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Structural Biologists Get First Picture of Complete Bacterial Flagellar Motor

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When it comes to tiny motors, the flagella used by bacteria to get around their microscopic worlds are hard to beat. Composed of several tens of different types of protein, a flagellum (that's the singular) rotates about in much the same way that a rope would spin if mounted in the chuck of an electric drill, but at much higher speeds-about 300 revolutions per second.

Biologists at the California Institute of Technology have now succeeded for the first time in obtaining a three-dimensional image of the complete flagellum assembly using a new technology called electron cryotomography. Reporting in *Nature*, the scientists show in unprecedented detail both the rotor of the flagellum and the stator, or protein assembly that not only attaches the rotor to the cell wall, but also generates the torque that serves to rotate it.

The accomplishment is a tour de force within the field of structural biology, through which scientists seek to understand how cells work by determining the shapes and configurations of the proteins that make them up. The results could lead to better-designed nanomachines.

"Rotors have been isolated and studied in detail," explains lead author Grant Jensen, an assistant professor of biology at Caltech. "But in the past, researchers have been forced to break the motor into pieces and/or rip it out of the cell before they could observe it in the microscope. It was like trying to understand a car engine by looking through salvaged parts. Here we were able to see the whole motor intact, like an engine still under the hood and attached to the drive train."

In terms of basic science, Jensen says, the motor is intrinsically interesting because it is such a marvelous and complex "nanomachine." But the results of studying it may also one day help engineers, who might want to use its structure to design useful things.

"The process of taking science to practical applications goes from the observation of interesting phenomena, to mechanistic understanding, to exploitation," Jensen says. "Right now, we're somewhere between observation and the beginning of mechanistic understanding of this wonderful motor."

The bacterium used in the study was isolated from the hindguts of termites. Although beneficial to the termite host, the bacterium, belonging to a group of organisms known as spirochetes, is closely related to the causative agents of syphilis, Lyme disease, and several organisms thought to play a role in gum disease. In all these cases, swimming motility is implicated as a possible determinant in disease.

The article is titled "In situ structure of the complete Treponema primitia flagellar motor." It is available as an advanced online publication of *Nature* at www.nature.com/nature/journal/ … ull/nature05015.html.

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Source: Caltech