Microfluidic droplet generator for lymph node microphysiological models

Progress Report 8

Date: October 23, 2026 - October 29, 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 attempted to print beads again this week at flow rates of 100 µL/min for both channels but without using surfactant and aspirating the collagen solution to mix instead of vortexing. This was unsuccessful. The team also met with Professor Taimoor Qazi from Purdue University and the project's client, Dr. Sanchez de Diego. Professor Qazi suggested light-activated Gelatin Methacrylate as a backup if the temperature-sensitive polymerization of collagen proves unworkable. Professor Qazi mentioned his lab uses a polymer flow rate of 5 µL/min and an oil flow rate of 80-120 µL/min. This was a very helpful finding for the team. To guarantee even cell distribution within the droplets, Professor Qazi mentioned incorporating a Density Matching Medium to prevent the immune cells from settling out of the collagen suspension. Finally, the team learned we should use Span80 surfactant and mineral oil.

Current design: SolidWorks Mask Design

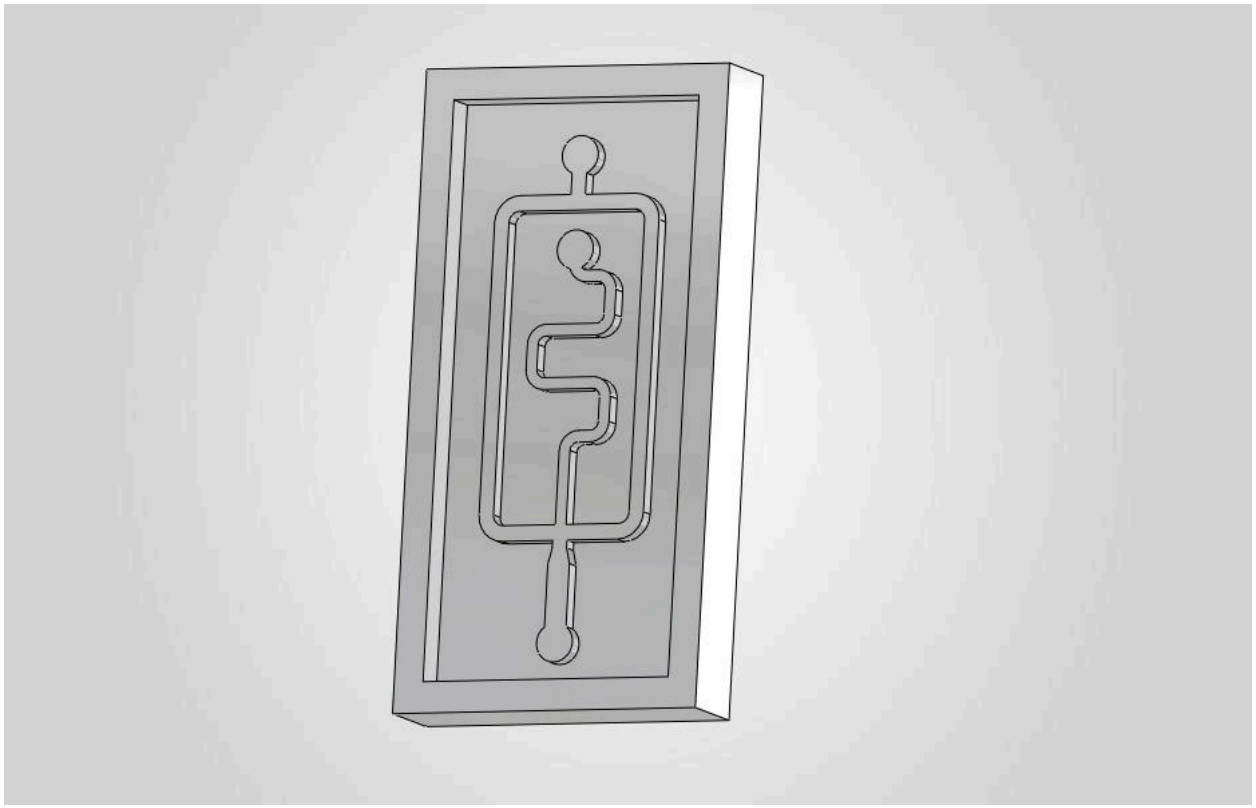


Figure 1: Current Microfluidic CAD design for 0.5uL Droplets

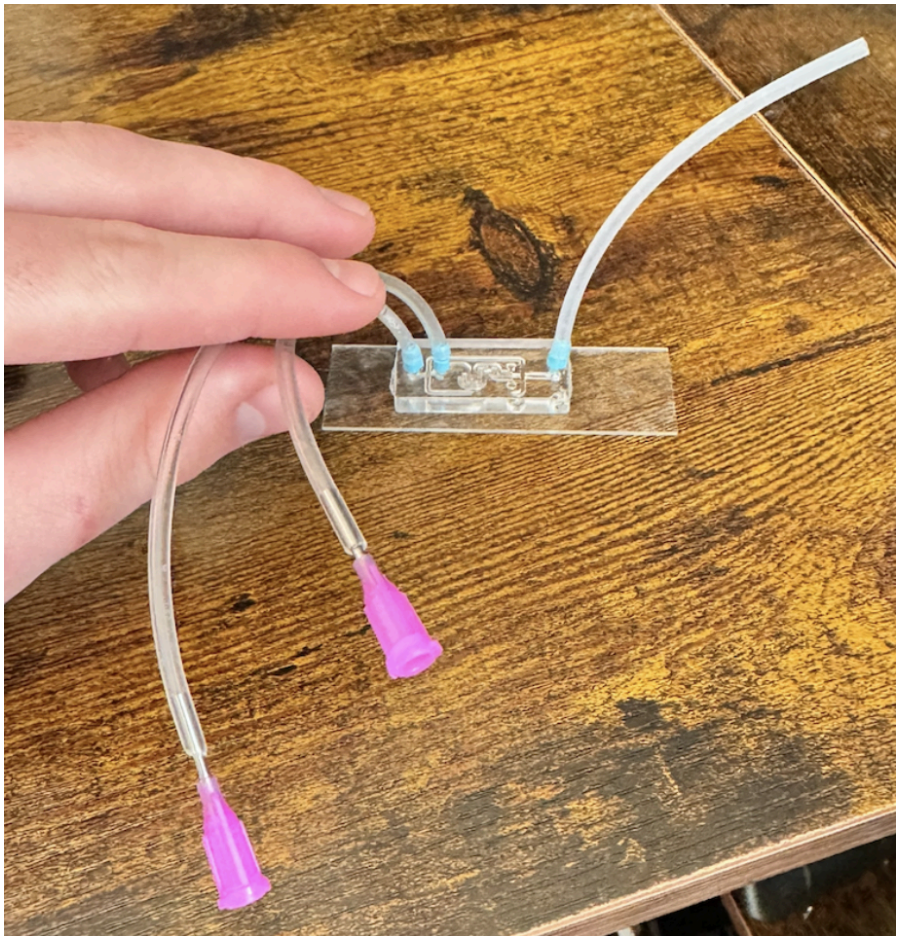
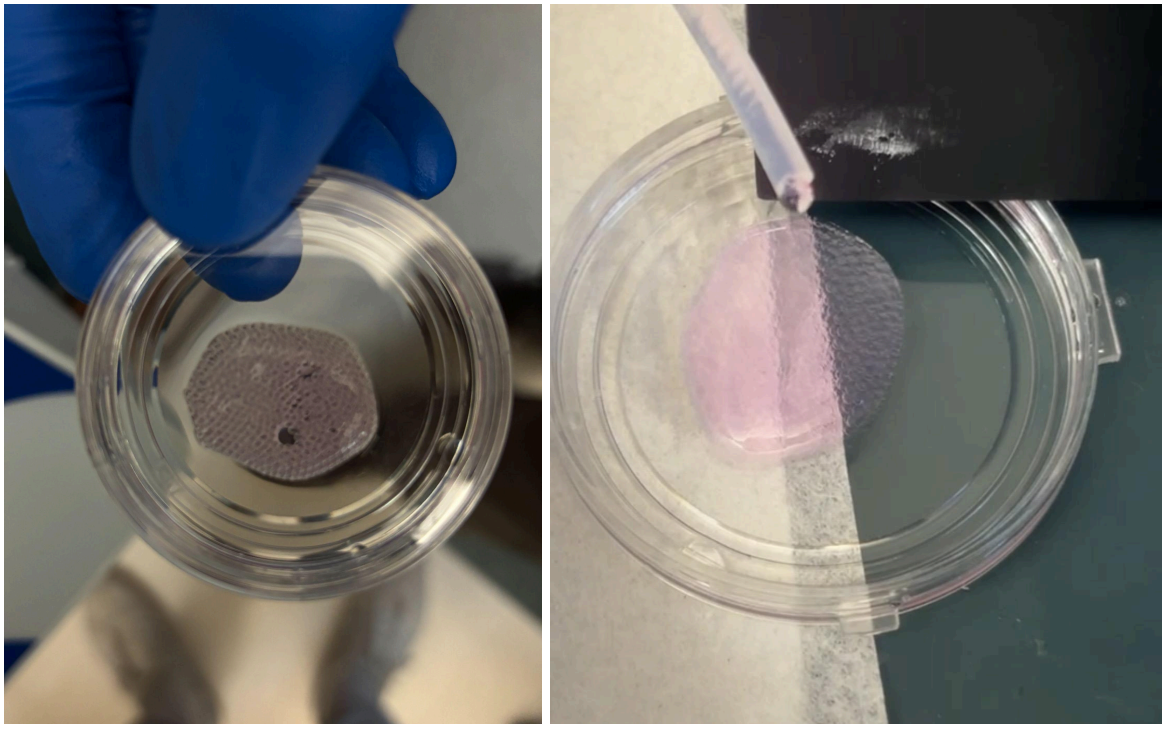
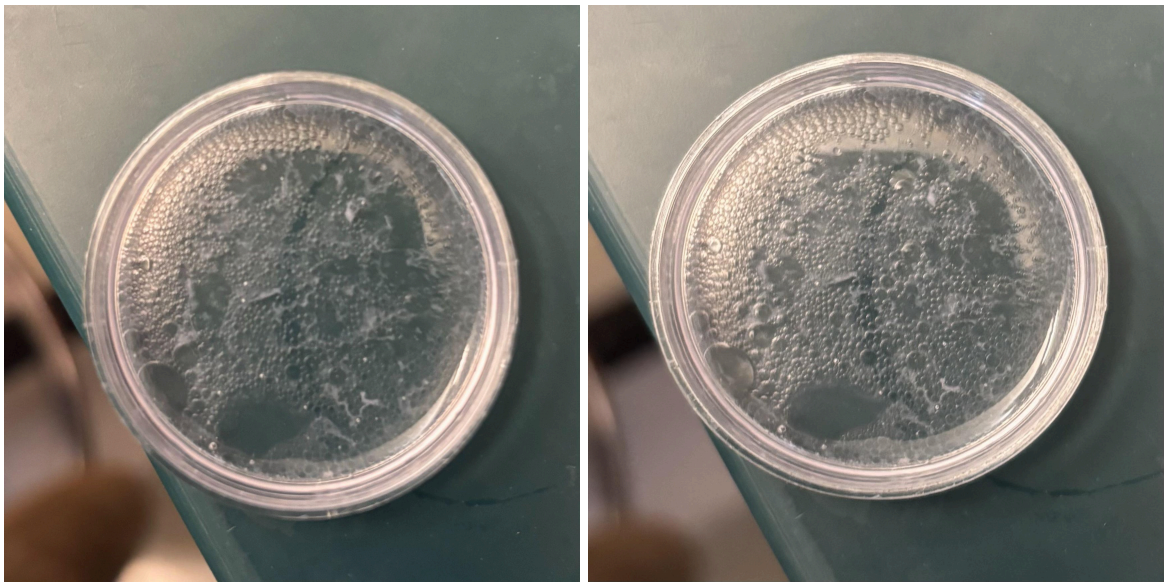


