Magnetotactic Bacteria as Living Biorobots for Targeted Therapy

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Magnetotactic bacteria (MTB) are motile aquatic microorganisms that orient and navigate along the Earth's magnetic field through a behavior known as magnetotaxis. This ability is enabled by magnetosomes, intracellular magnetic nanoparticles that are biosynthesized and assembled into chain-like structures along the cell's longitudinal axis. The composition, size, morphology, and organization of magnetosomes are tightly regulated at the genetic level, resulting in species-dependent magnetic properties. Beyond magnetotaxis, MTB exhibit aerotaxis, an oxygen sensing mechanism that directs them toward optimal oxygen conditions. The combined effects of magnetic guidance, oxygen sensing, and self propulsion, driven by flagella, position MTB as promising candidates for biorobotic therapeutic and diagnostic applications [1]. MTB can be externally guided by magnetic fields and naturally accumulate in hypoxic environments, such as those characteristic of tumor tissues. This talk presents recent advances in the collective control of bacterial navigation under time varying magnetic fields [2], together with a comparative analysis of the magnetic hyperthermia performance of different magnetotactic bacterial species [3]. The associated cytotoxic effects of magnetic hyperthermia on lung carcinoma cells are evaluated using *in vitro* models. Furthermore, the intracellular degradation kinetics of magnetosomes are examined using spatial resolution nano-XANES spectroscopy, revealing a time dependent degradation process within the cellular environment [4]. Finally, the incorporation of dopant elements such as gadolinium (Gd) and terbium (Tb) into the magnetosome crystal lattice is demonstrated to confer multifunctional properties, underscoring their potential for advanced biomedical applications [5].

References:

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