Project Title: Development of Bioelectronic Scaffolds for Hybrid Brain Tissue
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Project Description:
Bioelectronic devices embedded within the hybrid, engineered tissues could provide stable, long-term readouts of tissue function. We will achieve and optimize flexible, porous scaffolds that provide signals from up to 32 spatially-distinct locations. We will then embed these scaffolds within a 3D brain tissue model to obtain readouts of neural activity. Time permitting, we will apply algorithms to quantify changes in synaptic connectivity over time.

Engineering Design Elements:

1. *What are the objectives of the project and the criteria for selecting them?*

   The objective of the project is to embed a bioelectronic device into a 3D brain tissue model. We plan for the scaffold to grow around the bioelectronic device. Once this is accomplished we expect to be able to measure neural activity.

2. *What system, component, or process is to be designed?*

   A novel hybrid brain tissue that contains a bioelectronic embedded into the tissue. We are tasked with figuring out the best way to embed and track signals for the neurons in the hybrid tissue.

3. *What need does it fulfill (clinical, research, etc.)?*

   Allows for monitoring of electronic signals in live organoids, specifically in brain tissue. The monitoring is essential for understanding tissues that have systemic signalings such as cardiac tissue or brain tissue. Using the bioelectronic chips will allow for the creation of tissues that are more representative of actual tissues.

4. *What scientific, math, and/or engineering methods will be applied?*

   Currently, we are still exploring which methods will be applied for the integration of both parts of this project. We will be using soldering to connect the bioelectronic device to the PCP board to measure the voltage of the neurons.

5. *What realistic constraints (cost, safety, reliability, aesthetics, ethics and social impact, etc.) are to be considered?*

   Considering that individually both components of our project are well reviewed and established constraints are mainly surrounding the integration of the two components. This will be the first time evaluating so we will have to evaluate the constraints throughout our project.

6. What alternative solutions or changes to the plan will be considered?

We have considered embedding the bioelectronic prior to the scaffold being salt leeched, so we won't have to worry about the adhesive working well or degrading over time.

7. <u>What are the planned tests and what are the quantitative milestones that will demonstrate the achievement of the objectives?</u>
   Do a comparison of scaffold degradation with and without the device.
   Immunostaining and images to see neurons. We would also conduct a neural activity assay.

8. <u>Competition: what else is going on in the field that would compete with the project plans?</u>
   As of right now, there is no competition in this field. The combination of both the bioelectronic device and the tissue model is new to the field.

Introduction/Background:

The bioelectronic sensor we plan to use for our projects is a flexible scaffold that is designed to interface with neural cells. The sensors record real-time electrophysiology of electric active tissue. These readings allow us to characterize action potentials and cellular networks. Additionally, we can monitor ion channel states, and evaluate neural pathways. Specifically, the sensor is attached to a multielectrode array that was designed in the Timko Lab. The multielectrode array is rigid so it will not contour to the tissue meanwhile the sensor is flexible to allow for it to integrate with the active tissue, promoting cell-to-cell communications. Our main focus is the integration of the hybrid brain model. Separately these two innovations are well known and researched however it's unknown how these would work together jointly. We expect that sandwiching the scaffold around the sensors would promote the growth of neurons around the sensors. However, there is not much research on hybrid model integration.

Methods:

Exp 0 Make the scaffolds and implant them into devices without neurons.

1) Create silk scaffold donuts.
2) Prepare the flexible bioelectronic device.
3) Cut silk scaffold in half and input the bioelectronic
4) Use a surgical adhesive
5) Put in media and observe and compare degradation or lack of degradation of the scaffold.

Exp 1 Culture seed scaffold and make sure it is viable without bioelectronics and then also with bioelectronic.

- After seeding the differentiated neurons into the scaffold we will perform cell viability assays to see how neurons are functions and compare

Exp 2 Take some images to characterize the neurons' immunofluorescence and imaging etc.

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Exp 3 Gather signals from scaffold and neurons and perform more assays

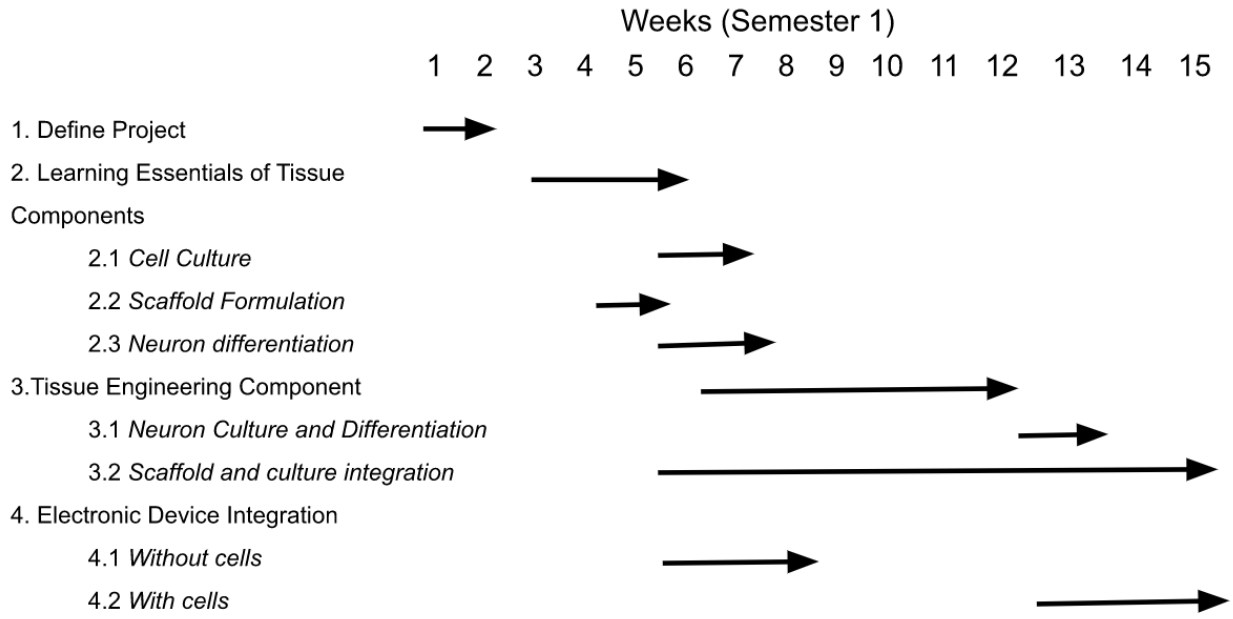
- See how the neurons signal each other

Results (future):
N/A

Discussion (future-work):
N/A

Participation:
We all are working together as much as possible on the project. We all worked together in order to fabricate the silk scaffolds.

Timeline:



https://docs.google.com/spreadsheets/d/11EqXJm2wkq5sWpO5xjxVH6rW2BIjKb9tk5Pm3v98FZc/edit#gid=0
(link to live timeline which we will add more aims and update)

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