Title: Microfluidic Device to Measure Effects of Substrate Stiffness, Shear Stress, and Chemotactic Gradient

Department: Biomedical Engineering

The purpose of this project is to create a low cost microfluidic device that will allow researchers to simultaneously test cells’ responses to varied shear stress, chemotactic agents, substrate stiffness.

The current design features multiple cell-holding chambers. The sizes of these chambers will be varied to produce different shear stresses when all of the chambers are connected to the same micro-pump. There will be two chambers of the same dimension paired together for each chamber size so that different substrate stiffness can be simultaneously tested. A chemotactic agent will be applied through a Y junction where a chemical agent will be injected on each side of the chamber. Cells will adhere to the substrate coating the chamber, and their response to their environment can be analyzed using a fluorescent microscope.

This device is innovative in that it will be the first microfluidic device that allows for simultaneous testing of the effects of shear stress, chemotactic gradient, and substrate stiffness. Simultaneous testing will allow researchers to investigate cellular responses to complex environments as to mimic the human body. Cells respond to a variety of signals and factors, and their response to one signal may depend on the presence of others. This device may also contribute to research on cell-sorting methods due to testing of both shear stress and chemotactic gradient. Because this device will be affordable and replicable, it will possible for other labs to purchase this device like a kit and perform their own testing.

Testing cellular responses to changes in substrate stiffness in addition to shear and chemotactic agents may also contribute to our understanding of how cells in different parts of the body respond to changes. This device could also be relevant to vasculature research and cancer research. Tumors are typically composed of dense, stiffer tissue than its surrounding environment, and cells on the tumor border may have altered behavior due to the increased stiffness and other signaling factors.

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