

Microfluidic droplet generator for lymph node microphysiological models

Progress Report 7

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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: This week the team went to the lab in WIMR to produce more collagen microspheres with red fluorescent polymer microspheres this time. Additionally, the fluorinated oil used included 1% by weight Triton X-100 surfactant. The initial run used a flow rate of 600 $\mu\text{L}/\text{minute}$ which was too fast, producing poor results. Two runs were performed at a flow rate of 100 $\mu\text{L}/\text{minute}$, the same flow rate used last week to successfully produce collagen microspheres. However, this week no collagen microspheres were successfully produced. The team believes this is due to the collagen polymerizing or from vortexing the collagen solution to mix in the fluorescent microspheres. The final appearance had wisps of collagen. Next time the team will not vortex and will keep the pumping syringes on ice until use.

Current design: SolidWorks Mask Design

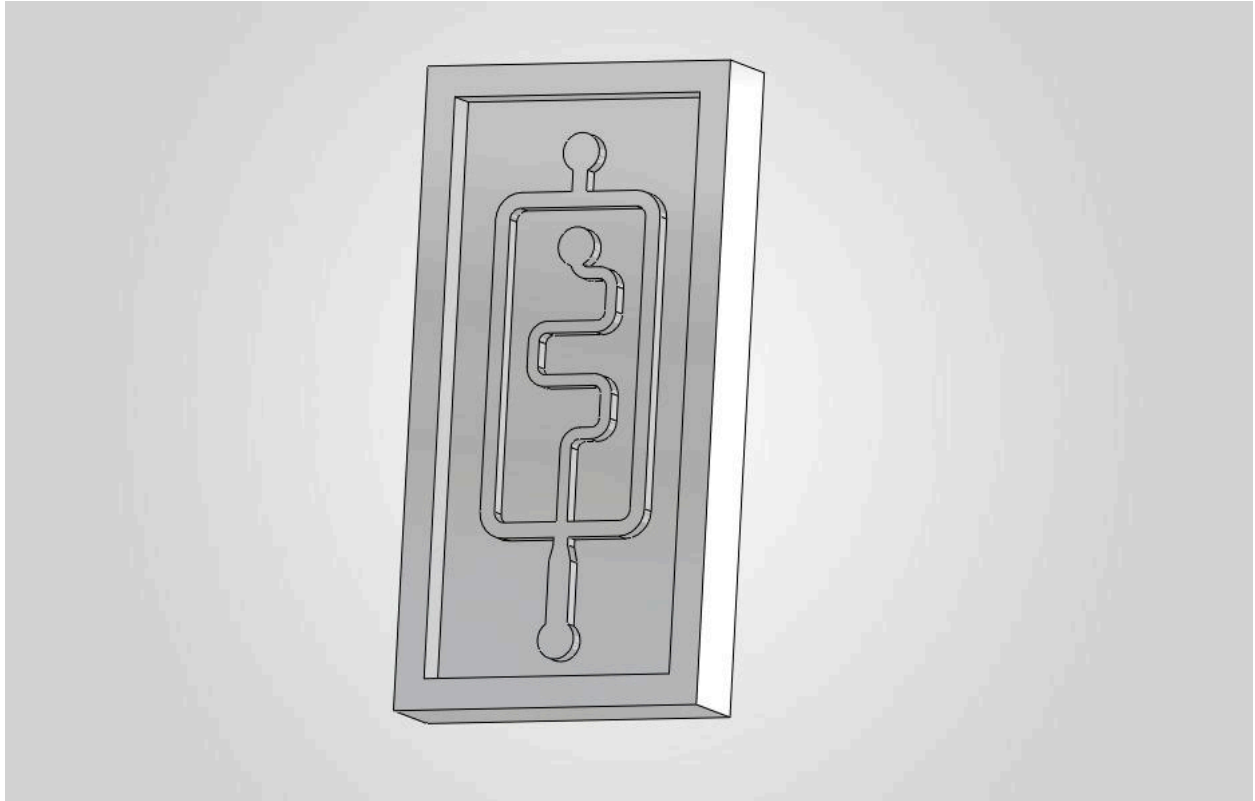


Figure 1: Current Microfluidic CAD design for 0.5uL Droplets

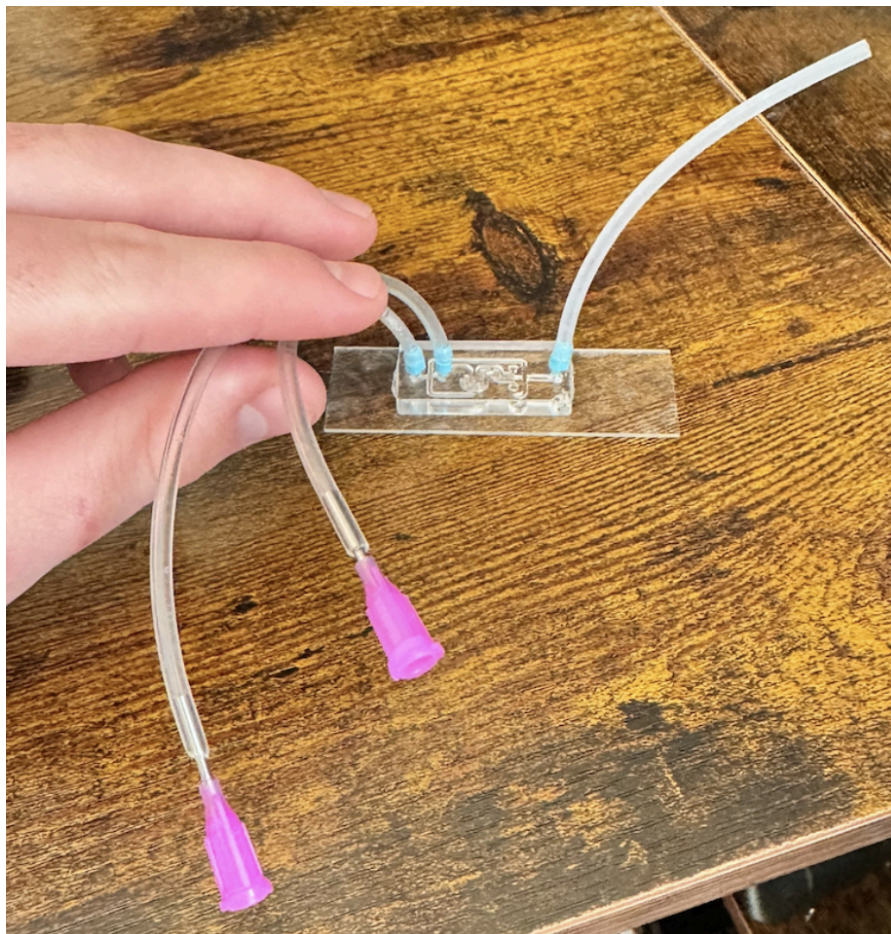
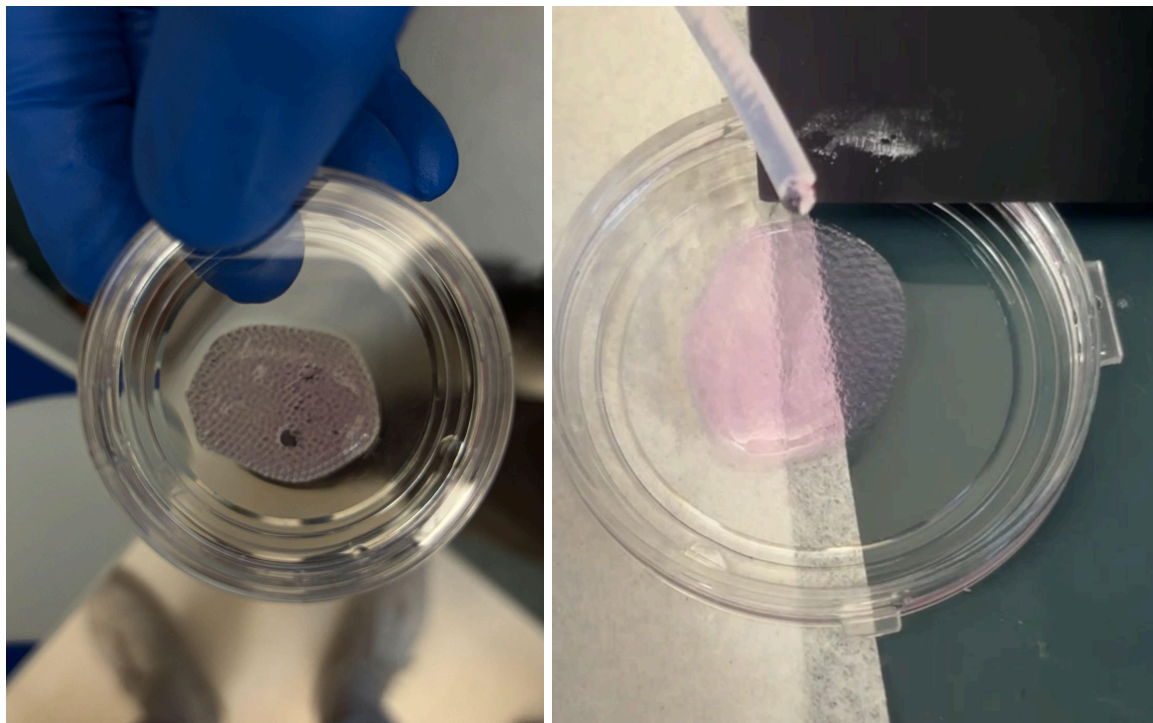
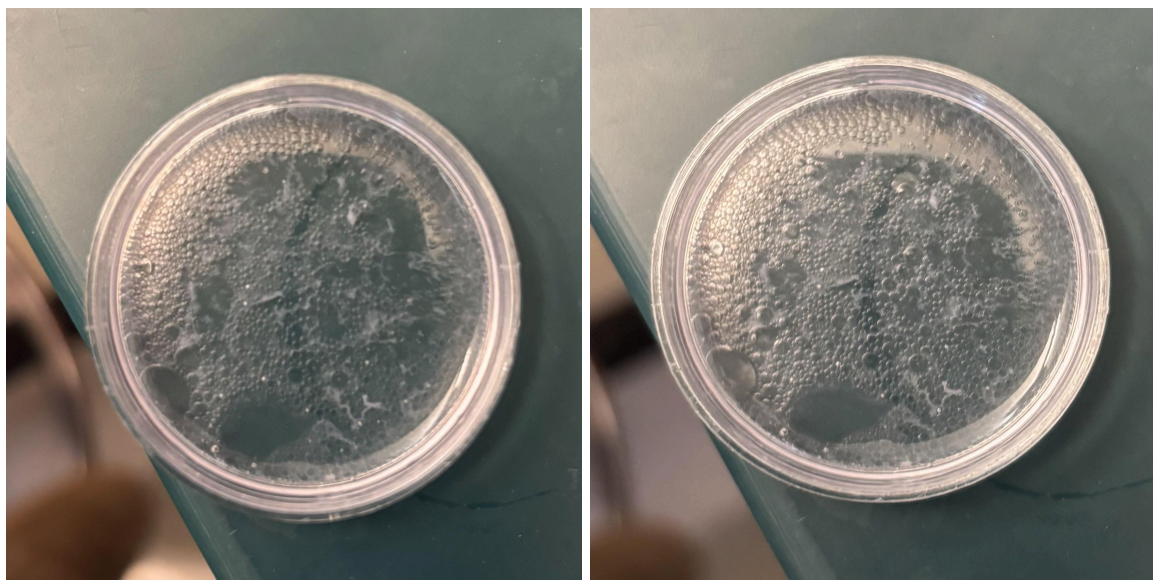


