New light on bacterial microcompartments

May 12 2015

Bacteria contain "microcompartments," which are poorly understood organelles that play critical roles in metabolism. Understanding how they work may ultimately enable engineering them for useful applications. In salmonella, which possess two microcompartment types, coexpression is prevented by gene regulation. Concurrent expression rendered them nonfunctional, and resulted in release of toxic metabolic intermediates into the cell cytoplasm, damaging the cell. But by engineering a regulatory override, Thomas Bobik, PhD, and collaborators shed new light on how microcompartments work. The research is published in the *Journal of Bacteriology*, a publication of the American Society for Microbiology.

"Microcompartments are found in hundreds of species of bacteria, in varying numbers", said Bobik, who is a professor in the Department of Biochemistry, Biophysics, and Molecular Biology at Iowa State University, Ames. "They prevent different biochemical reactions from interfering with one-another, accelerate reactions and sequester toxic metabolic intermediates. Understanding the principles by which they function might allow us to engineer them for the production of renewable chemicals, or as containers to improve drug delivery, or perhaps identify novel target sites for antimicrobials."

In salmonella, one type of microcompartment produces 1,2-propanediol, and another produces ethanolamine. Normally, the gene regulatory system prevents them from being produced at the same time. In the study, Bobik's override enabled production of both at once. "Nonfunctional microcompmartments were formed, and toxic metabolic

intermediates, normally sequestered by the microcompartment were released into the cell cytoplasm, causing cellular damage," said Bobik.

Unlike organelles, which are encased in lipid membranes, microcompartments are bounded by a protein shell. The findings indicate that a component of the propanediol-producing microcompartment system represses the ethanolamine-producing microcompartment, in order to prevent mixing of the shell proteins of the two microcompartments. "These findings suggest that numerous organisms, which produce more than one type of [microcompartment], likely need some mechanism to prevent aberrant shell protein interactions."

The origin of the experiment was accidental, said Bobik. "We noticed that the inducer of the 1,2-propanediol microcompartment repressed the ethanolamine microcompartment, when we were trying to develop a biosensor to measure vitamin B12 levels in vivo.

Nearly 20 percent of bacterial genomes encode microcompartments, and almost 40 percent of those contain multiple microcompartment gene clusters.

Provided by American Society for Microbiology