Microfluidic droplet generator for lymph node microphysiological models

Progress Report 3

Date: September 18, 2026 - September 24, 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: Our team has successfully created a PDMS-glass device bonded via plasma treatment. In the coming days, the team aims to connect the device to the syringe pump with the goal of pinpointing flow/channel width requirements needed to create a 0.5 µL droplet. The team has also begun testing collagen polymerization and fabricating cooling mechanisms to keep collagen cool throughout the device.

Current design: SolidWorks Mask Design

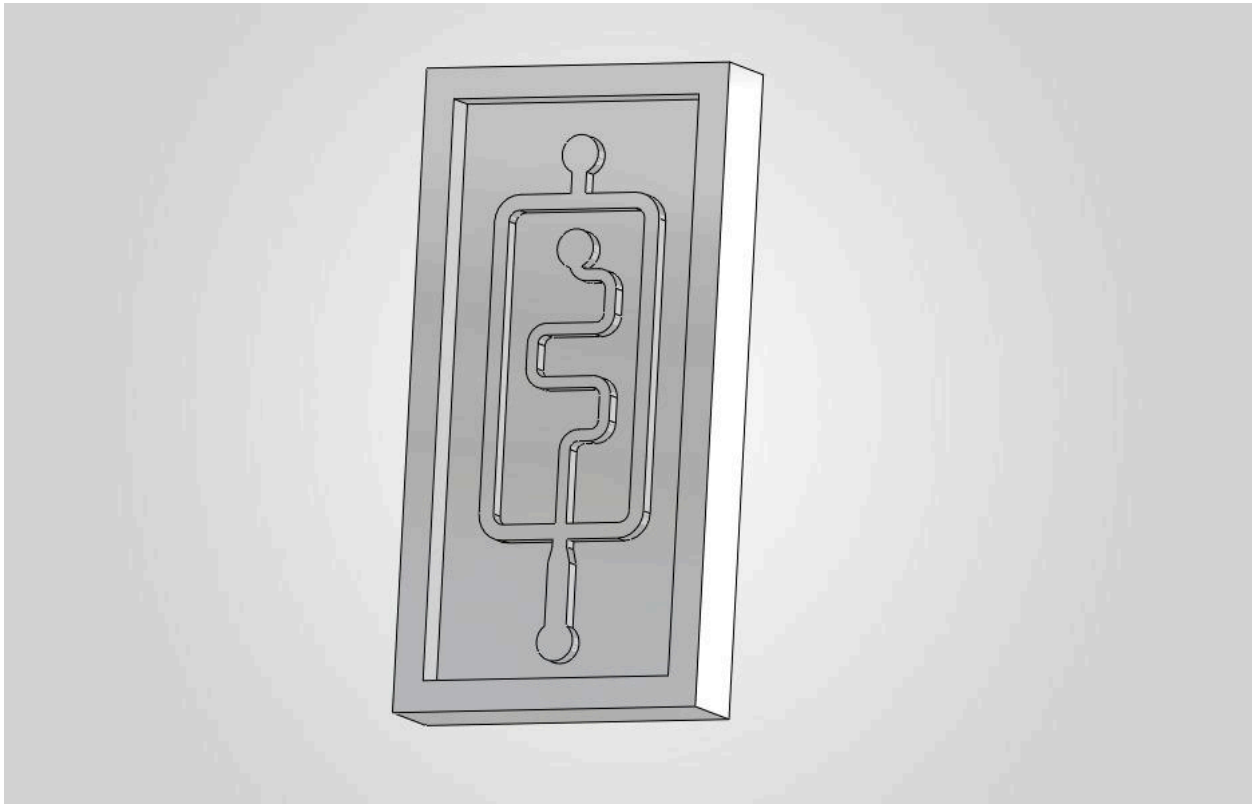

Figure 1: Current Microfluidic CAD design for 0.5uL Droplets

Figure 2: Assembled Microfluidic Device

Previous Week's Accomplishments

- Sam Kamin (4 hours)
    - Researched competing designs to a standard microfluidic droplet generator
    - Researched collagen gelation mechanism and how to control collagen gel properties
    - Worked on the design matrices and criteria
- Murphy Diggins (4 hours)
    - Assembled microfluidic prototype
    - Designed an ice cube mold as a cooling mechanism
    - Designed an alteration of our initial design with an adjacent collagen channel for cooling
    - Researched surfactant options to minimize bead merging
- Will McGuire (9 hours)
    - Visited WIMR to meet with Dr. Sanchez de Diego to discuss important specifications
    - Designed 2 microfluid prototypes, one for a more condensed collagen droplet generator and one for a channel mirroring cooling system
    - Researched and designed 3 unique incubation designs using resistance wire
    - Discussed design matrix with Dr. O

- Dylan Libel (3 hours)
    - Researched surfactants and their effects on the characteristics of collagen
    - Researched the gelation mechanism of collagen to better understand how it works and the constraints it has
    - Worked on the design matrices, characterizing and categorizing each design and criteria
- Eduardo Usandivaras (4 hours)
    - Visited WIMR to begin testing with collagen, studying how to make it and how quickly it polymerizes by making miniature tubing models.
    - Researched miniature incubation strategies to speed up polymerization
    - Communicated with client regarding training updates and lab safety qualifications
- Vir Jaiswal (3 hours)
    - Visited WIMR to meet with Dr. Sanchez de Diego
    - Learned the recipe of how to make collagen and prepared a batch that was placed in an incubator to polymerize
    - Practiced the production of collagen beads as small as 0.5 μL as that's the size we require.

Team Goals

- Complete fabrication of cooling methods and begin implementation into the design.
- Order necessary materials needed for running the prototype
- Begin collagen testing on the device and measure collagen bead sizes.
- Edit PDS based on comments.

Individual Goals

- Sam Kamin
    - Work on preliminary presentation
    - Research more into competing designs
    - Go into WIMR to work on getting a video of our microfluidic chip functioning with fluorescent beads before the preliminary presentation
    - Research more necessary project components as they come up
- Murphy Diggins
    - Print and assemble four-channel design
    - Print and test ice cube mold and water-glycerol adjacent cooling system
    - Quantify droplet throughput and approximate size
- Will McGuire
    - Look for potential substitute hot plates for incubation platform in lab
        - Potentially 3D model designs
    - 3D print cooling channel mold
    - Learn the PDMS process and practice procedure on cooling channel mold
    - Prepare information for initial presentation
- Dylan Libel
    - Assemble a working prototype of the droplet generator

    - Continue preliminary designs and research on collagen
    - Finalize the initial presentation based off the previous deliverables
- Eduardo Usandivaras
    - Continue researching and developing models for cooling the system as well as heating it in a reservoir to speed up polymerization
    - Gather usable data on polymerization rates in tubing to ensure collagen stays liquid for long enough
    - Communicate with Dr. Sanchez de Diego and Dr. Onshorg on any questions we have since our last meeting
- Vir Jaiswal
    - Continue with the collagen testing and start preparing batches of unsterilized collagen for our experimentation purposes.
    - Research about collagen and learn more about its polymerization properties
    - Observe the viscosity of the collagen over time

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												
Product Design Specification		X													
Design Matrix			X												
Preliminary Oral Presentation															
Preliminary Lab Notebook															
Preliminary Report															
Preliminary Evaluations															
Final Presentation															

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

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