

## How bacterial organelles assemble

Structure of microcompartment's protein shell could help research in bioenergy, pathogenesis, and biotechnology

*Date:* June 22, 2017

*Source:* DOE/Lawrence Berkeley National Laboratory

*Summary:* Scientists are providing the clearest view yet of an intact bacterial microcompartment, revealing at atomic-level resolution the structure and assembly of the organelle's protein shell. This work could benefit research in bioenergy and pathogenesis, and it could lead to new methods of bioengineering bacteria for beneficial purposes.

### FULL STORY

Scientists are providing the clearest view yet of an intact bacterial microcompartment, revealing at atomic-level resolution the structure and assembly of the organelle's protein shell.

The work, led by scientists at the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) and Michigan State University (MSU), will appear in the June 23 issue of the journal *Science*. They studied the organelle shell of an ocean-dwelling slime bacteria called *Haliangium ochraceum*.

"It's pretty photogenic," said corresponding author Cheryl Kerfeld, a Berkeley Lab structural biologist with a joint appointment as a professor at the MSU-DOE Plant Research Laboratory. "But more importantly, it provides the very first picture of the shell of an intact bacterial organelle membrane. Having the full structural view of the bacterial organelle membrane can help provide important information in fighting pathogens or bioengineering bacterial organelles for beneficial purposes."

These organelles, or bacterial microcompartments (BMCs), are used by some bacteria to fix carbon dioxide, Kerfeld noted. Understanding how the microcompartment membrane is assembled, as well as how it lets some compounds pass through while impeding others, could contribute to research in enhancing carbon fixation and, more broadly, bioenergy. This class of organelles also helps many types of pathogenic bacteria metabolize compounds that are not available to normal, non-pathogenic microbes, giving the pathogens a competitive advantage.

The contents within these organelles determine their specific function, but the overall architecture of the protein membranes of BMCs are fundamentally the same, the authors noted. The microcompartment shell provides a selectively permeable barrier which separates the reactions in its interior from the rest of the cell. This enables higher efficiency of multi-step reactions, prevents undesired interference, and confines toxic compounds that may be generated by the encapsulated reactions.

Unlike the lipid-based membranes of eukaryotic cells, bacterial microcompartments (BMCs) have polyhedral shells made of proteins.

"What allows things through a membrane is pores," said study lead author Markus Sutter, MSU senior research associate and affiliate scientist at Berkeley Lab's Molecular Biophysics and Integrated Bioimaging (MBIB) division. "For lipid-based membranes, there are membrane proteins that get molecules across. For BMCs, the shell is already made of proteins, so the shell proteins of BMCs not only have a structural role, they are also responsible for selective substrate transfer across the protein membrane."

Earlier studies revealed the individual components that make up the BMC shell, but imaging the entire organelle was challenging because of its large mass of about 6.5 megadaltons, roughly equivalent to the mass of 6.5 million hydrogen atoms. This size of protein compartment can contain up to 300 average-sized proteins.

The researchers were able to show how five different kinds of proteins formed three different kinds of shapes: hexagons, pentagons and a stacked pair of hexagons, which assembled together into a 20-sided icosahedral shell.

The intact shell and component proteins were crystallized at Berkeley Lab, and X-ray diffraction data were collected at Berkeley Lab's Advanced Light Source and the Stanford Synchrotron Radiation Lightsource, both DOE Office of Science User Facilities.

The study authors said that by using the structural data from this paper, researchers can design experiments to study the mechanisms for how the molecules get across this protein membrane, and to build custom organelles for carbon capture or to produce valuable compounds.

#### Story Source:

Materials provided by **DOE/Lawrence Berkeley National Laboratory**. *Note: Content may be edited for style and length.*

#### Journal Reference:

1. Markus Sutter, Basil Greber, Clement Aussignargues, Cheryl A. Kerfeld. **Assembly principles and structure of a 6.5-MDa bacterial microcompartment shell**. *Science*, 2017 DOI: 10.1126/science.aan3289

#### Cite This Page:

[MLA](#)
[APA](#)
[Chicago](#)

DOE/Lawrence Berkeley National Laboratory. "How bacterial organelles assemble: Structure of microcompartment's protein shell could help research in bioenergy, pathogenesis, and biotechnology." ScienceDaily. ScienceDaily, 22 June 2017. <[www.sciencedaily.com/releases/2017/06/170622142937.htm](http://www.sciencedaily.com/releases/2017/06/170622142937.htm)>.

#### RELATED STORIES

**Clearst View Ever of Cell Membrane Yields Unexpected Structure, Research Possibilities**

Dec. 12, 2018 — Scientists have gained the clearest view yet of a patch of cell membrane and its components, revealing unexpected structures and opening up new possibilities for pharmaceutical ... **read more »**

**Viruses Over Antibiotics: Determining the 3D Structure of Phages at Atomic Resolution Closer Thanks to New Method**

July 3, 2017 — Phages have become a focus of research in the battle against antibiotic resistance. These bacteria-eating viruses have already proven effective in experiments against multidrug-resistant bacteria. ...

**read more »**

### Too Much of a Good Thing: Extra Genes Make Bacteria Lethal

Feb. 10, 2015 — We, as most animals, host many different beneficial bacteria. Being beneficial to the host often pays off for the bacteria, as success of the host determines the survival and spread of the microbe. ... **read more »**

### X-Ray Laser Reveals How Bacterial Protein Morphs in Response to Light

Dec. 4, 2014 — Researchers have captured the highest-resolution snapshots ever taken with an X-ray laser that show changes in a protein's structure over time, revealing how a key protein in a photosynthetic ... **read more »**