Figure 2: Assembled Microfluidic Device



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



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

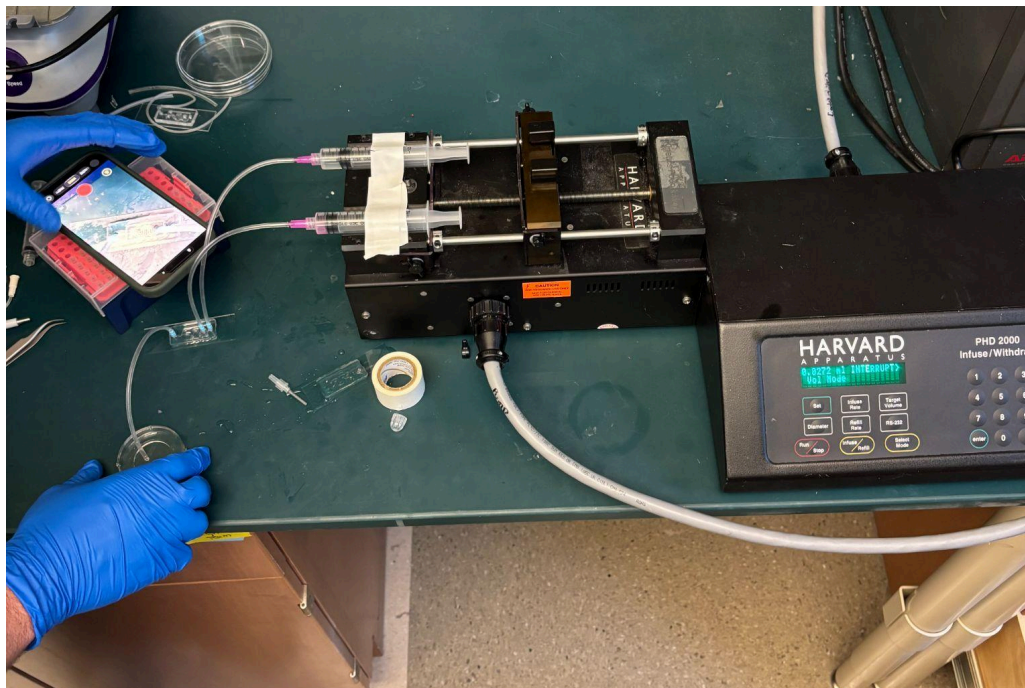
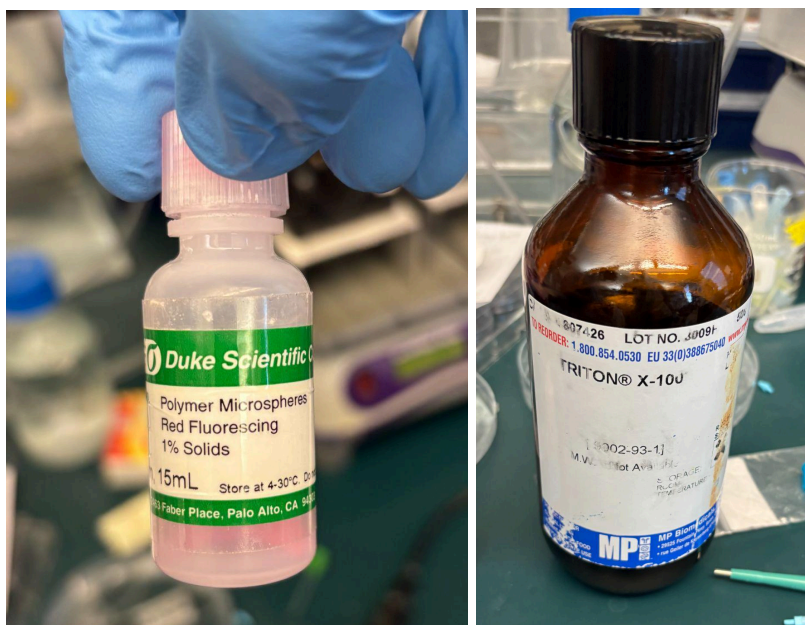


