Step 1: The strands, or “stays,” of a beta-barrel protein can’t be inserted into the membrane directly—it’s not stable. The interior of the BamA channel stabilizes each stay as the protein building machinery makes it.

Step 2: As the Anton simulations showed, BamA parts to create an opening, allowing the other protein’s strands to feed out into the membrane as they’re made.

Step 3: Once the other protein’s barrel is complete, it moves away, fully inserted in the membrane and ready to do one of a number of critical jobs for the bacterium’s survival.

Why It’s Important

In an era of diminishing antibiotic effectiveness, it’s no wonder that bacteria, how they live—and what molecular components they can’t live without—are an important focus for biomedical science.

This “beta barrel protein” inserts other beta barrel proteins into the outer bacterial membrane, including those that import nutrients or export toxins that kill host cells. The process is a promising target for antibacterial drugs.

“When I saw the lateral opening in the simulation, I was surprised—even shocked. I never imagined beta barrels just opening spontaneously like that.”
—James C. Gumbart, Georgia Institute of Technology

How Anton Helped

The researchers revealed BamA’s side exit using molecular dynamics (MD) simulations that lasted from one- to two-millionths of a second. In the world of computational biochemistry, that’s a very long time—supercomputers take months to perform simulations of the necessary length. On Anton, a special-purpose supercomputer designed to dramatically increase the speed of MD simulations, it can be accomplished in a day. The researchers reported their work in the journal Nature.

“Anton was critical for the work,” Gumbart says. “If limited to conventional systems, I probably would have run about 50 to 100 nanoseconds”—a tenth or less the time scale. If he’d only looked at this scale, he says, he might have thought, “Well, I don’t see anything, and that’s what it is.” Anton allowed him to push farther, to a remarkable result.