Microfluidic droplet generator for lymph node microphysiological models

Progress Report 9

Date: October 30, 2026 - November 5, 2026

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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: Another microfluidic droplet generation experiment was conducted at WIMR. The continuous phase, consisting of mineral oil supplemented with 2% (v/v) Span 80 surfactant, was loaded into a 10 mL syringe, while the dispersed collagen phase was loaded into a 1 mL syringe. Flow rates were controlled via syringe pumps and maintained at 80 µL/min for the continuous phase and 8 µL/min for the dispersed phase, replicating parameters established by the Qazi laboratory. To maintain optimal temperatures, the syringes and the PDMS chip were actively cooled with ice packs throughout the procedure, which successfully yielded collagen microspheres. This protocol was subsequently repeated to encapsulate fluorescent beads within the collagen matrix. Finally, both the standard and fluorescently-loaded microspheres were characterized using fluorescence microscopy and ImageJ. One example droplet recorded a diameter of 1012 µm, corresponding to a droplet volume of around 0.5 µL.

Current design: SolidWorks Mask Design

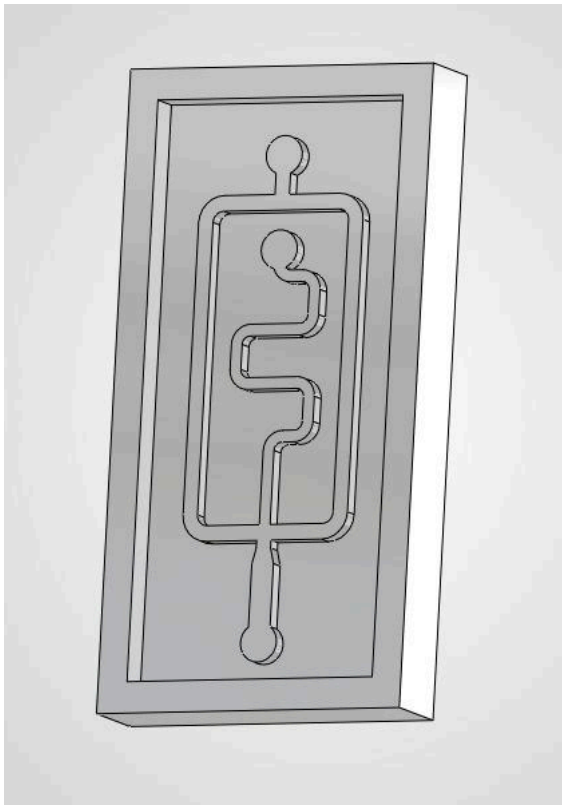


Figure 1: Current Microfluidic CAD design for 0.5uL Droplets

