MEMBRANES & MOLECULES

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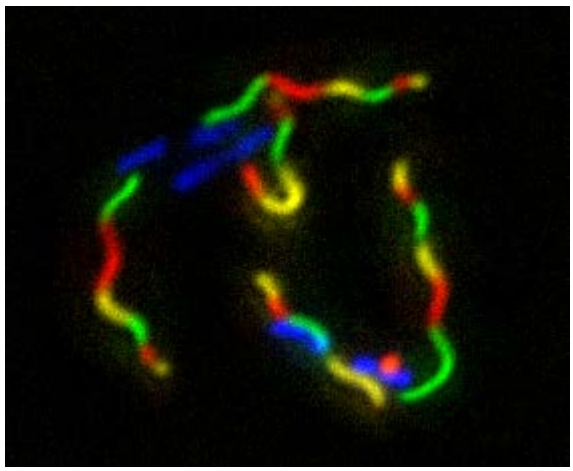
Self-Assembly of a Bacterial Nanomachine: the Flagellum



The flagellum, an extracellular appendage which bacterial utilize for chemotaxis-driven motility, is a remarkably complex nanomachine made up of dozens of different protein subunits. Building of the flagellum relies on a tightly regulated self-assembly, both on the temporal and spatial levels. In particular, the filament which can reach more than ten times the cell body length requires the export and assembly of up to 20,000 flagellin subunits.

At the base of the flagellum, a type-III secretion system (T3SS) – energized by the proton motive force – unfolds and translocates the filament building blocks at a high-speed of more than 1,700 amino-acids per second. Injected proteins then travel through a narrow 2 nm channel in the hollow filament to finally assemble at the tip of the structure.

Those structural constraints raised the fundamental question of the molecular mechanism of filament elongation: how does assembly of such a long structure combine energization far away from the cell body, fast growth, length control, and robustness upon perturbation (*e.g.*, disruption of the energization or recovery after filament break)? How are organized and regulated the membrane components of this export apparatus that orchestrates the rapid export of the flagellar substrates?

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