PRELIMINARY SYLLABUS

BME 410L: Introduction to Biomaterials and Tissue Engineering

Units: 4
Lecture: TBD (two 80-minute lectures per week)
Lab: TBD (one 170-minute lab session per week)

Location: TBD

Instructor: Prof. Megan L. McCain
Office: DRB 318
Office Hours: TBD (one hour per week and by appointment)
Contact Info: mlmccain@usc.edu

Teaching Assistants: TBD
Office:
Office Hours:
Contact Info:

Course Description

This course introduces students to the cells, materials, and techniques used to engineer human tissues for applications in regenerative medicine and drug screening.

Extended Course Description

This course has both lecture and lab components. The first part of the course focuses on characteristics and sources of cells, with an emphasis on human stem cell acquisition and differentiation and associated ethical considerations. The second part focuses on the synthesis and characterization of biomaterials and techniques for engineering 2-dimensional (2-D) and 3-D scaffolds. The final part focuses on tissue engineering approaches specifically for the heart, as well as pathways of commercialization and translation for engineered tissues and Organs on Chips. During the lab sessions, students will be trained in many of the fundamental techinques introduced in the lectures, including cell culture, microscopy, biomaterial characterization, and microfluidic device fabrication. Students will be assessed through in-class work, group presentations, article summaries, exams, and lab reports.

Learning Objectives

(1) Describe the key features of cells and extracellular matrix that are pertinent to the form and function of human tissues.
(2) Compare and contrast common types of human stem cells, biomaterials, and techniques for engineering 2-D and 3-D scaffolds for tissue engineering.
(3) Implement several lab techniques routinely used in biomaterials and tissue engineering.

Course Outcomes

(1) Interpret and critique data from research papers related to tissue engineering.
(2) Collaborate with classmates to communicate important findings from research articles to the public.
(3) Demonstrate proficiency with several fundamental experimental techniques in tissue engineering.

(4) Generate professional images, graphs, analyses, descriptions, and interpretations of experimental data.
(5) Summarize the current state of tissue engineered products for regenerative medicine and drug screening in society today.
(6) Evaluate the ethical implications of different tissue engineering strategies.

Relationsihip to BME Student Outcomes (a-k):

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Course outcomes↓ Student Outcomes →	a	b	c	d	e	f	g	h	i	j	k
Outcome 1:	x						x			x	
Outcome 2:	x			x			x		x	x	
Outcome 3:	x	x	x	x	x				x	x	x
Outcome 4:	x	x			x	x	x				x
Outcome 5:	x							x	x	x	
Outcome 6:	x		x			x		x	x	x	
All course outcomes	x	x	x	x	x	x	x	x	x	x	x

Course Preparation

Co-Requisite: Chem 322A: Organic Chemistry
Recommended Preparation: BISC 220L: Cell Biology and Physiology; BISC 320L: Molecular Biology

Course Notes

Lecture slides are posted on Blackboard at least 24 hours before each lecture. All other course materials (syllabus, assignment descriptions, lab protocols, etc.) will also be posted on Blackboard.

Technological Proficiency and Hardware/Software Required

Students are required to bring an internet-enabled device with browser capabilities, such as a cell phone or a laptop to class. If you require an internet-enabled device, the USC Computing Center Laptop Loaner Program - USC Information Technology Services provides loaner laptops at the general-use computing centers in King Hall, Ahmanson Information Commons at Leavey Library, and Waite Phillips Hall. This service is only available to currently enrolled USC students with a

valid USCard. To check out a laptop, go to the service desk at an USC computing center and log into the laptop checkout webpage. https://itservices.usc.edu/spaces/computingcenters. For more information about the program, see: https://itservices.usc.edu/spaces/laptoploaner

Required Reading Assignments

Students should read the assigned reading materials (posted on Blackboard) before each lecture. Because this course does not follow a single textbook, students are highly encouraged to take notes during lecture and use the supplemental reading material as needed to clarify concepts from the lectures. Any topics that appear only in reading material (and not in lectures) will NOT be tested.

Description and Assessment of Assignments:

In-Class Work: Open-note quizzes, polls, or other similar assignments will be given in class throughout the semester at unannounced times and will be administered using Blackboard. The lowest two in-class work grades will be dropped to accommodate student illness, travel schedules, etc. There is no option to make-up in-class work.

Group Presentations: Twice in the semester, students will work in groups of 3-4 to present a journal club article in the form of a public science museum display during regular class time. All students will be assigned the same grade for the content of the presentation. More details regarding the presentation and a rubric will be distributed in a separate document.

Article Summaries: On presentation days, non-presenting students will read one of the articles (of their choice) that will be presented that day. Students will be asked to respond to a series of questions related to summarizing and critiquing the article. More details regarding the article summary and a rubric will be distributed in a separate document.

