Nature Reviews Microbiology | AOP, published online 2 January 2014; doi:10.1038/nrmicro3202

BACTERIAL PHYSIOLOGY

Multitasking in *Myxococcus*

Processive transport systems are widely used in eukaryotes to regulate a range of fundamental cellular processes, but only one such system, the Agl–Glt machinery, has been found in bacteria. Now, Mignot and colleagues show that, in *Myxococcus xanthus*, the Agl motor protein, which was previously shown to mediate gliding motility, is repurposed for assembly of the spore coat during sporulation.

During *M. xanthus* gliding motility, the motor protein Agl, which is located in the inner membrane, couples the energy that is generated from the proton motive force to the Glt complex, which spans the cell envelope. Although the molecular details remain to be elucidated, motility is thought to result from the transported Glt proteins producing thrust, which is facilitated by interactions between the Glt complex and an undefined extracellular polysaccharide (known as slime) that attaches to the underlying surface.

As this transport machinery is present in other bacteria that do not exhibit gliding motility, the authors postulated that the system might be adapted for other functions. Interestingly, the *glt* genes are paralogous to the *nfs* (necessary for sporulation) genes, and the encoded proteins of the *nfs* gene cluster also localize to the cell envelope, suggesting that the Nfs proteins form a sporulation-specific Glt-like complex that might associate with the Agl motor to facilitate spore formation. Indeed, the authors found that a mutation that blocks Agl proton conductance, or deletion of any of the three *agl* genes, resulted in a severe sporulation defect. Furthermore, a bacterial two-hybrid assay showed that the Agl motor physically interacts with the Nfs complex, which confirms that Agl is modular and can associate with both the Glt complex and the Nfs complex.

Bacterial spores are encased in a mesh-like shell known as the spore coat, and recent work has indicated that the polysaccharide Exo is the main component of the myxococcal spore coat. Transmission electron microscopy showed that *algQ* and *nfsD* mutants produced a spore coat that was only loosely attached, which suggests that the Agl–Nfs machinery is required for proper compaction of the spore coat. To determine how the Agl–Nfs machinery drives spore coat assembly, a microfluidic chamber assay was developed, and the activities of fluorescently labelled Agl and Nfs complexes were monitored by live microscopy. The data revealed that Agl accumulated all around the spore surface throughout sporulation, whereas Nfs produced distinct foci that rotated around the spore surface. Rotation of Nfs was also shown to be directional and dependent on Agl activity.

During motility, Agl interacts with the Glt complex to transport slime along the cell surface; thus, the authors examined whether Exo is the terminal cargo of the Agl–Nfs machinery. A series of microscopy experiments showed that Exo is only secreted at a few discrete sites around the spore periphery, and colocalization of Exo with Nfs suggested that the rotating Agl–Nfs complexes distribute Exo around the spore surface to produce a compact coat. Consistent with this, Exo was not required for rotation of the Agl–Nfs machinery around the spore circumference, but it was required for directional movement.

Together, these data suggest that the Agl motor is a core component of two processive transport systems in *M. xanthus*: it can associate either with Glt to mediate gliding motility or with Nfs to construct the densely packed spore coat that is required for sporulation. As Agl–Glt-like machinery is also found in a broad range of bacteria, the authors note that processive, modular transporters might be more widespread in bacteria than previously appreciated.

Christina Tobin Kåhrström

> “the rotating Agl–Nfs complexes are required to distribute Exo around the spore surface to produce a compact coat.”

ORIGINAL RESEARCH PAPER Wartel, M. *et al.* A versatile class of cell surface directional motors gives rise to gliding motility and sporulation in *Myxococcus xanthus*. *PLoS Biol.* **11**, e1001728 (2013)