Microfluidic droplet generator for lymph node microphysiological models

Progress Report 10

Date: November 6th, 2026 - November 12, 2026

Client: Dr. Cristina Sanchez de Diego

Advisor: Prof. Monica Ohnsorg

Team:

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Project Website: Link

Problem Statement: Prostate cancer (PCa) commonly metastasizes through the lymphatic system. Understanding how cancer cells spread through lymph nodes is therefore critical to developing therapies that can prevent or limit metastasis. However, current lymph node models primarily represent tissue in two dimensions and cannot fully replicate its complex three-dimensional structure and cellular interactions. This project aims to fabricate a microfluidic droplet device capable of producing B- and T-cell-containing collagen microspheres, which will serve as building blocks for a realistic 3D lymph node model to more accurately study cancer metastasis.

Brief status update: The team learned cell culture and sterile technique for handling immune cells at WIMR. Dr. Sanchez de Diego will be leaving for the rest of the semester, so she showed the team where all of the necessary equipment was and provided us with the necessary protocols. The team has also fabricated a cooling sleeve for the syringe to prevent premature polymerization of collagen.

Current design: SolidWorks Mask Design

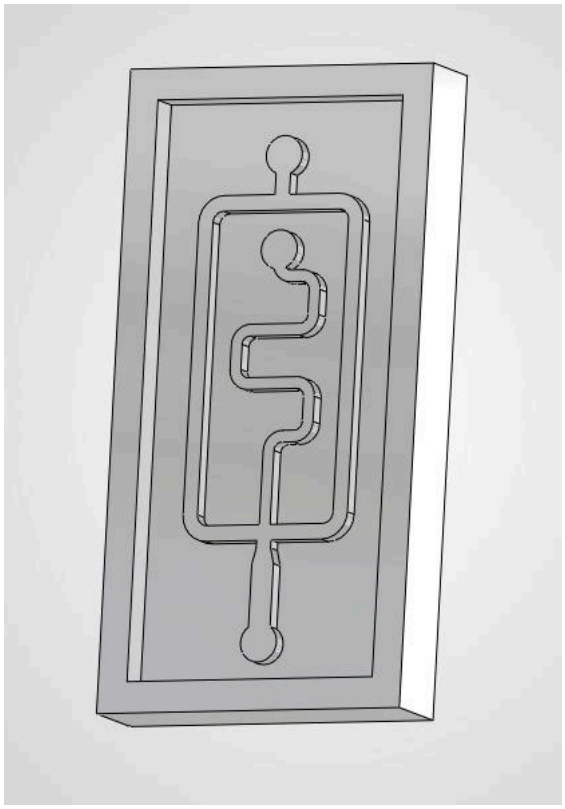


