BACTERIAL PHYSIOLOGY

Wrapped up in each other

Bacteria interact in various ways to exchange proteins, nutrients and genetic material. In a recent issue of *Cellular Microbiology*, Kudryashev and colleagues describe a new type of bacterium–bacterium interaction among *Borrelia* spp.: the partial fusion of the outer membranes of two closely apposed bacteria.

Bacteria of the genus *Borrelia* are spirochaetes, named after their characteristic spiral shape. As they are all Gram-negative bacteria, they have

an inner membrane, which encloses the cytoplasm (also referred to as the protoplasmic or cytoplasmic cylinder in *Borrelia* spp.), and an outer membrane. Between the membranes is the periplasm, containing a thin peptidoglycan layer as well as flagella that form a bundle which wraps around the bacterium along almost its entire length. The outer membrane thus separates the periplasm, including the flagella, from its surrounding environment.

When the authors viewed different *Borrelia* spp. under the microscope, they noticed that two motile cells often came together and moved together — usually for periods of seconds but in some cases for minutes — after which they separated. Such apposed bacteria could also be detected by electron microscopy. These bacteria looked morphologically normal, and some seemed to be wrapped around each other. Closer inspection using cryo-electron tomography, a form of electron microscopy that allows a three-dimensional image to be generated, revealed that the outer membranes of these bacteria had fused over a section spanning several micrometres, joining the periplasms of the two bacteria.

Furthermore, the flagella had combined to form a large bundle. In one case, the authors even detected fusion of the cytoplasmic cylinders, which in principle could allow the bacteria to exchange cytoplasmic components.

The part that this membrane fusion may play in the growth of the bacteria is not known. Interestingly, no systems for conjugation have been detected in *Borrelia* spp., so one possible function for membrane fusion may be the exchange of genetic material; genetic analysis of the multiple isolates of *Borrelia* spp. have indicated that gene exchange occurs between these bacteria. Alternatively, fusion of the flagella may provide advantages in terms of motility or under nutrient-poor conditions. Identification of the machinery that promotes membrane fusion would allow a bioinformatic search for other bacteria that may undergo this type of fusion.

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Two fused *Borrelia garinii* cells. Cytoplasmic cylinders are shown in light and dark magenta, and flagella are shown in yellow. Dark lines represent the outer membrane. Image courtesy of M. Kudryashev, Biocenter, University of Basel, Switzerland.

ORIGINAL RESEARCH PAPER Kudryashev, M. *et al.* Evidence of direct cell–cell fusion in *Borrelia* by cryogenic tomography. *Cell. Microbiol.* 30 Jan 2011 (doi:10.1111/j.1462-5822.2011.01571.x)

FURTHER READING Rosa, P. A., Tilly, K. & Stewart, P. E. The burgeoning molecular toolkit of the Lyme disease spirochaete. *Nature Rev. Microbiol.* 3, 129–143 (2005)