Microfluidic droplet generator for lymph node microphysiological models

Progress Report 2

Date: September 11, 2026 - September 17, 2026

Client: Dr. Cristina Sanchez de Diego

Advisor: Prof. Monica Ohnsorg

Team:

Co-*Team Leader:* Sam Kamin (sjkamin@wisc.edu)

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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 gained more specifics on our client's needs and will begin prototyping a basic model to begin flow rate testing. Our team will also begin designing a cooling mechanism while continuing research on handling collagen and immune cells. We have received a collagen protocol from our client, which makes that part of the project much easier.

Current design: SolidWorks Mask Design

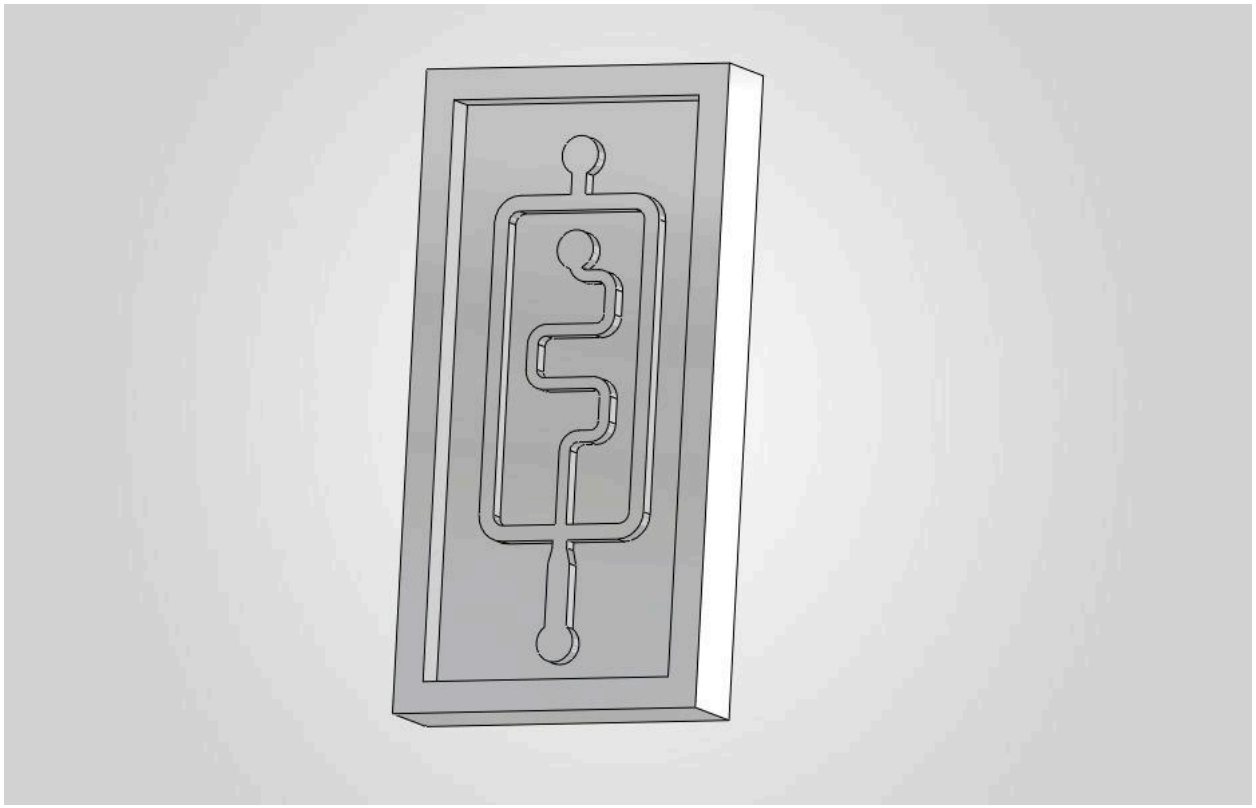

Figure 1: Current Microfluidic CAD design for 0.5uL Droplets

Previous Week's Accomplishments

- Sam Kamin (3 hours)
    - Went back to WIMR for training on the various tools available to us throughout the design process
    - Continued researching the project scope and background
    - Began researching droplet generators and the components necessary
    - Worked on PDS and did research on applicable standards that will guide us throughout the design process
- Murphy Diggins (3.5 hours)
    - Designed an updated CAD file based on a 0.5 μL droplet size
        - Printed mold and cured PDMS, waiting to plasma-treat to bond to glass.
    - Researched Collagen protocols (we were later sent Cristina's exact protocol)
    - WIMR visit to meet with Adeel to go over printing procedures
- Will McGuire (2 hours)
    - Visited WIMR to meet with Dr. Sanchez de Diego to discuss important specifications regarding quantity, rate, and temperatures so that we will be able to optimize her research needs
    - Researched systems regarding temperature control both to cool the collagen and to immediately begin incubating the droplets after production
- Dylan Libel (3 hours)
    - Went to WIMR again and learned how to properly use the 3D resin printers
    - Got an introduction to the CNC machines, picked up other materials such as spare PDMS molds, tubing, and biopsy punches
    - Researched collagen type I and alternatives we could use in the lab for testing and evaluation
    - Worked on the PDS, focusing on the function and specifications of the overall system
- Eduardo Usandivaras (2 hours)
    - Visited Dr. Sanchez de Diego's lab to go over methods for speeding up the polymerization process, keeping the collagen solution cool throughout the process, how many droplets will be required of us and in what time, and other details regarding the thermodynamics of our project.
    - Researched the polymerization of collagen and concluded that we must keep the solution at cool temperatures and have constant awareness of the fact that it will start to gel as soon as it is exposed to temperatures above 4°C.
- Vir Jaiswal (2 hours)
    - Researched the collagen fibrillation process and the factors that accelerate the process.
