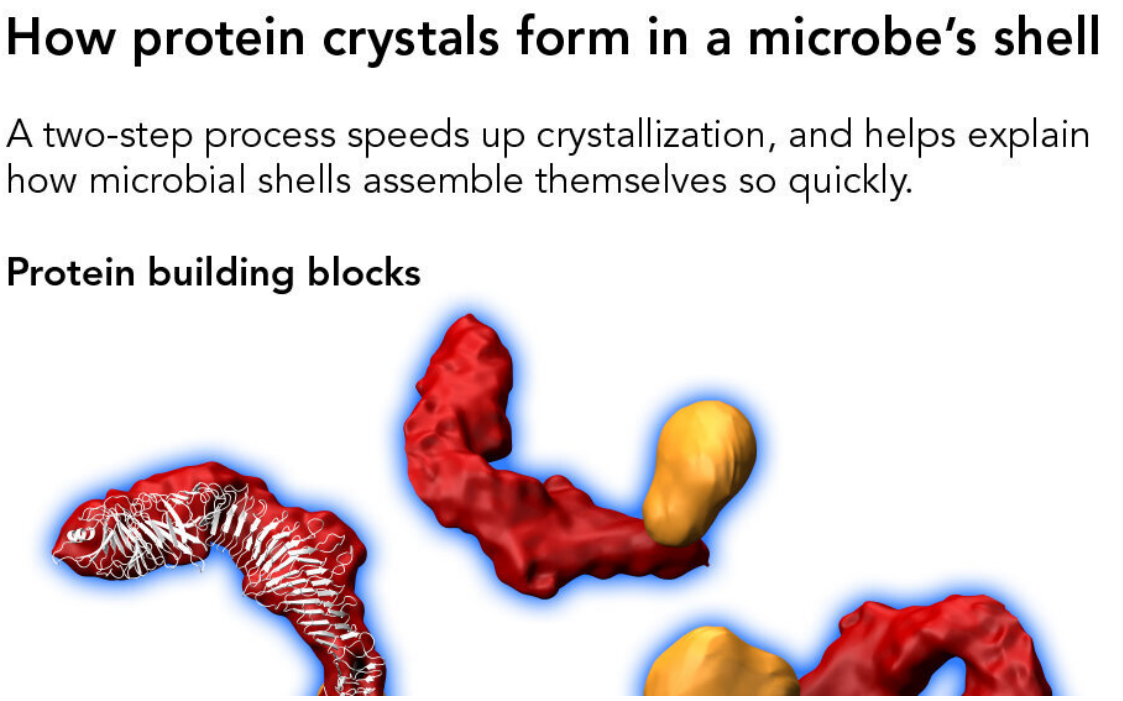
Scientists discover how proteins form crystals that tile a microbe's shell

December 17 2019, by Glennda Chui



It's a two-step process that speeds up crystallization. Credit: Greg Stewart/SLAC National Accelerator Laboratory, J. Herrmann et al./PNAS