Exams: Two midterm exams will be administered during regular class time and a final exam will be administered during the final exam period. Midterm exams will not be cumulative. The final exam will be cumulative. Exams will focus on lecture material. Students may be tested on material that appears in lecture and not reading assignments, but not vice versa.

Pre-labs: Before each lab session, students will answer a series of questions related to comprehension of the protocol for that lab session to ensure that students read the protocol and lab time is used effectively.

Lab Reports: Throughout the semester, students will complete four lab reports. Each lab report relates to 2-4 lab sessions and will be similar in format to a short journal article, with sections for Introduction, Materials and Methods, Results (including figures), and Discussion. More details regarding lab reports and a rubric will be distributed in a separate document.

Students are expected to spend 8 hours per week on work outside of class, on average.

Assignment Submission Policy

Article summaries, pre-labs, lab reports, and group presentation files are to be submitted via Blackboard before the start date of the lecture or lab indicated on the syllabus. Article summaries and lab reports will be accepted late, but 10% of the total possible points will be subtracted every

24 hours, starting immediately after the due date and time. Late pre-lab assignments or group presentation files will not be accepted.

Grading Timeline

All assignments will be graded and grades will be posted on Blackboard within one week of the due date.

Grading Breakdown

Assessment	% of Grade
In-class work (~15)	5
Group presentations (2)	20
Article summaries (2)	6
Midterm exams (2)	24
Final exam (1)	16
Pre-labs (13)	5
Lab reports (4)	24
TOTAL	100

Grading Scale

Final letter grades will be assigned based on the mean and standard deviation (SD) of the class:

(mean + 0.75*SD) and above = A
(mean + 0.25*SD) to (mean + 0.75*SD) = A-
(mean – 0.25*SD) to (mean + 0.25*SD) = B+
(mean – 0.75*SD) to (mean - 0.25*SD) = B
(mean – 1.25*SD) to (mean – 0.75*SD) = B-
(mean – 1.75*SD) to (mean – 1.25*SD) = C+
(mean – 2.25*SD) to (mean – 1.75*SD) = C
(mean – 2.75*SD) to (mean – 2.25*SD) = C-
(mean – 4.25*SD) to (mean – 2.75*SD) = D
(mean – 4.25*SD) and below = F

Depending on the class distribution, grades may be altered from this structure, but only in a way that favors the students.

Regrade Policy

Regrade requests are due within one week of the date they are returned to the students. Students must type a justification for their request and submit it to Prof. McCain, stapled to the original assignment. Each student is limited to two regrade requests for any type of assignment throughout the semester. This does not include administrative errors (incorrect point additions, etc.), which should be brought to the attention of a TA immediately for correction without penalty.

Collaboration Policy

Students may work together on article summaries, pre-labs, and lab reports, but every student should write and submit their own individual assignments. Excluding multipe choice questions, any identical (or nearly identical) assignments will be given zero points. The Turnitin feature on

Blackboard will be used to check for plagiarism. Students may not work together for in-class work or exams. Plagiarism or other forms of academic misconduct will result in a zero grade for the assignment and will be reported to USC's Office of Student Judicial Affairs and Community Standards, as detailed at the end of the syllabus.

Technology Policy

During class time, students should use their devices only to participate in activities guided by the instructor or for note-taking. Use of devices for other purposes is not permitted. Device use for non-academic purposes that distracts the instructor or other students will result in no credit for in-class work for the day. During exams, device use is strictly prohibited and will result in a zero grade for the exam. Restroom use during exams is permitted, but all devices must be left with the instructor or TA at the front of the classroom.

Communication Policy

If a student has a question, he/she should follow these steps in order: (1) consult the syllabus; (2) ask a classmate; (3) review lecture slides and reading material; (4) ask a TA at office hours; (5) ask the instructor at office hours; (6) email the TA; (7) email the instructor. Emails that require short responses (at the discretion of the instructor or TA) will be answered within 24 hours between 9am-5pm on business days. Responses received on weekends or holidays will be delayed to the next business day. Emails that require a long response (at the discretion of the instructor or TA) will not be answered over email. Instead, the student will be directed to office hours.

Attendance Policy

Attendance for student presentations, lab sessions, and exam periods is mandatory and will only be excused in case of an emergency, at the discretion of the instructor. If a student knows in advance that he/she will be absent on the day of an exam, presentation, or lab for an important occasion (at the discretion of the instructor), notify the instructor as soon as possible or at least two weeks in advance such that arrangments can be made. Notifications given with less than two weeks notice cannot be excused.

