Hot new manufacturing tool: A temperature-controlled microbe

April 17 2012

Many manufacturing processes rely on microorganisms to perform tricky chemical transformations or make substances from simple starting materials. The authors of a study appearing in *mBio*, the online open-access journal of the American Society for Microbiology, on April 17 have found a way to control a heat-loving microbe with a temperature switch: it makes a product at low temperatures but not at high temperatures. The innovation could make it easier to use microorganisms as miniature factories for the production of needed materials like biofuels.

This is the first time a targeted modification of a hyperthermophile (heat-loving microorganism) has been accomplished, say the authors, providing a new perspective on engineering microorganisms for bioproduct and biofuel formation.

Originally isolated from hot marine sediments, the hyperthermophile *Pyrococcus furiosus* grows best at temperatures around 100ºC (212ºF). *P. furiosus* is an archaeon, single-celled organisms that bear a resemblance to bacteria, but they excel at carrying out many processes that bacteria cannot accomplish. Like other hyperthermophiles, *P. furiosus*' enzymes are stable at the high temperatures that facilitate many industrial processes, making it a well-used tool in biotechnology and manufacturing. But not all products can be made at high heat. Some enzymes will only work at lower temperatures.

In the study in mBio®, the authors inserted a gene from another

organism into *P. furiosus* and coaxed it to use that gene to make a new product by simply lowering the temperature. The donor organism, Caldicellulosiruptor bescii, prefers to grow at a relatively cool 78ºC, so the protein product of its gene, lactate dehydrogenase, is most stable at that comparatively low temperature.

The authors of the study inserted the lactate dehyrogenase gene into a strategic spot, right next to a cold shock promoter that "turns on" the genes around it when *P. furiosus* is out in the cold at 72ºC. This essentially gives scientists a switch for controlling lactate production: put the organism at 72ºC to turn on lactate production, restore it to 100ºC to turn it off, thus preventing the need for chemical inducers. What's more, since *P. furiosus* is mostly shut down at these lower temperatures, making the new product doesn't interfere with its metabolism, or vice-versa.

The lead author on the study, Michael Adams of the Department of Biochemistry & Molecular Biology at the University of Georgia, explains that this is the key benefit of this system: although *P. furiosus* now makes the enzyme that carries out the process, at these lower temperatures the organism's other metabolic processes don't get in the way.

"The hyperthermophile is essentially the bioreactor that contains the foreign enzymes," says Adams. *P. furiosus* just supplies cofactors and a cytoplasmic environment for the highly active foreign enzymes, according to Adams. This makes for a cleaner, more controllable reaction.

More information: mbio.asm.org/