

Bone marrow microenvironment culturing system for mesenchymal stem cells

msc_culture

Client: Dr. Wan-Ju Li

Advisor: Dr. Tracy Puccinelli

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Date: 12/20/17 – 12/26/17

Problem Statement:

Mesenchymal stem cells (MSCs) are widely studied for their valuable multipotent character that could enable tissue regeneration, especially in orthopedic injuries. Unfortunately, the yield of MSCs through extraction from bone marrow is low, and cells must be expanded in culture without the risk of spontaneous differentiation. Current culture methods are variable in their ability to maintain MSCs in a multipotent state, and do not adequately attempt to recreate the physiological conditions that prevent differentiation. For this reason, there is a need for a culture system that allows researchers to sustain multipotency in their cells by mimicking the bone marrow microenvironment through substrate stiffness and oxygen concentration.

Last Week's Goals:

- Discuss O2 Bioreactor ideas
- Update team on biomaterial progress
- Plan Outreach project
- Ask Dr. Puccinelli about the format of the midsemester report

Summary of Individual/Team Role Accomplishments:

- **Taylor Marohl:** Wrote progress report.
- **Veronica Porubsky:** Reached out to client to schedule a regular meeting. Requested materials to be ordered by the client's lab manager; documented this in the budget.
- **Michelle Tong:** N/A
- **Maddie Meier:** Started website.

Summary of Design Accomplishments/Literature Search:

- Discussed ideas for the O2 Bioreactor, resulting in multiple possible designs (each with challenges/flaws)
 - Build a small incubator with controllable oxygen tension from scratch
 - Build a unit that goes in an existing cell incubator that does not exchange gas with the incubator (just uses it for temperature)
 - Small gas tanks (like mini scuba tanks) sit in the incubator and feed to the culture system

- Gas lines run into the incubator from outside the incubator and feed to the culture system (this would require a seal on the incubator door to prevent leakage of temperature/gas/contamination)
 - Charge a device with gas to the desired oxygen concentration, place in incubator, and replace with gas periodically to maintain the appropriate oxygen tension
 - For each of these ideas, we would need to regulate oxygen, nitrogen, carbon dioxide, and humidity in our device within the incubator.
 - The gas output line would contain an oxygen sensor that feeds to an Arduino/computer to regulate the oxygen tension.
 - This system requires a mechanical component that releases more/less oxygen as necessary.
- Biomaterial evaluation will continue with a higher molecular weight PEGDA once materials are delivered
- We have a rough draft of our Outreach project, which has been approved by the organization leader in charge of the venue at which we will do our activity. Modifications will be made based upon feedback from Dr. Puccinelli this week. We will practice the activity this weekend and will complete the activity next Tuesday.

Activities:

Person	Task	Time	Weekly Total	Sem. Total
Taylor	-Progress report -Bioreactor research -Biomaterial "E" alternate testing methods -LabArchives setup -Review outreach activity	-1hr -1hr -0.5hr -0.5hr -0.5hr	3.5 hr	3.5 hr
Veronica	-Protocol research for updated biomaterial -Reagent search and order preparation	-5hr -2hr	7 hr	7 hr
Michelle	-Outreach activity	-6hr	6 hr	6 hr
Maddie	-Bioreactor ramp-up and presentation	-2hr	2 hr	2 hr
Team	-Team Meeting	-1.5 hr	1.5hr	1.5hr

Goals for This Week:

- Finalize a client meeting time
- Discuss O2 Bioreactor ideas with Dr. Nimunkar or a Bioinstrumentation TA.
- Complete a design matrix for a bioreactor to decide on a design.
- Finish planning the Outreach project
- Begin preparing the midsemester paper

Schedule for Upcoming Week :

- **Friday 2:30pm** Advisor Meeting
- **Thursday 6:00pm** Team Meeting

Difficulties:

- We tried reaching out to Dr. Nimunkar to discuss our bioreactor ideas and troubleshoot the options, but he has not gotten back to us. We will attempt to connect with a BioInstrumentation TA this Thursday during lab time.
- We have not yet been able to achieve our goal biomaterial stiffness. Veronica submitted a new materials request to Dr. Li's lab manager so that we may work with a higher molecular weight chemical. These materials will likely be ordered on Monday and will hopefully arrive next week.

Project Schedule/Timeline:

Color Key: Deliverables Bioreactor Biomaterial Outreach Questions

Mon 1/16 - Sun 1/22

- Discuss O2 bioreactor ideas (Maddie)
 - Take the week to research/plan any updates
- Update on biomaterial
 - Need to formulate a rationale for choosing our stiffness goal (100-200 Pa) so it can be included in our paper.
- Ask Dr. Puccinelli about format of midsemester report (scientific publication?)
- Plan Outreach project

Mon 1/23 - Sun 1/29

- Plan a client meeting
- Meet with Dr. Nimunkar/Bioinstrumentation TA to discuss bioreactor ideas/difficulties
- Design matrix for bioreactor
 - Decide on design, start discussing/researching materials
- Order new biomaterial materials, hopefully they arrive this week
- Finish planning Outreach project
- Begin preparing midsemester paper

Mon 1/30 - Sun 2/5

- Conduct outreach at Bayview Community Center on Tues (1/31) from 3:45-4:45pm
- Finish biomaterial experimentation
- Michelle - MSC cell training in Li lab
- Finalize bioreactor design, discuss materials
- PDS due Friday 2/3
- Continue working on midsemester paper, start working on presentation

Mon 2/6 - Sun 2/12

- Fabricate multiple biomaterial stiffnesses, freeze
- Michelle - MSC cell training in Li lab
- Order bioreactor materials
- Continue working on midsemester presentation and paper

Mon 2/13 - Sun 2/19

- Start cell evaluation on biomaterial
- Begin bioreactor fabrication
- **MIDSEMESTER PRESENTATION Friday 2/17**
- Finish midsemester paper

Mon 2/20 - Sun 2/26

- Continue cell evaluation on biomaterial, analyze data
- Continue bioreactor fabrication
- **MIDSEMESTER PAPER DUE Wednesday 2/22**

Mon 2/27 - Sun 3/5

- Finish cell evaluation on biomaterial, analyze data
- Finish bioreactor fabrication

Mon 3/6 - Sun 3/13

- Begin cell evaluation on bioreactor

Mon 3/14 - Sun 3/19

- Continue cell evaluation on bioreactor, analyze data

Mon 3/20 - Sun 3/26

- **SPRING BREAK**

Mon 3/27 - Sun 4/2

- Begin final cell evaluation on bioreactor + substrate

Mon 4/3 - Sun 4/9 (MADDIE GONE THIS WEEK)

- Continue final cell evaluation on bioreactor + substrate

Mon 4/10 - Sun 4/16

- Finish final cell evaluation, analyze data
- Begin working on poster, final report

Mon 4/17 - Sun 4/23

- Finish poster, continue working on final report

Mon 4/24 - Sun 4/30

- **Fri 4/28 FINAL POSTER PRESENTATION Friday 4/28**
- Finish final report

Mon 5/1 - Sun 5/7

- **Wed 5/3 FINAL REPORT DUE Wednesday 5/3**