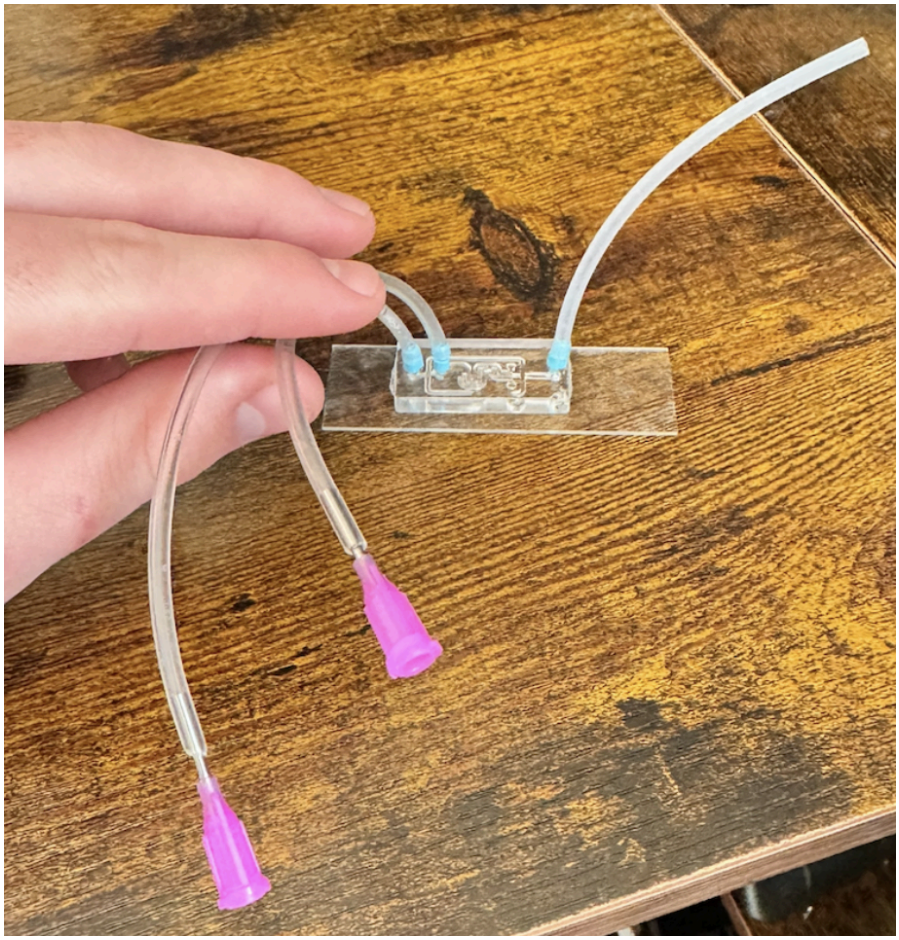


Figure 2: Assembled Microfluidic Device



Figure 3: Experimental Setup

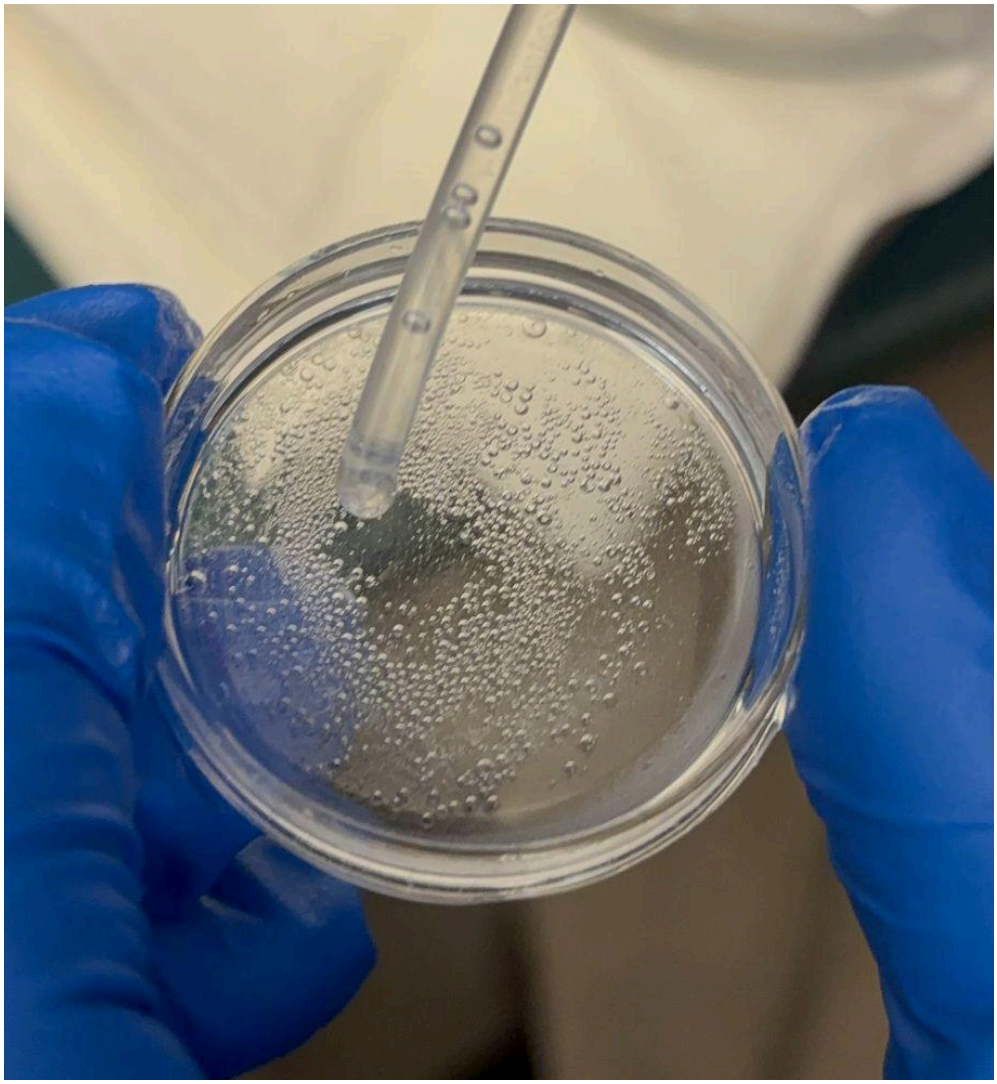


Figure 4: Collagen Microspheres

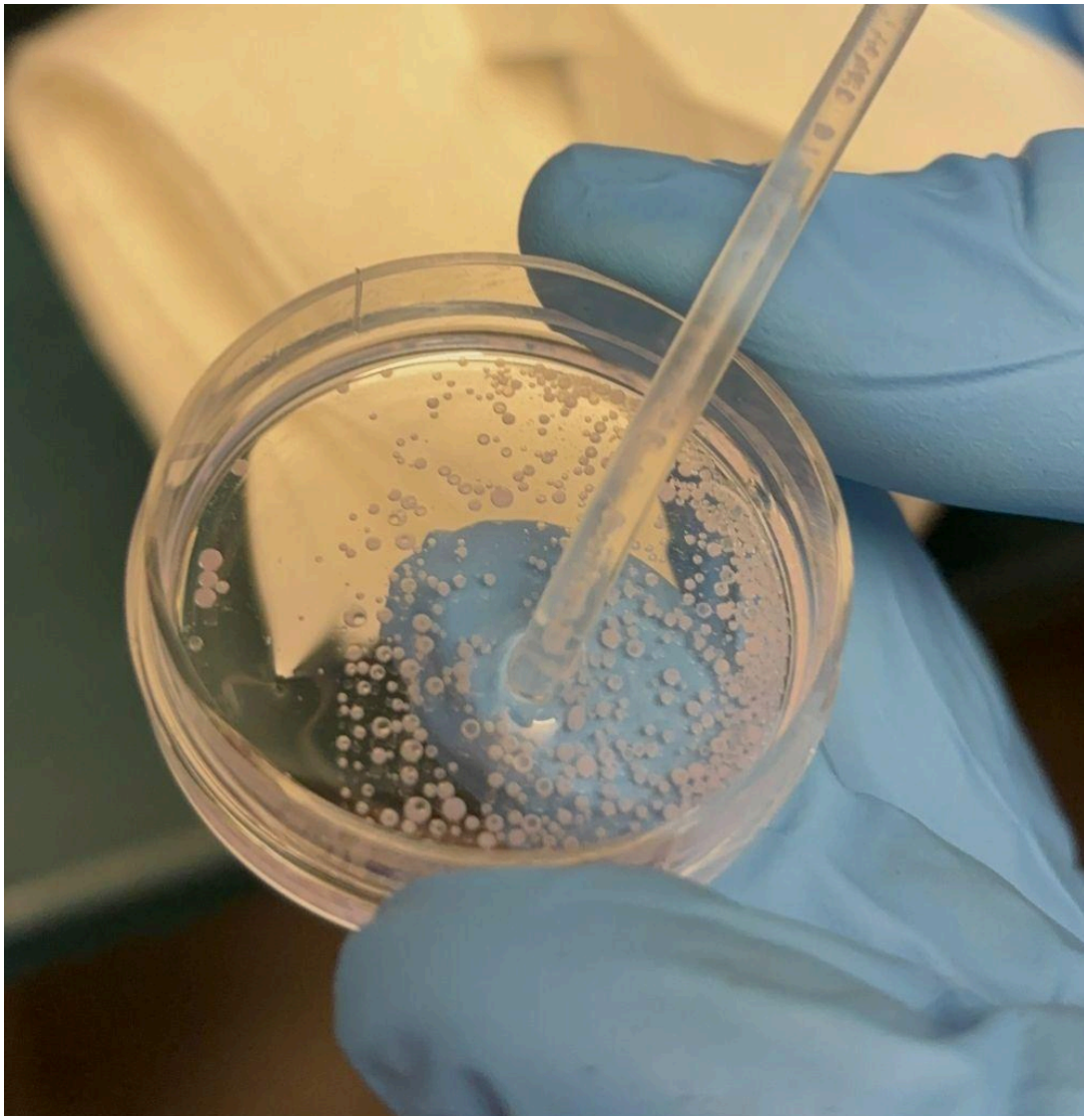


Figure 5: Collagen Microspheres with Fluorescent Beads Added

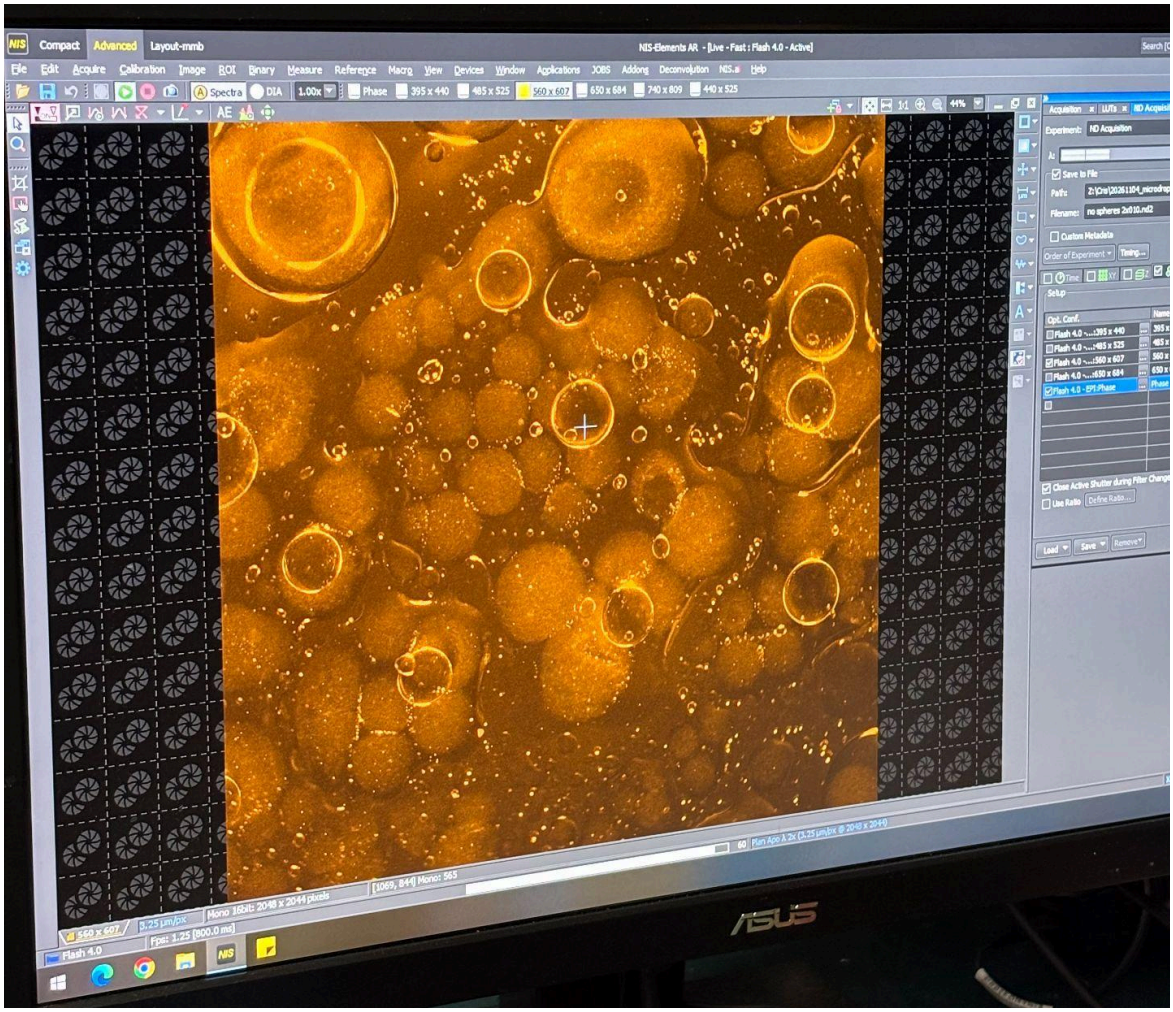


Figure 6: Collagen Microspheres with Fluorescent Beads under the Fluorescent Microscope

