

**Tissue Engineering:
27-520 / 42-699 E
Spring 2014**

**Carnegie Mellon University
Department of Materials Science and Engineering
Department of Biomedical Engineering**

Course Pages, Blackboard
(<http://www.cmu.edu/blackboard/>)

Course Overview:

Cells integrate local mechanical, physical and chemical interactions via a host of signaling pathways. Recent advances in microscale engineering and materials science have enabled precise control of this interface between cells and surfaces, i.e. the biotic/abiotic interface. The student will learn physical laws governing cellular homeostasis including the role of the microenvironment on cell life, death, and differentiation and how to control cellular function and genetic programs by adhesion to substrates. Focus will be placed on the interaction between cell shape, substrate mechanics, receptor mediated adhesion and applied force with mechanical and chemical signal transduction pathways.

Course Goals:

This course will train students in advanced cellular and tissue engineering methods that apply physical, mechanical and chemical manipulation of materials in order to direct cell and tissue function. Students will learn the techniques and equipment of bench research including cell culture, immunofluorescent imaging, soft lithography, variable stiffness substrates, application/measurement of forces and other methods. Students will integrate classroom lectures and lab skills by applying the scientific method to develop a unique project while working in a team environment, keeping a detailed lab notebook and meeting mandated milestones. Emphasis will be placed on developing the written and oral communication skills required of the professional scientist. The class will culminate with a poster presentation session based on class projects.

Course Objectives:

- To understand the fundamentals of tissue engineering including cells and scaffolds.
- To train students in cutting-edge cell and tissue engineering laboratory techniques.
- To develop the skills needed to formulate a hypothesis and work on a scientific team towards a well-defined research objective.

Tissue Engineering**27-520 / 42-699 E****Spring 2014****12 Units**Course Blackboard Page: <http://www.cmu.edu/blackboard/>

Blackboard Course Name: S13-Special Topics: Tissue Engineering

Lectures:

Instructor: Adam W. Feinberg, Ph.D.

Office: PTC 4315

Office: Roberts Hall 143

Phone: 8-4897

Email: feinberg@andrew.cmu.edu

Lecture Days: Monday / Wednesday / Friday (exact days vary by week)

Lecture Times: 9:30 PM — 11:20 PM

Location: Smith Hall 125

Office Hours: Professor Feinberg will be available after each lecture day for 45 min. If you cannot make these times then please make an appointment by email. I will schedule other extra help times near the exam dates.

Location: Smith Hall 125

Laboratory:

TA: Rebecca Duffy

Office: PTC 4204

Email: rduffy@andrew.cmu.edu

TA: TJ Hinton

Office: PTC 4204

Email: thinton@andrew.cmu.edu

Lab Days: Variable

Lab Times: 9:30 AM — 11:20 AM

Lab Location: Smith Hall 125

Office Hours: The TA's will be available during each lab session.

Location: Smith Hall 125

Policies**Attendance:**

Lecture attendance is MANDATORY and is important for your success in this class.

Class participation is HIGHLY recommended. In-class exchanges lead to a better understanding of the subject matter, and they provide me (the instructor) with an opportunity to discern what material needs additional/less coverage.

Laboratory attendance is MANDATORY!!! Makeup of a missed laboratory is subject to the discretion of Prof. Feinberg.

Grading:

- 20 % Exam #1 (Covering lecture, assigned readings and laboratory materials)
- 20 % Exam #2 (Covering lecture, assigned readings and laboratory materials)
- 20 % Laboratory reports
- 15 % Team taught lecture
 - Student research teams will collaborate to prepare and deliver a 50 minute lecture on the assigned topic. The students will prepare PPT slides and handouts and submit five exam questions based on their presentation.
- 20 % Final Team-Based Project (Proposal and Poster Presentation)
 - Each team will conceive a novel hypothesis using the model cell-line available in the class and apply the learned skills to test it.
 - The team will be required to create a proposal for the project. There will be an initial presentation of the proposal to the class and feedback will be provided. Teams will then create a short written proposal based on the feedback.
 - For the final report, groups will be expected to present a poster that details their work from throughout the semester.
- 5 % Peer Assessment, (group members will evaluate themselves and each other to generate a peer assessment score)
- Unless otherwise told, the final grades will be based on the following scale:
A > 90 > B > 80 > C > 70 > D > 60 > R

Notes:

- The two exams will cover only the materials covered since the last exam.
- The Final Project will be comprehensive in scope meaning students will be expected to incorporate relevant skills they have learned in the laboratory and integrate this with topics covered in lecture.