Figure 1: Current Microfluidic CAD design for 0.5uL Droplets

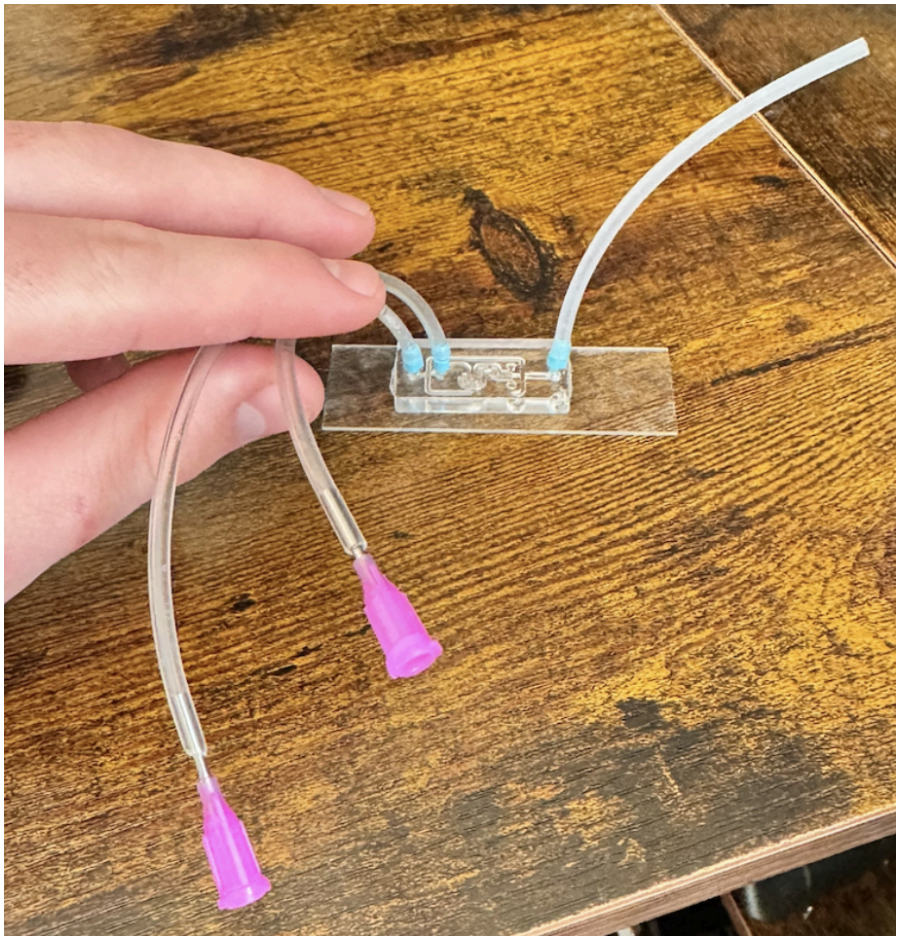


Figure 2: Assembled Microfluidic Device



Figure 3: Experimental Setup

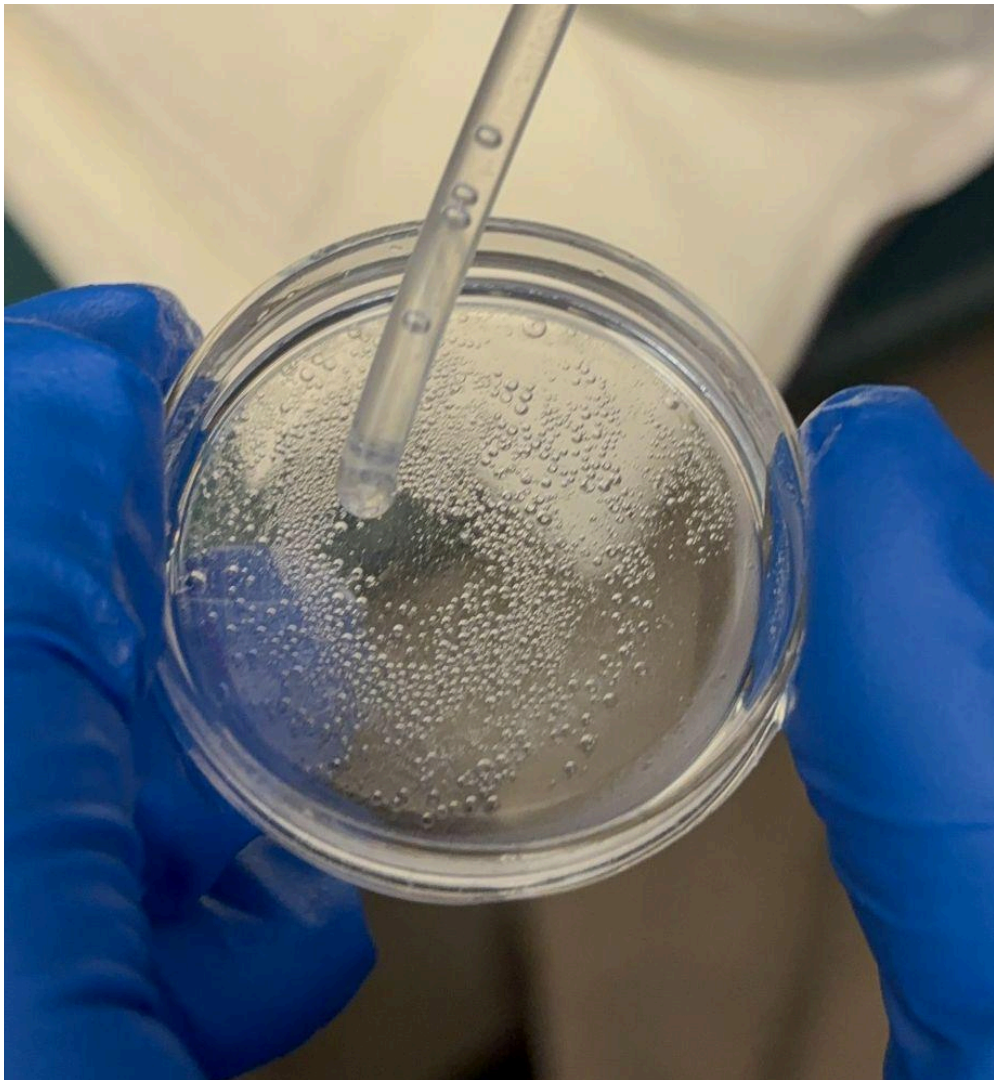


Figure 4: Collagen Microspheres

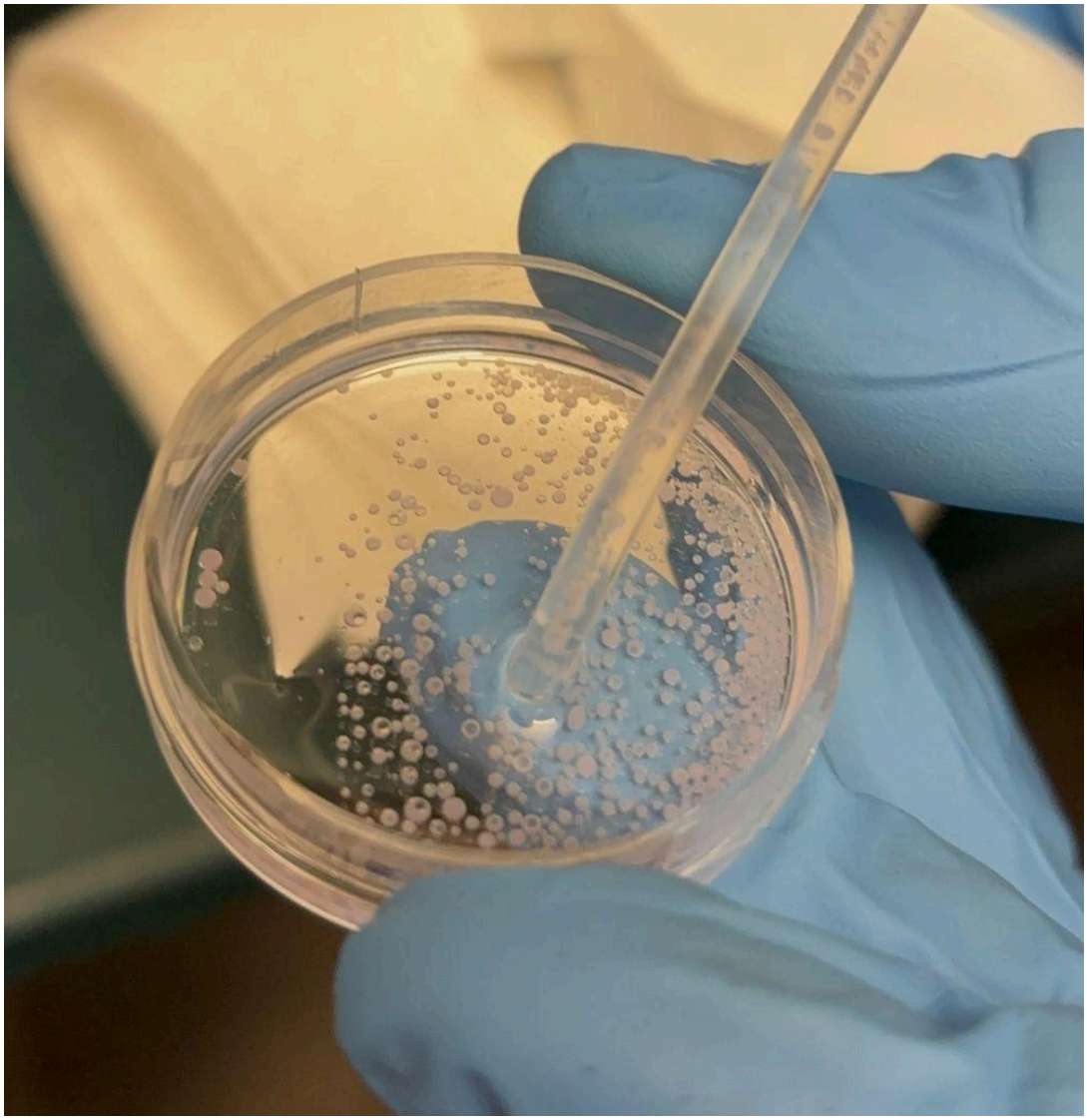


Figure 5: Collagen Microspheres with Fluorescent Beads Added

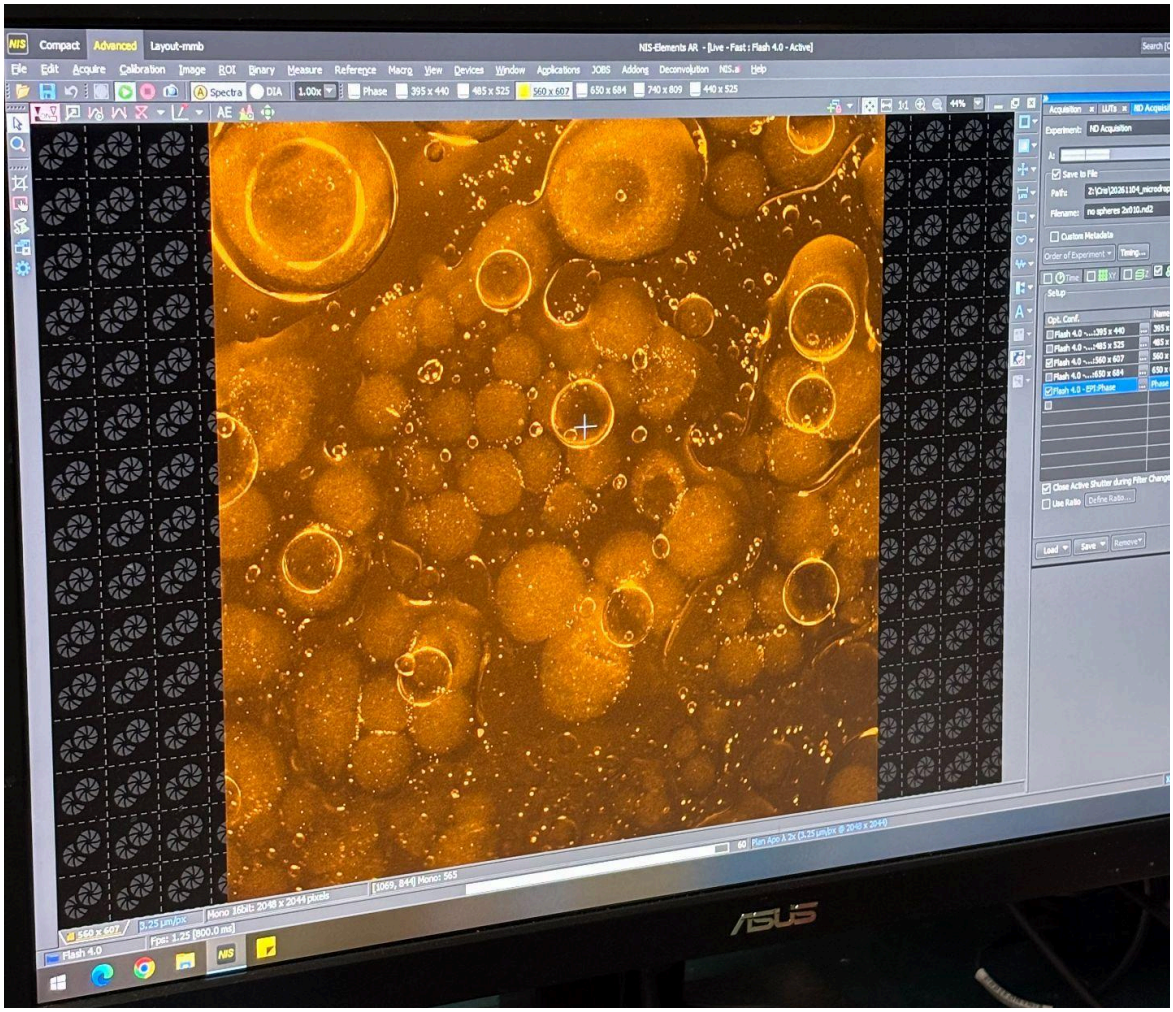


Figure 6: Collagen Microspheres with Fluorescent Beads under the Fluorescent Microscope