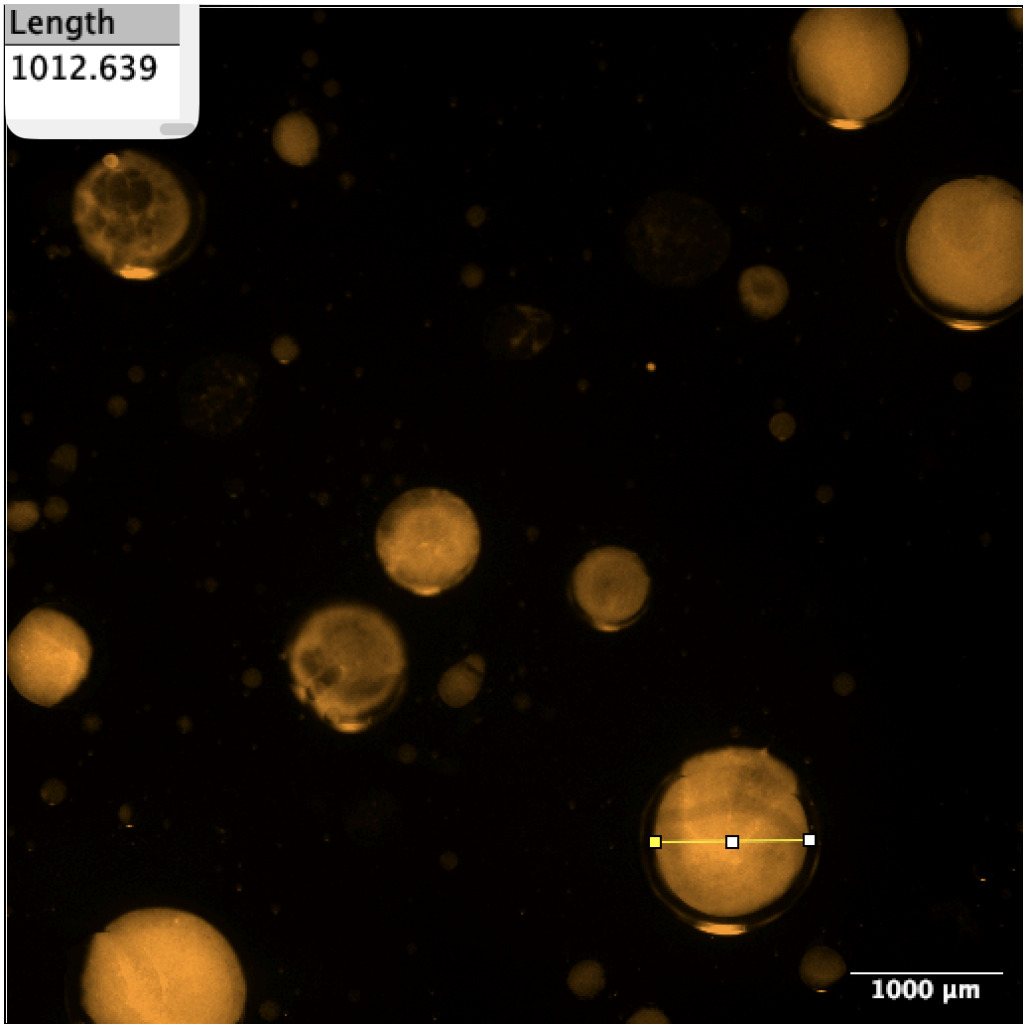


Figure 7: FIJI Quantification of a Single Collagen Droplet

Previous Week's Accomplishments

- Sam Kamin (5 hours)
    - Went to WIMR to form droplets
    - Worked on improving and optimizing the experimental setup
    - Researched more methods for improving the setup from microfluidic laboratories
- Murphy Diggins (5 hours)
    - Went to WIMR to form droplets
    - Used the scale bar and measure feature inside ImageJ/FIJI to quantify droplet size, recording a diameter of 1012 μm, corresponding to a droplet size of around 0.5 μL.
    - Edit existing SolidWorks file to assist in PDMS/mold release
    - Researched cooling mechanisms and created a SolidWorks part to encapsulate and cool syringes inside of the syringe pump.
- Will McGuire (5 hours)
    - Researched flow rates and the transition to live cells.
    - Worked on seeping throughput in solid works
    - Cooked up droplets at WIMR
    - Imaged droplets and learned how to implement ImageJ for measurement
- Dylan Libel (5 hours)
    - Went to WIMR to continue work on the test setup
    - Worked on quantifying droplet size with the fluorescence microscope and fluorescent beads
    - Researched cooling methods and testing methods
- Eduardo Usandivaras (2 hours)
    - Researched the biology of collagen microspheres as models for cells and how they can degrade in the human body due to specific enzymes
    - Researched competing methods for microsphere generation
- Vir Jaiswal (2 hours)
    - Filled out the BPAG spreadsheet to order the ice packs for the syringes
    - Conveyed whatever we needed ordered to Cristina
    - Researched more sterilization methods

Team Goals

- Learn about incorporating cells into the project from Dr. Sanchez de Diego
- Continue to improve the experimental setup and cooling mechanisms
- Document the entire experimental procedure