All assignment must be submitted on time to receive full credit. Late assignments will be penalized 20% per day.

Cheating is unacceptable in any form!

TextsRequired:

1. "Tissue Engineering," Senior Editor Clemens Van Blitterswijk, Elsevier Inc., (2008). (Available online)
2. Selected articles from the current literature (To be posted on blackboard).
3. Laboratory Protocols (To be posted on blackboard).
4. Laboratory Notebook (To be purchased by you. The type will be discussed on the first Friday of classes. You can contact Dr. Feinberg if you have questions and you can purchase an appropriate book in the bookstore.)

Recommended (additional reading options):

1. Tissue Engineering: Engineering Principles for the Design and Replacement of Organs and Tissues, Mark Saltzman, 2004.
2. Tissue Engineering, Palsson and Bhatia, Pearson Prentice Hall, 2004..
3. Biomaterials Science: An Introduction to Materials in Medicine, Second Edition, Buddy Ratner et. al., Elsevier Academic Press, 2004.
4. Cell and Tissue Reaction Engineering, Regine Eibl, Dieter Eibl, Ralf Pörtner, et. al., Springer, 2008.

27-520 / 42-699 E Spring 2014: Projected Schedule

Week	Monday	Wednesday	Friday	Assignments
#1, Jan 13, 15, 17	Course Introduction	Overview of Cell Biology	Lab: Intro to Laboratory Skills Demo: Microscopy	Read: Intro (01/17) Form Teams
#2, Jan 20, 22, 24	Demo: Cell Culture Lab 1: Part 1, Cell Culture	Stem Cells	Demo: ImageJ Demo: Substrate Fabrication	Read: Ch1,
#3, Jan 27, 29, 31	Lab 1: Part 2, Cell Differentiation	Morphogenesis, embryonic development	Tissue Homeostasis	Read: Ch2, Ch3, Ch11,
#4, Feb 3, 5, 7	Lab Report Overview Demo: Fixation, staining & imaging	Cellular Signaling	Extracellular Matrix	Read: Ch4, Ch5
#5, Feb 10, 12, 14	Lab 2: 2D Muscle Tissue Engineering	Natural Polymers in Tissue Engineering	Synthetic Polymers in Tissue Engineering	Read: Ch6, Ch7 (02/14) Lab 1 Due
#6, Feb 17, 19, 21	Cytoskeleton and Cell Motility	Cell Source and Cell Nutrition	(Lab Open)	Read: Ch10, Ch12, handouts
#7, Feb 24, 26, 28	Exam #1 (Lab Open)	Demo: Microfab, 3D Printing (at PTC)	Lab 3: 3D Muscle Tissue Engineering	
#8, Mar 3, 5, 7	Teams Present: (1) Myogenesis (2) Contractility	Teams Present: (3) Tissue Eng (4) Regen Medicine	<i>No Lecture or Lab</i> (Spring Break)	Read: Handouts (03/06) Lab 2 Due
#9, Mar 10, 12, 14	<i>No Lecture or Lab</i> (Spring Break)	<i>No Lecture or Lab</i> (Spring Break)	<i>No Lecture or Lab</i> (Spring Break)	
#10, Mar 17, 19, 21	Scaffold Design & Fabrication	Bioreactors	Project Proposals: All Teams Present	Read: Ch 14, Ch16
#11, Mar 24, 26, 28	Lab 4: 3D Printed Scaffolds	No Lecture (work on Lab or Proposal)	Controlled Release	Read: Ch15 (03/28) Lab 3 Due
#12, Mar 31, Apr 2, 4	Team Based Project (Lab Open)	Ophthalmic Tissue Engineering	Cardiac Tissue Engineering	Read: Handouts (03/31) Written Project Proposal Due
#13, Apr 7, 9, 11	Current Topics in Tissue Engineering	Current Topics in Tissue Engineering	No Class, Lab Open (Spring Carnival)	Read: Handouts (04/11) Lab 4 Due
#14, Apr 14, 16, 18	Exam Review	Exam # 2 (Lab Open)	Team Based Project (Lab Open)	
#15, Apr 21, 23, 25	Future Perspectives Tissue Engineering	Team Based Project (Lab Open)	Team Based Project (Lab Open)	Read: Handouts
#16, Apr 28, 30 May 2	Team Based Project (Lab Open)	Team Based Project (Lab Open)	Final Poster Presentation	(05/02) Final Poster