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MICROFLUIDIC MAGNETIC MULTI-CELL SORTING

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ABSTRACT

We propose a cell sorting system that uses permanent magnets in a microfluidic device. Functionalized magnetic beads attached to cells and take on different trajectories based on the magnetic forces acting on them.

OVERVIEW

Many biological processes that were traditionally done in full-scale labs are being miniaturized and integrated into lab-on-a-chip devices. One important biological process is cell sorting. Presently, most microfluidic cell sorting studies have made use of on-chip sample analysis, feeding back to a system that triggers a switch in the microfluidic device [1]. A prominent example of this kind of device is the microfabricated fluorescence activated cell sorter (μFACS) [2], [3]. However, due to the off-chip components involved in these systems, such as a laser for fluorescence activation and optical switching, it is difficult to make these systems portable.

Using magnetic forces to separate particles and cells in lab-on-a-chip devices have been demonstrated before [4-10]. However, the separation has been mostly binary, removing one target from the rest. Where more than one target was removed [8], the number of targets was limited by the separation technique.

We propose a system that uses forces due to a gradient of a magnetic field to sort populations containing multiple types of cells. Different paramagnetic beads, based on their size, are coated with different antibodies. The antibodies are chosen based on the known cell-surface antigens that they bind to uniquely. The cells bind to their corresponding beads after immersing the antibody-coated paramagnetic beads in the solution of cells for a period of time.

PROPOSED DEVICE

As shown in Fig. 1, permanent magnets are embedded on one side of the separating chamber on the device. The magnetic field gradient produces a force on the beads, pulling the cells towards the magnets. Since larger paramagnetic beads result in larger magnetic moments, those cells bound to larger beads will have trajectories different from cells bound to smaller magnetic beads. Different types of cells are sorted into different outlets on the device.

We have developed a numerical model that that describes the trajectories of the cells. The magnetic force on a cell is countered by Stokesô drag. Quantifying these effects provide a rational route to the design of the device. Experimentally, we demonstrate that different sized magnetic beads travel in different trajectories and compare those trajectories with trajectories predicted by the numerical model. Our eventual goal is to demonstrate the separation of multiple types of cells by attaching the different sized magnetic beads to different types of cells and passing them through a microfluidic magnetic device.

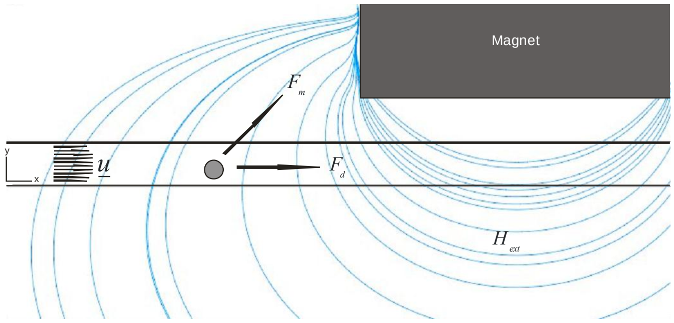

Figure 1 - Particles traveling through the fluid channel experience forces due to the magnet as well as the fluid. These forces produce the resulting trajectory.

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