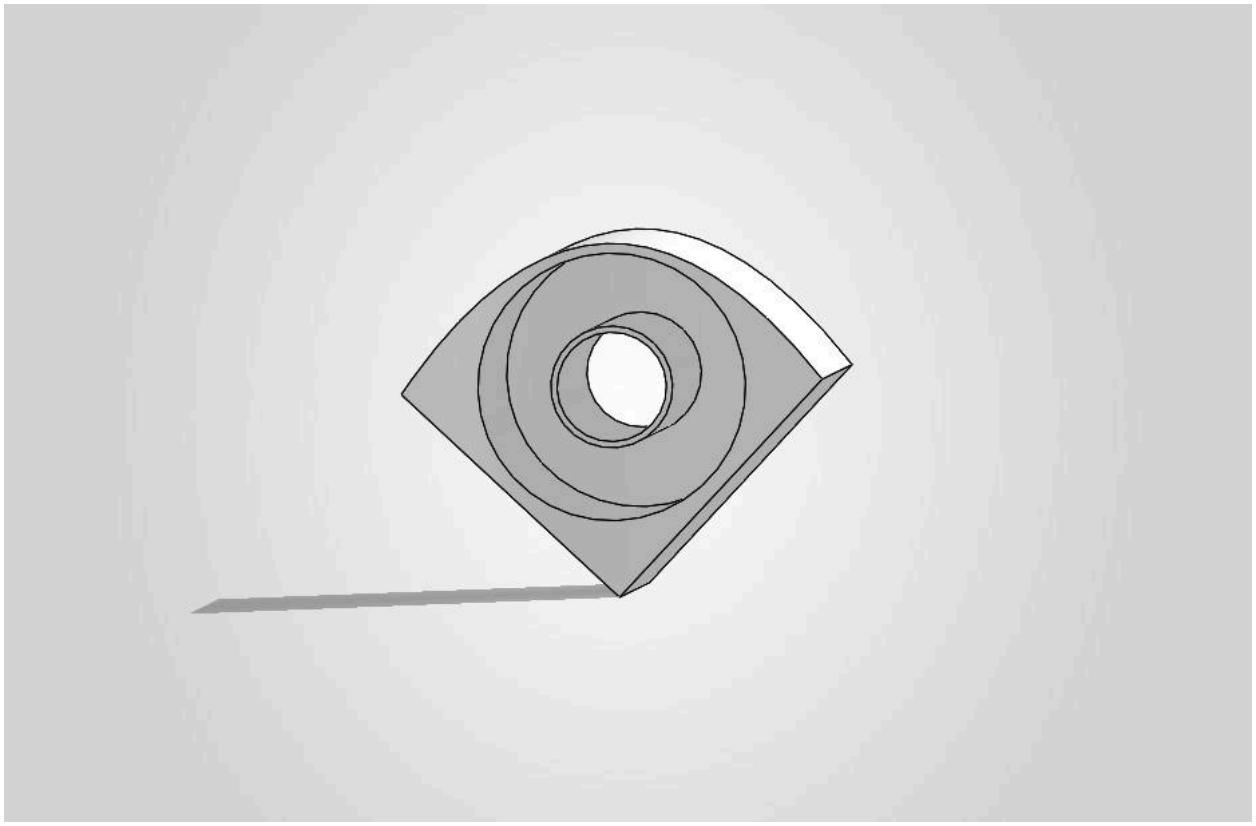


Figure 7: SolidWorks Drawing of Syringe Cooler

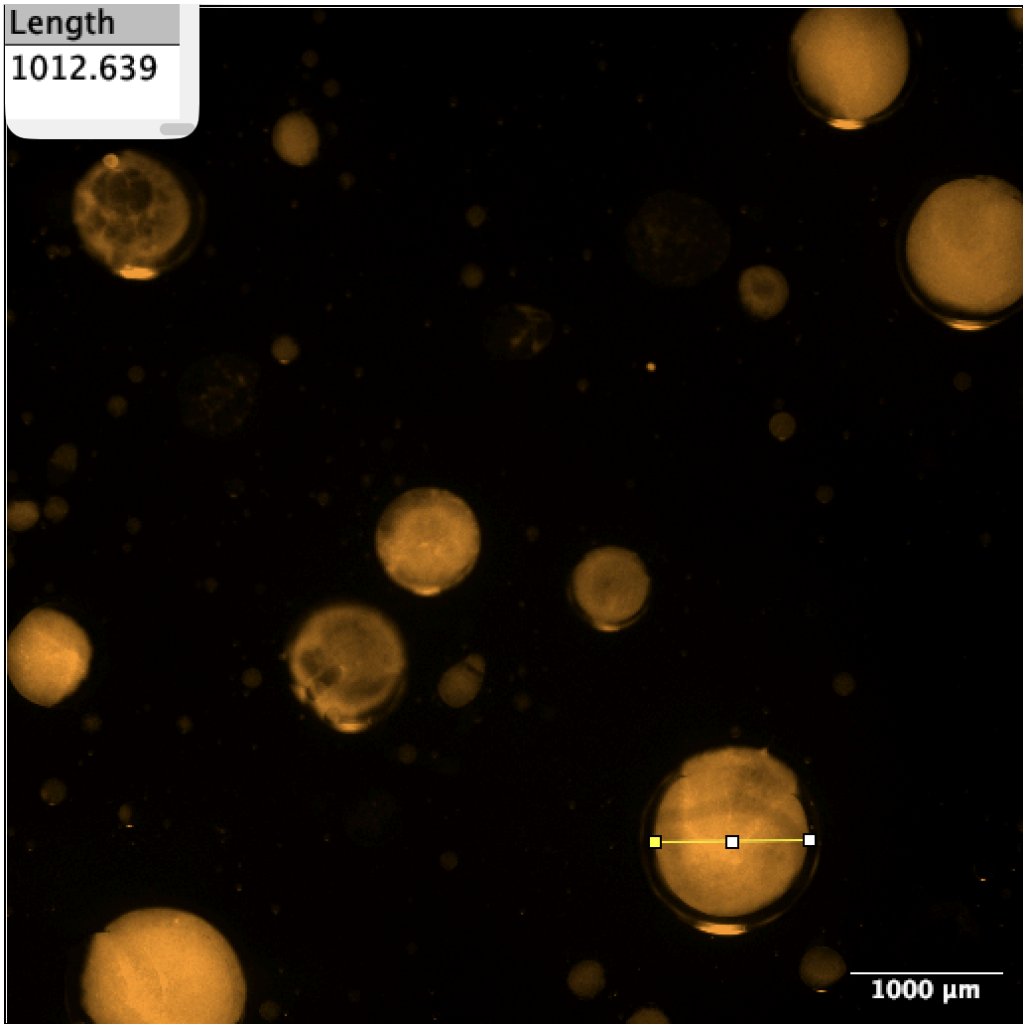


Figure 8: FIJI Quantification of a Single Collagen Droplet

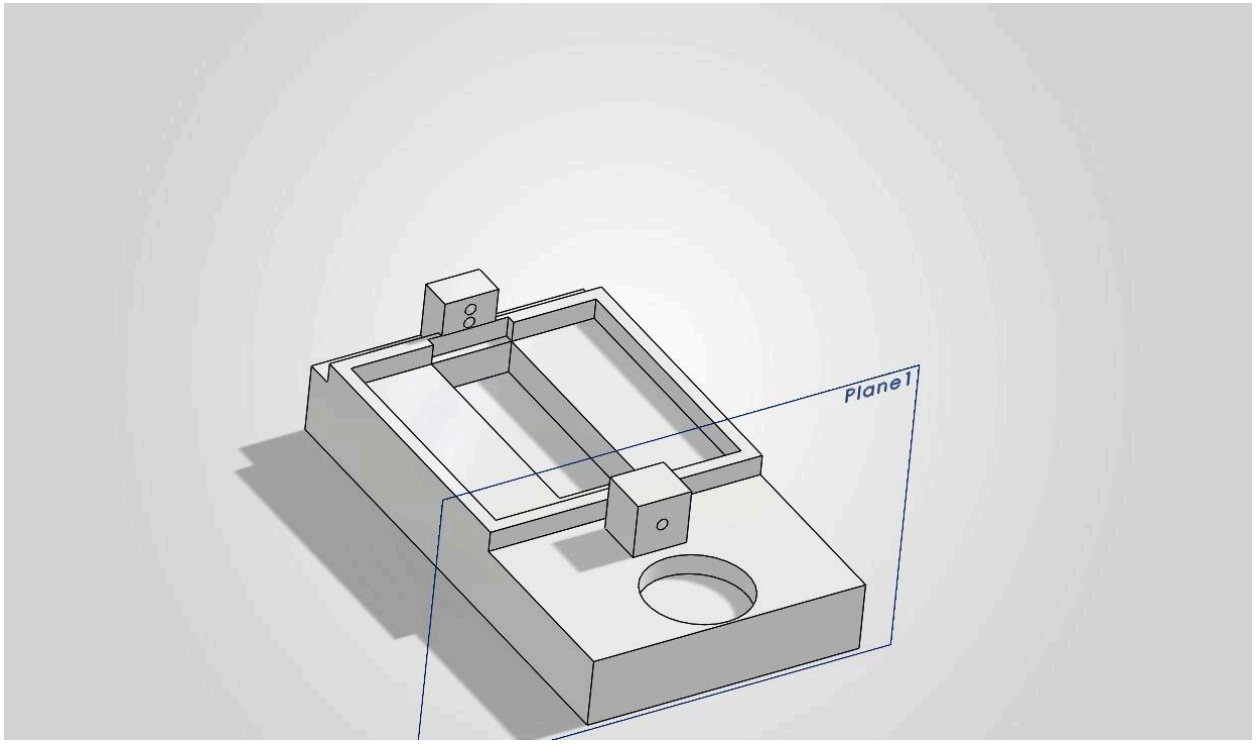


Figure 9: Petri Dish & Tube Holder

Previous Week's Accomplishments

- Sam Kamin (4 hours)
    - Went to WIMR to learn about cell culture and sterile technique from Dr. Sanchez de Diego
    - Continued researching more methods for improving the setup from relevant microfluidic laboratories
- Murphy Diggins (4 hours)
    - Created SolidWorks part for a syringe cooling mechanism
    - Fabricated multiple PDMS devices