    - Researched the factors of the collagen that we need for our experiment.
    - Visited WIMR to meet with Cristina and discuss the research work.

Team Goals

- Build a functional prototype and begin testing flow rates.
- Begin designing a cooling mechanism.
- Finish necessary training to be added to the training protocols.

Individual Goals

- Sam Kamin
    - Continue researching necessary topics as we progress through the design process
    - Design brainstorming
    - Prepare for the initial design matrix
- Murphy Diggins
    - Build a functional prototype for the team to begin flow testing and cooling
    - Design a larger 8- or 16-channel device for increased droplet production
- Will McGuire
    - Work with Murphy to optimize the mold towards the rate and speed needs
        - Research how flow and fluid input will enable us to reach the desired droplet generation rate
    - Research how cooling and heating systems can be implemented into a prototype
- Dylan Libel
    - Continue research on fluid mechanics and other useful topics pertaining to collagen and flow rates
    - Look into surfactants and proper use of them for our specific scenario
    - Use ComSol to run fluid simulations on the current mold designs we have
- Eduardo Usandivaras
    - Continue to research methods of keeping collagen cooled during the droplet generation process
    - Communicating with the team about further methods on how to optimize droplet generator designs.
    - Communicate with the client and advisor about our team's current progress check.
- Vir Jaiswal
    - Continue to research collagen and see if there's any way to separate the B and T cell collagen gels to make Cristina's work easier.
    - Research the concept of variable thermal zones in the microfluidic chip.
    - Try to prepare a batch of unsterile collagen (fluidic state) if possible.
    - Start to check off the required training protocols.

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													

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															
Preliminary Oral Presentation															
Preliminary Lab Notebook															
Preliminary Report															
Preliminary Evaluations															
Final Presentation															
Final Lab Notebook															
Final Report															
Final Evaluations															
Meetings															
Team	X	X													
Advisor	X	X													
Client	X	X													
Project Research/Design															
Literature Research	X	X													
Design Brainstorming		X													
Cost Estimation															
Final Design Revision															
Materials Acquisition															

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													
Product Design Specification		X													
Design Matrix															
Preliminary Presentation Slides															
Preliminary Report															
Final Presentation Poster															
Final Report															