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Microfluidic Viability Studies of Magnetotactic Bacteria

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ABSTRACT

Magnetotactic bacteria (MTB) *Magnetospirilium magneticum* strain AMB-1 have shown a great potential as carriers for therapeutic agents within the human body. MTB are a polyphyletic group of bacteria that orientate themselves along the Earth's magnetic field lines due to magnetosomes, specialized magnetic organelles aligned along cytoskeletal filaments which function as intracellular compass needles. Current research has found that MTB are able to survive in many environments and demonstrated their ability to travel through micro-vessels while under both flow and viscous stress. Some studies show the ability of MTB to bond with therapeutic agents, so they can act as natural nanocarriers, but their specific survivability in the human body still needs to be determined. To investigate MTB survival in the human body, microfluidic platforms are used to model the environmental stressors the bacteria will encounter if introduced to the blood stream. These platforms are developed using computer-aided design (CAD) tools and the designs are virtually simulated prior to microfabrication. These microfluidic platforms consist of two injection points, one for MTB and one for fluidic stressors. The MTB and fluidic stressor are combined through diffusive mixing in a long channel ending in an observation chamber. The MTB observed in the chamber, with 40x magnification, and the bacteria health is examined under varying environmental stressors found in the human body including a pH range between 4 and 8 and a temperature range of 22-40^{o}C. MTB's viability under these conditions is determined through observation of their mobility on-chip. After parameters have been set for individual stressors, a different platform is used to examine MTB behavior under multiple stressors. This platform has two injection sites from which the fluidic stressors flow through a concentration gradient generator before separating into channels where the varied concentrations of stressors diffusively mix with MTB before reaching the observation chambers where their mobility is again examined to determine viability. The concentration gradient allows for multiple stressors to be applied to a single chamber, allowing for a more accurate environmental resemblance to the circulatory system. The experiments are designed to interrogate MTB survival under the applied stressors, neglecting the effect of viscous stress.

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