

Multi-chamber culture insert for connected neuronal aggregates

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Client: Dr. Jason Brant

Advisor: Prof. Mehmet Orman

Team:

Greta Mahlke	gmahlke@wisc.edu (Co-Leader)
Eli Von Holtum	evonholtum@wisc.edu (Communicator)
Sam Brandt	sdbrandt@wisc.edu (Co-Leader)
Safia Syed	ssyed23@wisc.edu (BSAC)
Sri Krishnan	skrishnan32@wisc.edu (BPAG)
Sophia Mazer	smazer@wisc.edu (BWIG)

Problem statement

Common devices used in biological research, including well plates and petri dishes, are readily accessible, provide easy platforms for addition of cells, media, and reagents, and allow for observation using standard laboratory microscopes; however, they fail in their ability to model the complex physiological environments of the human body. In recent decades, there has been a large push toward the development of microphysiological systems used for research, for example, the Organ-on-a-Chip platforms. The ability to model complex tissue environments is incredibly important for the study of the auditory pathway because of its dynamic environment. 2D systems completely isolate cells from the complex physical forces, specialized microenvironments, and 3D neural networks that are vital to the transduction of sound to the brain. The multi-chamber culture insert device provides a more dynamic platform to study the growth and interactions of neuronal cell bodies on a 3D platform. The device allows for growth and interaction of neuronal cell aggregates in a structured manner. The device separates a well plate chamber into distinct sections each holding a neuronal aggregate. The device allows for growth of neurons between chambers, but separates the media in each chamber, allowing for independent treatments of aggregates.

Brief status update

The team met and discussed brainstormed design ideas and decided on 4 to move forward with. The team met with the client on 9/23 to discuss PDS, progress, and design ideas. The 4 designs were evaluated in a design matrix and a design was chosen to move forward with based on criteria discussed below.

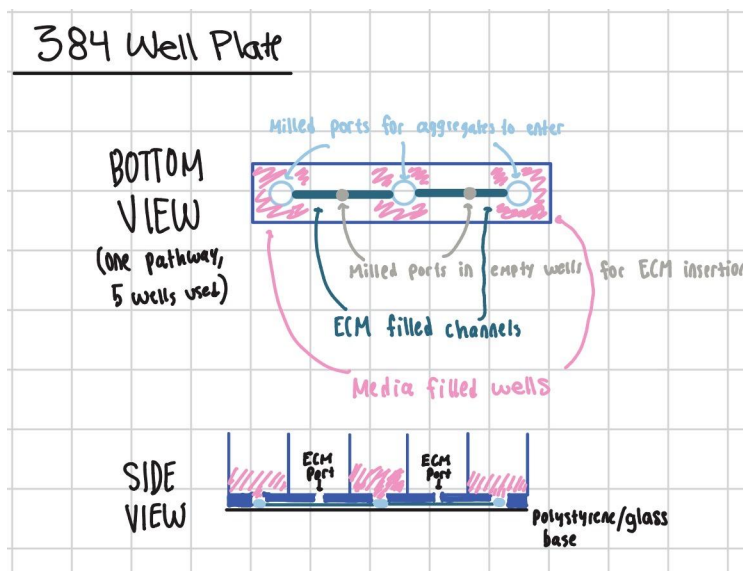
Difficulties / advice requests

- N/A

Current design

Design Criteria (Weight)	Glass slip w/ PDMS Cover		Milled Well Plate		PDMS w/ divots for agarose tubes		Campanot Inspired	
	Raw Score (X/5)	Weighted Score	Raw Score (X/5)	Weighted Score	Raw Score (X/5)	Weighted Score	Raw Score (X/5)	Weighted Score
Aggregate Stability/Positioning (30)	3/5	18	5/5	30	4/5	24	2/5	12
Media Isolation (25)	3/5	15	5/5	25	3/5	15	2/5	10
Imaging Ability/Cell Recovery (20)	4/5	16	5/5	20	2/5	8	3/5	12
Ease of Use (10)	4/5	8	4/5	8	3/5	6	5/5	10
Ease of Fabrication/Reproducibility (10)	3/5	6	2/5	4	3/5	6	5/5	10
Cost (5)	4/5	4	1/5	1	5/5	5	4/5	4
Total (100)	67		88		64		58	

The team brainstormed 4 distinct design ideas, which were evaluated based on the following criteria in a design matrix: aggregate stability/positioning, media isolation, imaging ability/cell recovery, ease of use, ease of fabrication/reproducibility, and cost. These criteria are described more in detail in our design matrix document. Our design matrix is pictured above. We ultimately decided to move forward with the milled 384 well plate, pictured below with a top view and cross section of one aggregate network.