Figure 2: Assembled Microfluidic Device



Figures 3A (left) and 3B (right): Close-up Images of Collagen Microspheres



Figures 4A (left) and 4B (right): Close-up Images of The Collagen Microspheres From the Runs Using Fluorescent Beads and Triton X-100 Surfactant

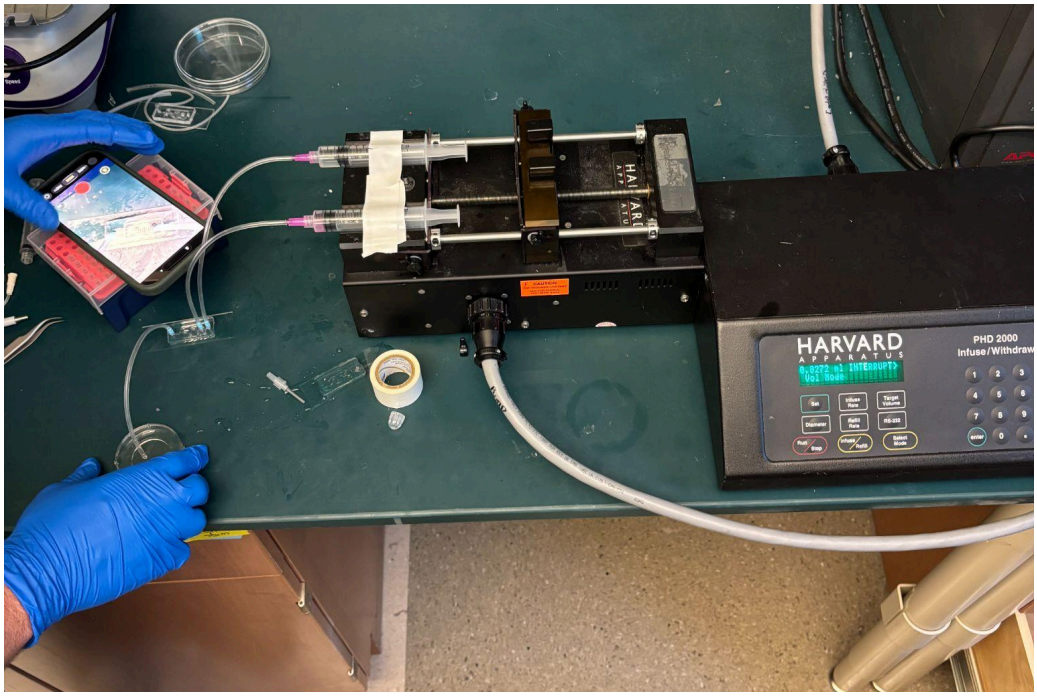


Figure 5: Experimental Set-Up

