Project Plan (Version 1)
EE491 - Senior Design

Studying cell behaviors in 3D microtissues using a LabChip

Advisor: Long Que
Client: Long Que

The team - May1634

Role	Group Member
Team Leader	Jonathan Yatckoske
Team Webmaster	Yaxiong Zhang
	Chun-Hao Lo
Team Communication Leader	Yuqian Hu
Team Key Concept Holder	Kaiyu Xu

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Project Statement

This project is to use a LabChip suitable for studying the cell behaviors in 3D microtissues, mimicking the tissue in human body. We will perform systematic studies of the migration of one or multiple cells in arrayed 3D microtissues formed by a polymer microfluidic chip developed in the lab.

We will make videos of the experiments, and then analyze the videos to study the migration trajectory of the cells in the microtissue in the microfluidic chambers. The analysis will be done using a Matlab program.

System Requirements

- ## Project Requirements

We must design experiments to study cell migration in microtissues and make videos of the cell migration using the optical microscope and provided software.

We must develop a Matlab program to identify and track the location of one or multiple cells in the droplets stored in the device chambers. The program must identify the number of cells in the chamber, collect location data and produce plots of the migration trajectory of the cells, as well as calculate velocity, distance traveled, and displacement of the cells.

We must then use the Matlab program we developed to analyze the data collected from the experiments we designed.

- ## Microtissue vs. Macrotissue

Traditional cell studies are done using large amounts of cells, in the range of hundreds to thousands of cells in a container. This is useful for studying cell behavior on a large scale, but doesn't provide much information on single-cell behavior.

The device we will be working with addresses this issue, allowing the storage of a single cell per chamber. Isolating single cells or just a few cells per chamber allows for the study of single cell movement.

- ## Validation Test

  There are other analysis methods for these kinds of experiments. One goal of our project is to improve on these other methods. We can verify the functionality and performance of both the design of our experiments and the design of our Matlab program by comparing our results to the other analysis methods. Our results should at least meet, but preferably exceed, the accuracy of the other methods.

System Description

- ## Design specification

  Each chamber of the microfluidic device contains one droplet with one or a few cells in microtissue. In the images, the cells appear a different color than the microtissue around them. If the cells don't stand out enough, we can use a fluorescent dye to make them appear red or green, making them easier to identify.

  The image of the chamber will be recorded every 1 or 2 minutes, creating videos over a long duration with a low frame rate. The frames of these videos will be the input to our Matlab program.

  The Matlab program will identify the location of the cells by looking for the expected color of the cells, and will store the coordinate data for the cells in each frame. The program will then use the coordinate data to plot the migration of the cells, convert the coordinate data to distance units suitable for analysis, and convert the frame rate and frame index data to time units suitable for analysis.

- ## Technical approach

  The more videos we can collect of the experiments, the more data we have to work with, and the more data our Matlab program is capable of handling, the better our results will be.

- ## Process details

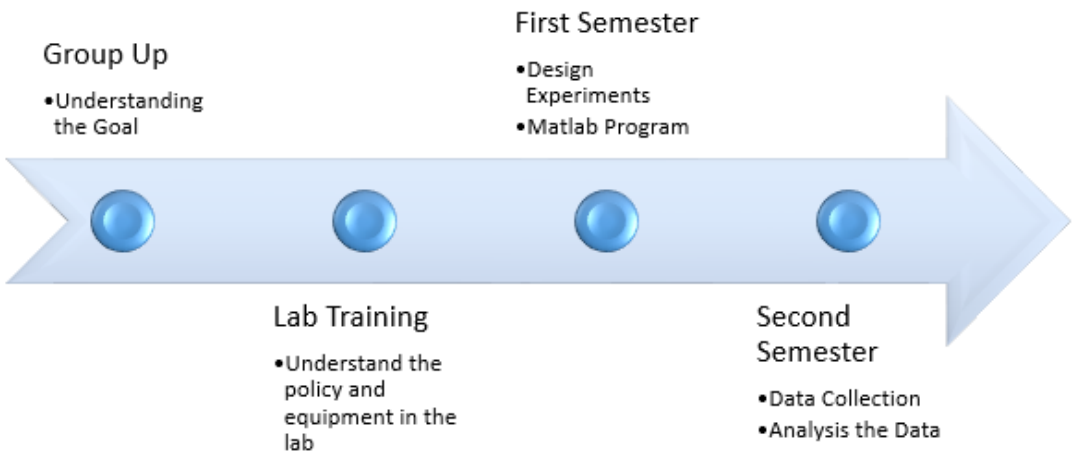
  1. Image the migration of cells in microtissues using optical microscope.

  2. Plot the migration trajectory of the cells using our Matlab program.

  3. Analyze the effect of density and composition of microtissues on the cell migration.

Work Breakdown

Project Schedule



A more detailed project timeline will be developed.

Risks

Accuracy:

There are concerns that the final product might not be as accurate as what our client wants. Our method and program must improve on the other methods, or it will not be accurate enough for our client.

Software feasibility:

The software that we are using might not be capable of actually tracking the target cell.

Licensing:

Might need access to additional software, and access to resources in ECpE teaching and research labs.

Data and Results:

We might have problems in analyzing data and the amount of data being processed is unexpected. The test code we come up with might not be able to actually track cell migration. We must be able to improve our program and method to handle the amount of data we collect.

- ## Cost

  Anticipated Cost: $1800

  Financial Resources Provided by Client: $1000

  We will likely need to purchase items to perform the experiments, such as collagen, cells, syringes, etc. We will also likely purchase items to improve the experiments, such as the fluorescent dye. We have not yet determined the quantity or costs of these items. We will develop a more detailed cost breakdown soon.

- ## Market

  This research is important for understanding cell behavior. Understanding cell response to the Extracellular Matrix and how cells communicate is critical to gaining insight for human diseases.

Conclusion

By monitoring the movement of cells in microtissues in the microfluidic device, we get some basic understanding of the cells' responses to the extracellular matrix and how cells communicate.