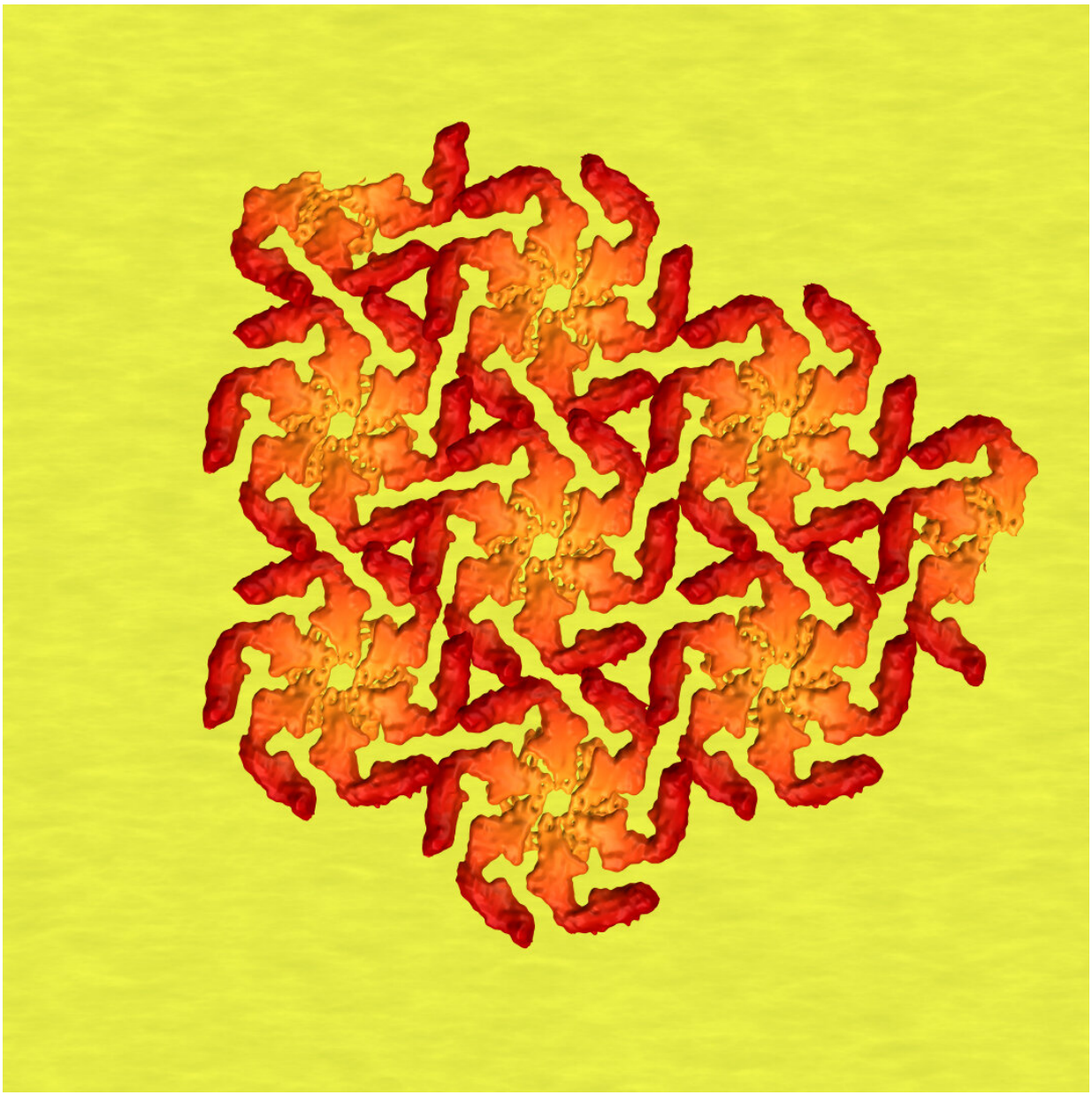
Many microbes wear beautifully patterned crystalline shells, which protect them from a harsh world and can even help them reel in food. Studies at the Department of Energy's SLAC National Accelerator Laboratory and Stanford University have revealed this food-reeling

process and shown how shells assemble themselves from protein building blocks.

Now the same team has zoomed in on the very first step in microbial shell-building: nucleation, where squiggly proteins crystallize into sturdy building blocks, much like rock candy crystallizes around a string dipped into sugar syrup.

The results, published today in the *Proceedings of the National Academy of Sciences*, could shed light on how the shells help microbes interact with other organisms and with their environments, and also help scientists design self-assembling nanostructures for various tasks.

Jonathan Herrmann, a graduate student in Professor Soichi Wakatsuki's group at SLAC and Stanford, collaborated with the structural molecular biology team at SLAC's Stanford Synchrotron Radiation Lightsource (SSRL) on the study. They scattered a powerful beam of X-rays off protein molecules that were floating in a solution to see how the atomic structures of the molecules changed as they nucleated into crystals. Meanwhile, other researchers made a series of cryogenic electron microscope (cryo-EM) images at various points in the nucleation process to show what happened over time.



In this illustration, protein crystals join six-sided 'tiles' forming at top left and far right, part of a protective shell worn by many microbes. A new study zooms in on the first steps of crystal formation and helps explain how microbial shells assemble themselves so quickly. Credit: Greg Stewart/SLAC National Accelerator Laboratory

They found out that crystal formation takes place in two steps: One end of the protein molecule nucleates into crystal while the other end, called the N-terminus, continues to wiggle around. Then the N-terminus joins in, and the crystallization is complete. Far from being a laggard, the N-terminus actually speeds up the initial nucleation step—although exactly how it does this is still unknown, the researchers said—and this helps explain why microbial shells can form so quickly and efficiently.

More information: A bacterial surface layer protein exploits multistep crystallization for rapid self-assembly, *Proceedings of the National Academy of Sciences* (2019). DOI: 10.1073/pnas.1909798116 , www.pnas.org/content/early/2019/12/16/1909798116

Provided by SLAC National Accelerator Laboratory