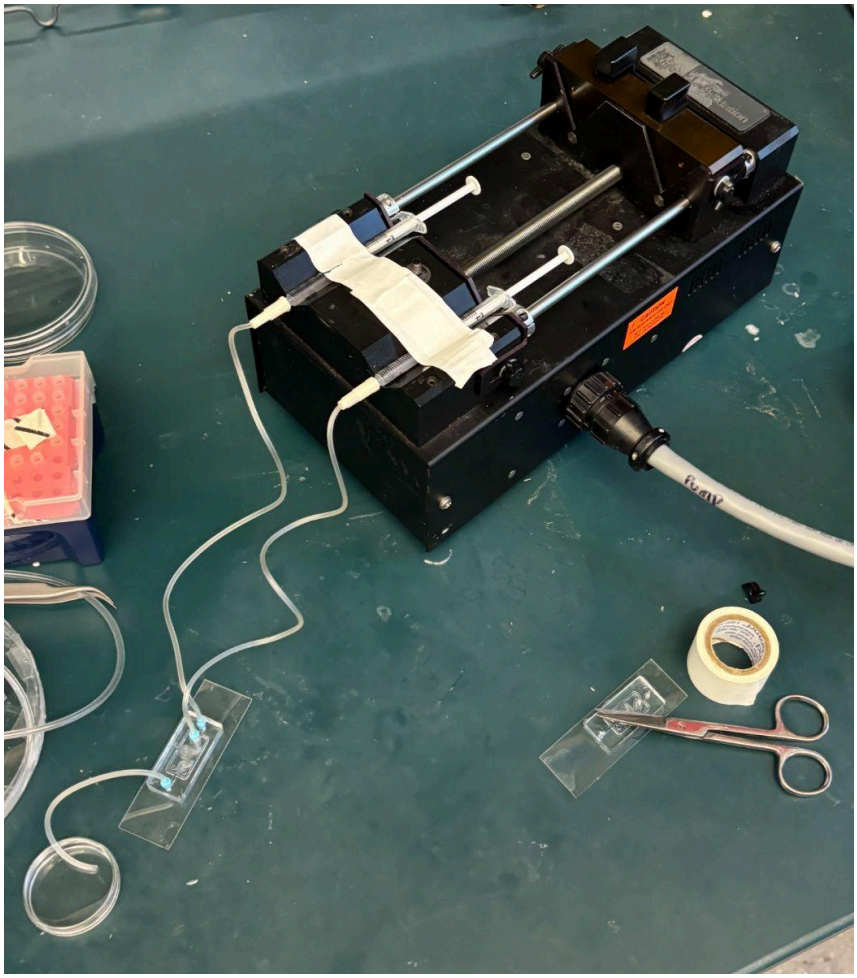
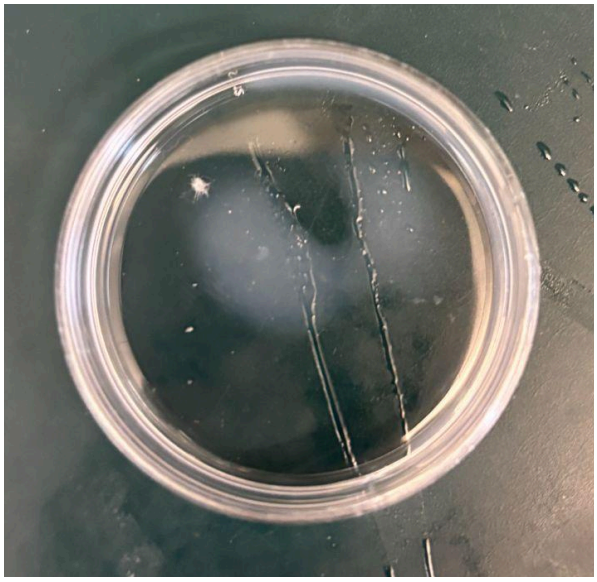
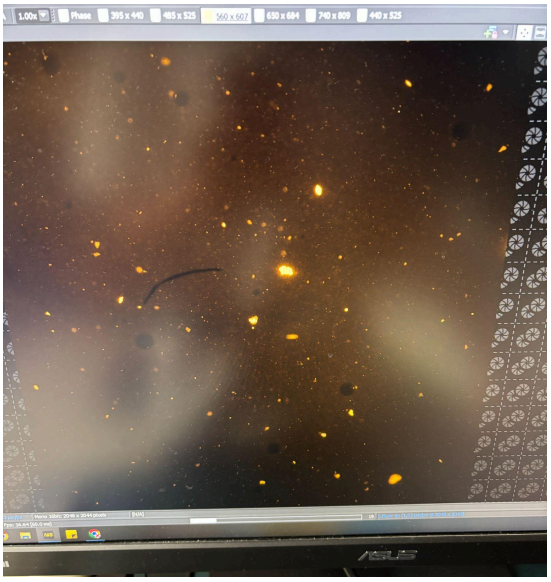


Figure 6: Experimental Set-Up Used This Week with 1 mL Syringes





Figures 7A (left) and 7B (right): Results From Using Fluorescent Beads and Attempting to Create Microspheres Without Surfactant