Course Schedule

Week	Topics	Readings	Assignments
1	Lecture 0: Course introduction	-	-
	Lecture 1: Human cell and tissue structure	PTE Ch. 7	-
	Lab 0: Intro to lab	Lab policies	
2	Lecture 2: Cell harvesting and culture	PDF: cell culture	-
	Lecture 3: Structure and function of chromatin	MBoC Ch. 4, 6	-
	Lab 1: Cell culture and passaging	Lab 1 protocol	Pre-lab 1
3	No lecture (Labor Day)	-	-
	Lecture 4: Human embryonic stem cells	PTE Ch. 29	-
	Lab 2: Transmitted light microscopy and cell staining	Lab 2 protocol	Pre-lab 2
4	Lecture 5: Adult stem cells	PTE Ch. 31	-

	Lecture 6: Induced pluripotent stem cells	PTE Ch. 30	-
	Lab 3: Fluorescent microscopy	Lab 3 protocol	Pre-lab 3
5	Lecture 7: Stem cell differentiation	PTE Ch. 4	-
	Lecture 8: Gene editing	PDF: gene editing	-
	Lab 4: Image processing and analysis	Lab 4 protocol	Pre-lab 4
6	A Presentations - Groups 1-5	Groups 6-10 only: Group 1-5 article of choice	Groups 6-10 only: Group 1-5 article summary
	A Presentations – Groups 6-10	Groups 1-5 only: Group 6-10 article of choice	Groups 1-5 only: Group 6-10 article summary
	Lab 5: Gelatin hydrogel fabrication	Lab 5 protocol	Lab report 1 (labs 1-4) Pre-lab 5
7	Midterm exam 1 (Lectures 1-8)	-	-
	Lecture 9: Introduction to biomaterials	PDF: biomaterial properties PTE Ch. 25	-
	Lab 6: Mechanical characterization of hydrogels	Lab 6 protocol	Pre-lab 6
8	Lecture 10: The extracellular matrix	PTE Ch. 10	
	Lecture 11: Natural biomaterials	PDF: natural biomaterials	
	Lab 7: PDMS stamp fabrication and coverslip spin-coating	Lab 7 protocol	Lab report 2 (labs 5-6) Pre-lab 7
9	Lecture 12: Non-degradable synthetic biomaterials	PDF: synthetic hydrogels	
	Lecture 13: Photolithography and microcontact printing	Microntact printing review	
	Lab 8: Microcontact printing	Lab 8 protocol	Pre-lab 8
10	Lecture 14: Microfluidics and Organs on Chips	PDF: microfluidics PDF: Organs on Chips	
	Lecture 15: Degradable synthetic biomaterials	PTE Ch. 23	
	Lab 9: Immunostaining	Lab 9 protocol	Pre-lab 9
11	Lecture 16: Engineering 3-D tissues: porous scaffolds, nanofibers, and self-assembly	PDF: 3-D scaffold fabrication	
	Lecture 17: Bioprinting	PDF: bioprinting	
	Lab 10: Imaging and image analysis	Lab 10 protocol	Pre-lab 10
12	B Presentations - Groups 1-5	Groups 6-10 only: Group 1-5 article of choice	Groups 6-10 only: Group 1-5 article summary

	B Presentations – Groups 6-10	Groups 1-5 only: Group 6-10 article of choice	Groups 1-5 only: Group 6-10 article summary
	Lab 11: Microfluidic device design	Lab 11 protocol	Pre-lab 11 Lab report 3 (labs 7-10)
13	Midterm exam 2 (Lectures 9-17)		-
	Lecture 18: Cardiac tissue engineering: cell source	PTE Ch. 38	
	Lab 12: Microfluidic device fabrication	Lab 12 protocol	Pre-lab 12
14	Lecture 19: Cardiac tissue engineering: scaffolds and Heart on a Chip	PDF: Heart on a Chip	
	No lecture (Thanksgiving)	-	-
	No lab (Thanksgiving)	-	-
15	Lecture 20: Commercialization and ethical considerations for engineered tissues and Organs on Chips	PDF: Organs on Chips companies PTE Ch. 86, 88	
	Lecture 21: Engineered skin tissues in the clinic	PTE Ch. 77	
	Lab 13: Microfluidic device testing	Lab 13 protocol	Pre-lab 13
FINAL	Final Exam (Lectures 1-21) Refer to the final exam schedule in the USC *Schedule of Classes* at classes.usc.edu.		Lab report 4 (labs 11-13) (due by the final exam time scheduled for your lab section)

Statement on Academic Conduct and Support Systems

Academic Conduct: Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention and Services (RSVP) - (213) 740-9355(WELL), press "0" after hours – 24/7 on call studenthealth.usc.edu/sexual-assault
Free & confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED)- (213) 740-5086 | Title IX – (213) 821-8298
equity.usc.edu, titleix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following *protected characteristics*: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations. The university also prohibits sexual assault, non-consensual sexual contact, sexual misconduct, intimate partner violence, stalking, malicious dissuasion, retaliation, and violation of interim measures.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs - (213) 740-0776 dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Support and Advocacy - (213) 821-4710 uscsa.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101 diversity.usc.edu
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.