

**TO:** The Faculty of the College of Engineering  
**FROM:** The Davidson School of Chemical Engineering  
**RE:** New Graduate Course, CHE 52100 Principles of Tissue Engineering

The faculty of the Davidson School of Chemical Engineering have approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

**Course:** CHE 52100 Principles of Tissue Engineering  
Fall/Spring, Lecture, Cr. 3  
Restrictions: May not be enrolled as the following Classifications  
Freshman: 0 - 14 hours  
Freshman: 15 - 29 hours  
Sophomore: 30 - 44 hours  
Sophomore: 45 - 59 hours  
Junior: 60 - 74 hours  
Junior: 75 - 89 hours

**Description:**

This course is designed to provide background for the application of engineering principles with the life sciences to facilitate understanding of normal and pathological mammalian tissues. Applications of drug delivery, tissue and cell transplantation, bioartificial organs, tissue regeneration, disease models, and applications in clinical practice will be explored.

**Reason:** This course has been taught as Principles of Tissue Engineering CHE 59700, in the spring of 2011 semester with 14 students, in the spring of 2012 semester with 17 students, during the fall 2013 semester with 11 students, in the spring 2016 semester with 14 students and spring 20 semester with 7 students. This course is also cross listed with BME 59500.



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Sangtae Kim  
Jay and Cynthia Ihlenfeld Head of Chemical Engineering

**BME 595/CHE 597**  
**Principles of Tissue Engineering**  
**(3-Credit)**

**Instructor:** Prof. Solorio [lsolorio@purdue.edu](mailto:lsolorio@purdue.edu) 496-1956 Office: MJIS 3019  
Prof. Liu [julieliu@ecn.purdue.edu](mailto:julieliu@ecn.purdue.edu) 494-1935 Office: FRNY 1160

**Office Hours:** By appointment

**Lectures** Tues, Thurs 10:30 AM – 11:45 AM FRNY G124

### **Objectives**

This course is designed to provide background for the application of engineering principles with the life sciences to facilitate understanding of normal and pathological mammalian tissues. Applications of drug delivery, tissue and cell transplantation, bioartificial organs, tissue regeneration, disease models, and applications in clinical practice will be explored.

### **Learning Outcomes**

By the end of this course students will:

1. Understand the importance of cell sources, material properties, and mass transport on tissue structure and function
2. Be able to design a rational experiment and have improved understanding for how to characterize and analyze tissue engineered constructs
3. Improve their ability to present new concepts and ideas to a group of students and potential investors

### **Teaching Philosophy**

Learning is an active process. Learning should not be passive, such as simply listening to lectures, making notes, and taking exams. The most effective learning is through active participation, including asking questions, presenting opinions, and making suggestions. This course is designed to maximize students' participation in classes with free discussions, debates, and dialogues.

### **Learning Resources, Technology, and Texts**

All lecture materials will be made available through Blackboard Learn (<https://mycourses.purdue.edu/>), and Kahoots! will be used in class to evaluate the students understanding of concepts presented in lectures.

#### Recommended Textbooks:

*Tissue Engineering*, Bernhard Palsson *et al.*, CRC Press, 2003. Available free as an electronic resource through the Purdue Library.

*Principles of Tissue Engineering*, Robert Langer *et al.*, CRC Press, 2014. