Memorandum

Ben Gerber
1 May, 2018

Review of Printhead Problems and New Design Proposal

The microfluidic printhead that our group started off with at the beginning of Fall 2017 was designed as a vertical fluid delivery system for cells and new media. We believe it was based on the premise that the cells would settle at the bottom with the right flow rate. This did not happen. The particles would get trapped in the flow stream and not deposit. This is what we were trying to solve. The thought was perhaps new geometry of the wells would allow the flow to be more turbulent, and the cells would be able to break free of the stream.

After much time spent reviewing literature on turbulent flow and learning about flow equations, Stoke’s Flow, the Dean Vortex, and many other microfluidic principles, I deemed this was not possible. The problem was the fact that the printhead uses a design called the Wasatch design. I used COMSOL to simulate the Stokes Flow through the printhead using different flow rates and geometries based on this Wasatch design. COMSOL is not good at particle inside of fluid modeling for microfluidics, so I used the method of 2D flow simulation for our given geometry. Over the course of the simulations analyzed for velocity vectors, it became very apparent that there was not enough turbulence for the cells to break out.

My memorandum “Status Report of Literature on the Subject of Microfluidic Fluid Flow” goes over the further problems with fluid flow in the Wasatch design. It describes techniques to achieve turbulence that could allow the cells to break out, and the problems with design and manufacturing that make this improbable.

John-Luke Singh developed new ideas in conjunction with others in order to make a new design that could work. Right now we are in the early stages of testing this, and more tests will occur after the wait for the new test chips to be manufactured before analyzing the flow inside of them. The design is called an “aneurysm” design where the fluid flows in the middle of a circle an then up each side. The reason this could work for our cause is that the most prominent flow force would be in the middle of the well. Then, the flow rate cuts approximately in half in order to flow back up each side to 2 different ouputs. This could solve the problem because not only will turbulent flow be created when the fluid hits the bottom of the circle, but the cells would be less likely to get carried away because of the combination of gravity and the reduced upwards fluid force. This could also be more easily manufactured on the reusable well level with a new printhead design could incorporate everything we may want.

It seems as though the current printhead is not the route to continue on, and that time may be very well spent on the new Aneurysm design, and testing fluid flow through it.