Figure 5: Experimental Set-Up



Figures 6A (left) and 6B (right): Fluorescent Microspheres and Surfactant Used

Previous Week's Accomplishments

- Sam Kamin (5 hours)
 - Went in to WIMR to work on producing collagen microspheres
 - Researched thin thermistor / temperature sensing solutions to obtain temperature data for data-driven design decisions
 - Created a final thermistor circuit design for accurate temperature sensing within a range of -40 °C to 50 °C
- Murphy Diggins (4 hours)
 - Researched alternative surfactants compatible with fluorinated oil
 - Experimented with collagen droplet formation at WIMR
 - Redesigned mold design based on failure points from last weeks testing
- Will McGuire (3 hours)
 - Designed a new model using a seeping throughput channel design
 - Experimenting with collagen and oil droplets at WIMR
 - Researched external infrared thermometer techniques
 - Researched internal thermoregulation designs with sensors
- Dylan Libel (3 hours)
 - Continued work done in the previous week testing and perfecting flow rates and collagen solutions at WIMR
 - Continued research on testing methods for collagen and fluorinated oils
 - Looked into previously mentioned articles and labs around the country
- Eduardo Usandivaras (4 hours)
 - Researched alternated cooling mechanisms for collagen solutions
 - Researched how cell cultures survive in a microfluidic environment for our future trials with B and T cells
 - Designed 2 prototypes for cooling methods for the syringe pumps.
- Vir Jaiswal (3 hours)
 - Went to the WIMR and tried creating collagen droplets
 - Used a surfactant as well to see if the droplets would separate into individual structures rather than a coherent blob

Team Goals

- Produce a video of fluorescent beads encapsulated in collagen microspheres to show at the show and tell next Friday
- 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

- Decide on what actionable feedback / thoughts the team wants to ask for at the show and tell to help progress the project
- 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 make iterative design improvements to hopefully get collagen microspheres
 - Continue researching and prototyping
- Murphy Diggins
 - Experiment with an alternative surfactant compatible with fluorinated oil
 - Fabricate multiple devices
- Will McGuire
 - Continue testing at WIMR
 - Continue prototyping design ideas
 - Test thermal sensing and regulation designs
- Dylan Libel
 - Bring to show and tell working and comprehensive videos of droplet creation as well as images taken on the fluorescence microscope
 - Get a testing plan in order and begin taking data
- Eduardo Usandivaras
 - 3D print cooling sleeve for syringes
 - Test different flow rates at WIMR
 - Continue to experiment with our devices and collagen solution to get more consistent results
- Vir Jaiswal
 - Try fixing the mistakes we made in our last week's trials by reducing vortex time, reducing polymerization until droplets form and minimizing the air bubbles formed.
 - Try sterilization processes to slowly create an environment safe to use cells in

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								

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