MEMBRANES & MOLECULES

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How microbes make magnets: The molecular mechanism of magnetosome organelle biosynthesis

Abstract

Magnetotactic bacteria biosynthesize magnetic organelles known as magnetosomes, which are membrane-enveloped nanocrystals of the magnetic mineral Fe_3O_4 that serve for magnetic field navigation in their aquatic habitats (1). Magnetosomes are also a particularly intriguing example of a genetically encoded and engineerable magnetic nanomaterial with unprecedented properties (2).

Magnetosome biosynthesis is as stepwise process that starts with the formation of a dedicated compartment, the magnetosome membrane (MM), by invagination from the cell membrane which is orchestrated by the cumulative action of several proteins (3). MM formation is then followed by the active transport of iron into the preformed magnetosome vesicles, which serve as “nanoreactors” for the highly controlled biomineralization of magnetite crystals. To serve most efficiently as geomagnetic sensors, nascent magnetosomes are subsequently aligned into well-ordered chains that are assembled and positioned by a complex and dynamic cytoskeletal network comprised by various types of proteins (4). In the talk, several recent findings on genetics, cell biology and synthetic biology of bacterial magnetosome formation will be highlighted.

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3. Raschdorf, O., Y. Forstner, I. Kolinko, R. Uebe, J.M. Plitzko, and D. Schüler. 2016. Genetic and ultrastructural analysis reveals the key players and initial steps of bacterial magnetosome membrane biogenesis. PLOS Genetics, 10:12(6)

4. Toro-Nahuelpan, M., F.D. Müller, S. Klumpp, J. Plitzko, M. Bramkamp, D. Schüler. 2016. Segregation of prokaryotic magnetosomes organelles is driven by treadmilling of a dynamic actin-like MamK filament. BMC Biology 14:88

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