Previous Week's Accomplishments

- Sam Kamin (6 hours)
    - Attended Professor Taimoor Qazi's lecture
    - Went to WIMR to attempt printing collagen microspheres with no surfactant used this time and aspirating instead of vortexing
    - Met with Professor Taimoor Qazi and Dr. Sanchez de Diego
    - Worked on show-and-tell slideshow
- Murphy Diggins (4 hours)
    - Researched methods of measuring collagen temperature
    - Created show-and-tell slideshow
- Will McGuire (3 hours)
    - Met with Professor Taimoor Qazi and Dr. Sanchez de Diego to discuss important next steps and decision making for the assignment
    - It iterated on CAD design for seeping throughput mechanism.
    - Researched differences between vegetable oil and fluorinated oil and its effect on our microfluidic system
    - Worked on show-and-tell slideshow
- Dylan Libel (3 hours)
    - Met with Professor Qazi and Dr. Sanchez de Diego, asked about much of our projects and the drawbacks/limitations we were experiencing
    - Did more research on specific materials and fluids Professor Qazi mentioned in his meeting with us
    - Prepared for show-and-tell, gathering information and our thoughts on what would be best to ask others about
- Eduardo Usandivaras (3 hours)
    - Met with Prof. Taimoor Qazi to discuss his methods for microfluidics
    - Researched methods for quantifying collagen analysis
    - Researched alternative hydrogels that polymerize with light
- Vir Jaiswal (2 hours)
    - Researched cells in collagen
    - Researched the conditions required for them to survive

Team Goals

- Acquire Span80 surfactant and mineral oil
- Acquire a new syringe pump or use a manual method to test the new flow rates
- Produce a video of fluorescent beads encapsulated in collagen microspheres
- Document the experimental process and full procedure more thoroughly so errors can be figured out and the process can be perfected
- Continue improving upon PDMS chip design
- Continue editing product design specifications based on comments from Dr. Ohnsorg

Individual Goals

- Sam Kamin
    - Go in to WIMR to learn about PDMS chip fabrication and plasma treating for bonding materials together
    - Go in to WIMR to test the current designs with collagen and the new flow rates and new oil and new surfactant
    - Make iterative design improvements to hopefully get collagen microspheres
    - Continue researching and prototyping
- Murphy Diggins
    - Begin fabrication on an alternative cooling mechanism
    - Begin implementing bioinstrumentation into project
- Will McGuire
    - Get a completed prototype of the seeping throughput design
        - Including printing PDMS and plasma treating
    - Repeat our system for creating microdroplets at WIMR
    - Transition to vegetable oil and non fluorinated surfactant for cost efficiency
- Dylan Libel
    - Continue fabrication and testing of collagen and the microfluidic system
    - Image the fluorescent beads once full collagen beads are able to be made readily
    - Workshop the cooling ideas we have and find out which one will work best in our system
- Eduardo Usandivaras
    - Brainstorm ideas on how to control individual flow rates of our syringes to ensure proper microsphere formation
    - Continue testing with device and ensure the usage of vegetable or some other kind of oil
    - Research surfactants that are compatible with fluoridated oil for when we do tests with cell culture.
    - Image with fluorescent beads
    - 3D print collagen sleeves
- Vir Jaiswal
    - Plan to go the lab and get some hands on work done
    - Try replicating droplet generation and working on further refining techniques

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							

Task	Sept.				Oct.				Nov.					Dec.	
	10	17	24	30	7	14	21	28	4	11	18	25		5	12
Product Design Specification		X													
Design Matrix			X												
Preliminary Oral Presentation				X											
Preliminary Lab Notebook					X										
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							
Advisor	X	X	X	X	X	X	X	X							
Client	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							
Materials Acquisition								X							

Task	Sept.				Oct.				Nov.					Dec.	
	10	17	24	30	7	14	21	28	4	11	18	25		5	12
Manufacturing															
Testing and Analysis															
Website															
Progress Report	X	X	X	X	X	X	X	X							
Product Design Specification		X													
Design Matrix			X												
Preliminary Presentation Slides				X											
Preliminary Report					X										
Final Presentation Poster															
Final Report															