Next Generation Organ on Chip Platforms

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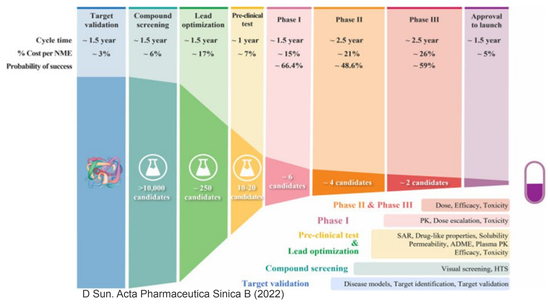
Abstract

Organ on chip platforms are used to investigate and answer biological questions. Cells are cultured into these devices, which model human organs. These chips are used by researchers as tools to more accurately mimic biological functions and their processes *in vitro*. For example, intestinal cells cultured on the chip mimic the organ's barrier function and regulate the diffusion of nutrients. This project's goal is to measure and compare the diffusion of particles across a membrane, which is similar to the intestinal barrier, using varied geometries. We will achieve our goal using the laser cut and assembly method to produce chips layer by layer with unique geometries. The chips will then be assembled and flow tested using a syringe pump. Flow data will be collected to analyze the effect of chip geometry on diffusion rates. The newer designs will be compared to control designs that are previously published. Our preliminary testing may give a better understanding of how diffusion occurs in organ chips, which can help with better predictive models of processes in the human body. In the future, this will enable engineers to create improved chips that can eventually be used for pre clinical testing. The new design of high throughput organ on a platform chips displayed no significant difference in diffusion. The length of membrane even with an equal area between all of the experimental nd control groups, demonstrated mitigating force. We designed two new geometrrys for the membrane and kept inlet area the same, to build an engineering process to investigate a varble and demonstrate the iterative design process of PET/PMMA Organ - Chips.

Background

- Organs on chips are used to help with pharmaceutical testing during pre clinical and lead optimization in the pipeline opposed to testing using mammals.
- They are used to model biological problems



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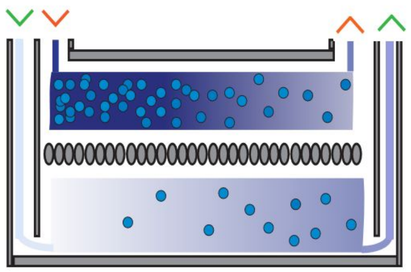
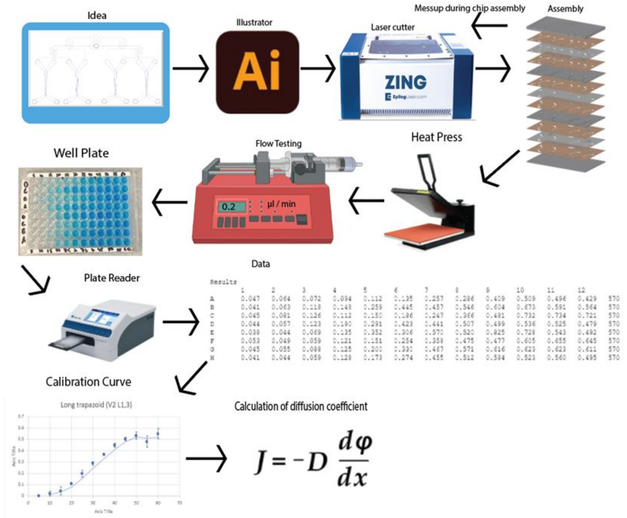
- They are two flow channels that are divided by a membrane.
- In biological applications, cells can be seeded on top of the membrane.
- The driving force of diffusion is the concentration gradient



Experimental Methods



Assembly process:

- Adobe illustrator for design
- Laser Cutter for chip layers
- Heat Press to finalize

Testing process:

- Flow testing using a syringe pump
- First test with water
- Final test with water and blue food coloring
- Ran well plate results in a plate reader

Materials:

- Water
- FD&C Blue #1
- 1 µm membrane
- 3/16 PMMA
- 3M tape
- 1/16 PET

Results

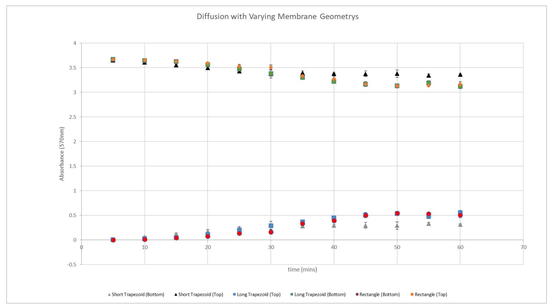


Fig 1. Both experimental groups (Short / Long) trapezoid and positive control (Rectangle) plotted based off average absorption of (570 nm) wavelength on a plate reader. Technical replicates (N = 2) for experimental conditions while (N =3) for positive control. Although steady state of the short trapezoid was 57% less than both the control and the long trapezoid, statistical t-test yielded ($p = 0.1275$) ($p > 0.05$) deeming our data insignificant.

Conclusion and Future Steps

Conclusions:

Our demonstration of the user experience conveys the engineering design process for high throughput chips. We investigated a small property, diffusion, which pertains to a larger biological technology. The geometry of our membrane overall displayed statistically similar diffusion between the long trapezoid experimental group compared to the control group. The short trapezoid chip reached steady state quicker than any other design, although the peak absorbance was less. Length of membrane between those groups was 21.7488 and 12.975. Each experimental group possessed runs equal (n =2). The length of the membrane displayed a correlation in absorbance during steady state; the short chip displayed a lower steady state absorbance. We theorize a couple potential fluid mechanical factors.

Future steps:

When building the engineering design process for this experiment , several extensions were omitted. For example, we wished to run computational fluid dynamics to better assess the mass transfer properties and the bulk transport area especially for our trapezoid designs. In the general implication, we focused on the iterative design process.

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