Memorandum

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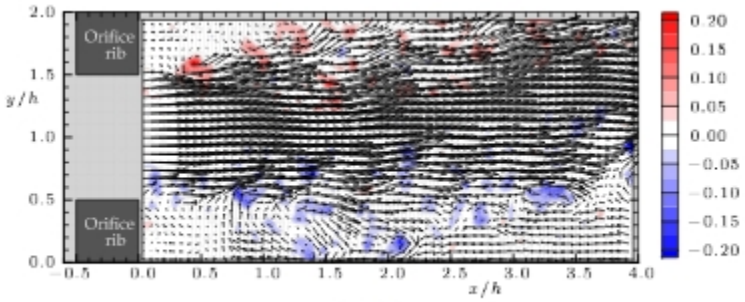
Status Report of Literature on the Subject of Microfluidic Fluid Flow

Over the spring semester, I have looked into different well geometries that could possibly be used to deposit cells with our current cell printhead. I had to take into account manufacturing of the well in order to get turbulent flow. All of the papers are referenced at the bottom of the spring learning objective page on the previous site.

There were multiple iterations of designs throughout the semester as far as fluid flow goes. We experimented with the Wasatch Design. This design is the only design that could be used with the current print head. This is because of the inlet and outlet geometry of the current printhead.

One thing that could induce turbulent flow and cause cells to stick together is using a gated opening such as in the paper "Turbulent Flow of Viscoelastic Fluid Through Complicated Geometry" (Tsukahara et al.).



(a) Water

The gate creates a nice turbulent flow along the sides of the chamber that could cause cells to collect into spheroids. The problem with trying this geometry is actually because of manufacturing. The only process that I could devise for creating this would to be a two-part agarose mold that would be able to stick onto the well plate that the print head could press into to create a gate. This would be nearly impossible to prototype using hand-alignment. We couldn't do it in one piece because 3D printing a mold will rip apart the agarose gel upon removal.

The second area I explored was creating mixing vortexes primarily used for mixing compounds. The idea was that a slanted well under a centripetal force would create eddy currents and dean vortexes in order to mix the compounds. My theory is that this could be used under stationary conditions to create a smaller pressure differential in order to create a gentle enough vortex to clump the cells without tearing them apart. Our Wasatch designs including different geometries according to a number of papers on mixing would not work because without a rotational force, vortexes could not be created. This is shows by 2D fluid simulations on the different geometries specified in "Appraisal of Fluid flow in A shaken bioreactor with conical bottom at different operating conditions" (Rodriguez et al.) in a separate document on this site: http://www.benjamingerber.org/learning_objectives_spring.html

Altogether I have learned many more things about fluid dynamics in microfluidic environments and what wouldn't work.