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Commentary

Magnetotactic Bacteria and their Applications

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DESCRIPTION

Magnetotactic Bacteria (MTB) is a polyphyletic genus of bacteria that orient themselves along the magnetic field lines of the Earth. This alignment, found in 1963 by Salvatore Bellini and rediscovered in 1975 by Richard Blakemore, is thought to aid these species in reaching regions of ideal oxygen concentration. Magnetosomes, which contain magnetic crystals, are organelles in these bacteria that accomplish this function. Magnetotaxis is the biological process in which microorganisms tend to move in reaction to the magnetic properties of their surroundings. This word, however, is deceptive because every other application of the term taxis incorporates a stimulus-response process. In comparison to animal magneto reception, bacteria include fixed magnets that drive the bacteria into alignment. Even dead cells are forced into alignment, similar to a compass needle.

The physical development of a magnetic crystal is governed by two factors: One move to align the magnetic force of the molecules with the developing crystal, and the other lessens the magnetic force of the crystal, allowing the molecule to attach while experiencing an opposing magnetic force. In nature, this results in the formation of a magnetic domain with a thickness of around 150 nm of magnetite surrounding the domain's perimeter, within which the molecules gradually shift orientation. As a result, in the absence of an applied field, iron is not magnetic. Similarly, extremely small magnetic particles show no evidence of magnetisation at normal temperature because their magnetic force is constantly changing by the thermal movements inherent in their composition. Individual magnetite crystals in MTB are instead between 35 and 120 nm in size, that is, large enough to have a magnetic field while remaining a single magnetic domain.

Scientists have also suggested that the stated concept of magneto-aerotaxis be extended to a more complicated redoxtaxis. The unidirectional flow of MTB in a drop of water in this situation would be merely one component of a complicated redox-controlled reaction. One clue to the putative role of polar magnetotaxis could be that the majority of the representative microorganisms have either significant sulphur inclusions or magnetosomes composed of iron-sulfides. As a consequence, it is possible that the metabolism of these bacteria, which are either chemolithoautotrophic or mixotrophic, is heavily reliant on the uptake of reduced sulphur compounds, which occurs only in deeper regions at or below the OATZ due to the rapid chemical oxidation of these reduced chemical species by oxygen or other oxidants in the upper layers.

Bacterial magnetite has various advantages over chemically generated magnetite in specific applications. Unlike chemically manufactured magnetosome particles, bacterial magnetosome particles have a uniform shape, a narrow size distribution within a single magnetic domain range, and a membrane covering composed of lipids and proteins. The magnetosome envelope facilitates the attachment of bioactive molecules to its surface, which is useful in a variety of applications. Magnetotactic bacterial cells have been utilised to locate south magnetic poles in meteorites and rocks containing fine-grained magnetic minerals, as well as to separate cells after magnetotactic bacterial cells were phagocytosed into granulocytes and monocytes. Magnetotactic bacterial magnetite crystals have been used in studies of magnetic domain analysis as well as a variety of commercial applications, including the immobilisation of enzymes, the formation of magnetic antibodies, and the quantification of immunoglobulin G; the detection and removal of *Escherichia coli* cells using a fluorescein isothiocyanate conjugated monoclonal antibody immobilised on magnetotactic bacterial magnetite particles; and the introduction of genes into cells and the "loading" of genes into cells, a technique in which magnetosomes are coated with DNA and "shot" into cells that are difficult to change using more traditional approaches using a particle cannon. Nevertheless, mass culture of magnetotactic bacteria or the introduction and expression of the genes essential for magnetosome synthesis into a bacterium, such as *E. coli,* that can be grown relatively cheaply to extraordinarily high yields is required for any large-scale commercial application. Despite some advances, the former has not been attained with the available pure cultures.

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