Materials and expenses

Item	Description	Manufacturer	Mft Pt#	Vendor	Vendor Cat#	Date	#	Cost Each	Total	Link
Category 1										
									\$0.00	
									\$0.00	
Category 2										
									\$0.00	
									\$0.00	
								TOTAL:	\$0.00	

Major team goals for the next week

1. Complete preliminary report
2. Complete preliminary presentation

Next week's individual goals

- Greta
 - Complete preliminary report
 - Complete preliminary presentation
 - Continue research on fabrication and biology aspects of the project.
- Eli
 - Complete preliminary report
 - Complete preliminary presentation
 - Continue research
- Sam
 - Complete preliminary presentation
 - Work with team on presentation skills and rehearsing presentation
 - Continue research into fabrication methods
- Safia
 - Continue research on the already brainstormed fabrication methods
 - Research other possible methods and already existing devices
 - Complete preliminary report and presentation
- Sri
 - Do some research on the silicone grease and its properties for Campenot-inspired insert
 - Work together with team on preliminary presentation and report
 - Help enhance designs for future fabrication
- Sophia
 - Look into less costly options
 - Complete preliminary report and presentation
 - Continue research on possible fabrication methods

Timeline

Task	Sept				Oct					Nov				Dec	
	4	11	18	25	2	9	16	23	30	6	13	20	27	4	9
Project R&D															
Empathize	X	X	X												
Background & Research	X	X	X	X											
Preliminary Designing				X											
Final Design Prototyping															
Testing															
Deliverables															
Progress Reports		X	X	X											
Product Design Specifications			X												
Design Matrix				X											
Prelim presentation & Selection of Final Design															
Show and Tell															

Final Poster															
All Deliverables Due															
Meetings															
Client			X	X											
Advisor	X	X	X	X											
Website															
Update	X	X	X	X											

Filled boxes = projected timeline

X = task was worked on or completed

Previous week's goals and accomplishments

- Greta
 - Brainstorm preliminary designs
 - Meet with team to share design ideas
 - Evaluate designs in design matrix
 - Continue research on potential materials and methods of fabrication.
- Eli
 - Create preliminary designs
 - Evaluate preliminary designs in design matrix
 - Continue research
- Sam
 - Create individual design ideas
 - Meet with team to share preliminary designs
 - Evaluate preliminary design in design matrix
 - Continue research
- Safia
 - Continue to gain more understanding about the fabrication process and the different ways of doing so.
 - Brainstorm and create initial project designs.
 - Meet with the team and client to collaborate on design ideas, and narrow down possibilities.
 - I did research and now understand more of some of the fabrication methods.
 - Met with the team twice this week and client once, resulted in narrowing down some device designs.
- Sri
 - Continue research on microfluidic devices and ergonomics aspect of it
 - Use research to develop 2-3 ideas, regroup and discuss our ideas with one another
 - Review client slides/guidelines to understand the research better
- Sophia
 - Brainstormed and roughly layout design ideas to meet with team and client
 - Continue research on possible fabrication methods
 - Evaluate designs

Activities

Name	Date	Activity	Time (h)	Week Total (h)	Sem. Total (h)
Greta	9/19	Researched background articles and materials for fabrication and came up with 3 design ideas to bring to team meeting on sunday	2	5.75	14
	9/20	Met with team to discuss designs	2		
	9/23	Met with client to discuss progress	1		
	9/23	Completed design matrix with team	0.25		
	9/23	Created preliminary fabrication protocol for milled well plate device	0.5		
Eli	9/19	Brainstormed four preliminary designs to bring to team meeting	2	5.75	12.75

	9/20	Met with team to discuss designs	2		
	9/23	Met with client to discuss PDS and preliminary designs	1		
	9/23	Completed Design Matrix w/ team	0.25		
	9/23	Research the use of plasma treatment for bonding of polymers	0.25		
	9/24	Conducted research on neuronal cell culture	0.25		
Sam	9/20	Individually brainstormed preliminary designs for team meeting	1	6.25	13.5
	9/20	Met with team to discuss designs	2		
	9/21	Researched an adhesive that we could use to fabricate our device.	1		
	9/23	Met with client to discuss designs and get feedback	1		
	9/23	Met with team to discuss design matrix	0.25		
	9/24	Researched a micro milling protocol	0.75		
	9/24	Worked on design matrix	0.25		
Safia	9/20	Met with the team to share, brainstorm, and narrow down preliminary design ideas.	2	6.25	13
	9/23	The team met with the client to share and explain preliminary design ideas to get feedback and more information.	1		
	9/23	Completed design matrix	0.25		
	9/23	Researched the use of milling, how it works, and benefits with cell cultures. Also how it works with PDMS. Then I wrote a research response.	2		
	9/24	Researched other microfluidic systems with cell culture chambers, and wrote a response.	1		
Sri	9/19	Drafted preliminary designs to share with team, helped develop understanding of project more	1.5	6.5	14
	9/20	Met with team to look over designs and pick top 3 designs, got started on the design matrix	2.5		
	9/23	Met with client to discuss design options	1		

		and got clarification on questions			
	9/24	Researched about microfluidic systems and specific structures, learned more about silicone grease	1.5		
Sophia	9/19	Researched and drafted a few preliminary designs with modifications.	2	6	13.75
	9/20	Met with the team to discuss designs and goals, as well as set up possible design matrix categories.	2		
	9/23	Researched organ on a chip technology Met with client to discuss design options and PDS.	2		