burrito-like, protective set of outer membranes that help the bacteria thrive in even harsh surroundings, creating the pond scum often found in backyard swimming pools.

To get the cyanobacteria to more easily release their precious, high fat cargo, Curtiss and postdoctoral researcher Xinyao Liu, placed a suite of genes into photosynthetic bacteria that were controlled by the simple addition of trace amounts of nickel to the growth media.

"Genetics is a very powerful tool," said Liu. "We have created a very flexible system that we can finely control."

The genes were taken from a mortal bacterial enemy, called a bacteriaphage, which infect the bacteria, eventually killing the microbes by causing them to burst like a balloon. The scientists swapped parts from bacteriaphages that infect E. coli and salmonella, simply added nickel to the growth media, where the inserted genes produced enzymes that slowly dissolved the cyanobacteria membranes from within (see figure 1).

This is the first case of using this specialized bacterial system and placing it in cyanobacteria to cause them to self-destruct. "This system is probably one of a kind," said Curtiss, who has filed a patent with Xinyao Liu on the technology. Curtiss has been a pioneer in developing new vaccines, now working on similar systems to develop a safe and effective pneumonia vaccine.

The project is a prime example of the multidisciplinary, collaborative spirit of ASU research. Other key contributors were School of Life Sciences professor Wim Vermaas, an expert on the genetic manipulation techniques of cyanobacteria, Robert Roberson, for help with transmission electron microscopy, Daniel Brune, who did mass spectrometer analyses of the lipid products, and many other colleagues in the ASU biofuel project team.

The project has also been the beneficiary of the state of Arizona's recent strategic investments to spur new innovation that may help foster future green and local industries. The state's abundant year-round sunshine and warm temperatures are ideally suited for growing cyanobacteria.

"This probably would never have gone anywhere if Science Foundation Arizona or BP had not funded the project," said Curtiss. The $5 million in funding was key to scaling up and recruiting new talent to work on the project, including paper first author Xinyao Liu, an expert in microbiology and genetics who had recently earned his Ph.D. from the prestigious Peking University in Beijing, China.

"Xinyao is unique," said Curtiss. "If he were a baseball player, he wouldn't be satisfied with anything less than a 1000 home runs in 10 years. Xinyao is always swinging for the fences. Now, we are moving forward with a number of new approaches to see how far we can push the envelope." The next phase of the research is being funded by a two-year, $5.2 million grant from the U.S. Department of Energy (DOE) led by researcher Wim Vermaas, Curtiss, Liu and others from the ASU biofuel team.

The results were published in the Dec. 7 issue of the *Proceedings of the National Academy of Sciences*.

Source: Arizona State University (news : web)