- For each run, gather data of timing, temperature, flow rates, any observations, and the resulting droplet size distribution to start correlating these variables for data analysis

Individual Goals

- Sam Kamin

    - Go to WIMR to learn about PDMS chip fabrication and plasma treating
    - Go to WIMR to learn how to incorporate cells from Dr. Sanchez de Diego
    - Document the complete working experimental setup and continue to make iterative improvements to it
    - Continue researching and prototyping
- Murphy Diggins
    - Print new molds and mass-produce devices
    - Learn how to encapsulate cells
- Will McGuire
    - Continued research
    - Print, PDMS, and Plasma treat seeping throughput
    - Experiment will cells
    - Continue experimenting with different flow rates.
- Dylan Libel
    - Continue to prototype and refine cooling fixtures
    - Finish up testing research and start implementing findings
    - Order any additional needed materials
    - Quantify droplet sizes in multiple trials
- Eduardo Usandivaras
    - Help the team begin testing with B and T cells
    - Print resin cooling sleeves for our syringes
    - Continue to find methods for measurement and data collection
- Vir Jaiswal
    - Visit WIMR next week
    - Help the team with collagen droplet formation
    - Try incorporating sterilization methods for the cells

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						
Product Design Specification		X													
Design Matrix			X												

Task	Sept.				Oct.				Nov.					Dec.	
	10	17	24	30	7	14	21	28	4	11	18	25		5	12
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	X						
Advisor	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						
Materials Acquisition								X	X						
Manufacturing															
Testing and Analysis															

Task	Sept.				Oct.				Nov.					Dec.	
	10	17	24	30	7	14	21	28	4	11	18	25		5	12
Website															
Progress Report	X	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															