    - Fabricated Petri Dish & Tube Holder

- Will McGuire (6 hours)
    - Created two solid works designs with seeping throughput mechanism
    - Went to WIMR to print syringe cooling mechanism
    - Researched uniform droplet size determination factors
    - Research and experimented with isolating syringe pump flow rates
    - Designed a trial around optimizing droplet size and uniformity by varying flow rates, flow ratio, and channel neck thickness.
    - Designed experiment to determine collagen polymerization throughout the dispensation process without requiring an internal thermistor.
- Dylan Libel (4 hours)
    - Learned to culture and stain cells at WIMR with the help of Cristina
    - Performed and wrote down a specific procedure for the culturing
    - Started to use Fiji to characterize the droplets created
- Eduardo Usandivaras (4 hours)
    - Researched how to quantify particles and how it can be applied to quantify how many cells are in our microgels
    - Got trained in doing cell culture for preparation for our trials with live cells in the microspheres
    - Researched other forms of pumps in microfluidics as a potential alternative
- Vir Jaiswal (2 hours)
    - Researched the microgel incubation process
    - Looked up and observed favorable conditions for living cells in the collagen solution

Team Goals

- The team plans to begin working with immune cells in the coming weeks and quantify cell encapsulation. Other goals include separating cells from the oil using a cell strainer, testing the cooling sleeve, experimenting with controls such as bulk emulsions, and collecting more data for analysis in MATLAB.

Individual Goals

- Sam Kamin
    - Continue running experiments to gather more data, perform testing, and improve the workflow even further
    - Edit the preliminary report and PDS with comments left by Dr. Ohnsorg
- Murphy Diggins
    - Test out cooling sleeve effectiveness and quantify effectiveness if applicable.
    - Begin working with immune cells and attempt cell encapsulation

- Will McGuire
    - Run experiment on chips to determine collagen polymerization factor
    - Once determined, run an experiment on chips with the existing channel neck thickness to determine if there is a flow rate that provides adequate size and uniformity.
    - Continue research.
    - Trials with seeping throughput design.
- Dylan Libel
    - Finalize the setup of the microfluidic droplet system
    - Run more trials to get constant droplet output
    - Put cells into the collagen medium and into the droplets
    - Start drafts of the final presentation, poster, and report
- Eduardo Usandivaras
    - Begin trials with cells and image them under a microscope
    - Continue to research and experiment ways to quantify real data and plot it
    - Gather more data on optimal flow rates and temperature with expiriments
- Vir Jaiswal
    - Go to WIMR for some hands on work
    - Collaborate with teammates to get the cells into the collagen microgels
    - Finish my required traning

Project Timeline

Task	**Sept.**				**Oct.**				**Nov.**					**Dec.**	
	10	**17**	**24**	**30**	**7**	**14**	**21**	**28**	**4**	**11**	**18**	**25**		**5**	**12**
Deliverables															
Progress Reports	X	X	X	X	X	X	X	X	X	X					
Product Design Specification		X													
Design Matrix			X												
Preliminary Oral Presentation				X											
Preliminary Lab Notebook					X										

Task	Sept.				Oct.				Nov.					Dec.	
	10	17	24	30	7	14	21	28	4	11	18	25		5	12
Preliminary Report					X										
Preliminary Evaluations					X										
Final Presentation															
Final Lab Notebook															
Final Report															
Final Evaluations															
Meetings															
Team	X	X	X	X	X	X	X	X	X	X					
Advisor	X	X	X	X	X	X	X	X	X	X					
Client	X	X		X		X	X	X	X						
Project Research/Design															
Literature Research	X	X	X	X											
Design Brainstorming		X	X												
Cost Estimation															
Final Design Revision					X	X	X	X	X	X					
Materials Acquisition								X	X	X					
Manufacturing															
Testing and Analysis															
Website															
Progress Report	X	X	X	X	X	X	X	X	X	X					
Product Design Specification		X													

Task	Sept.				Oct.				Nov.					Dec.	
	10	17	24	30	7	14	21	28	4	11	18	25		5	12
Design Matrix			X												
Preliminary Presentation Slides				X											
Preliminary Report					X										
Final Presentation Poster															
Final Report															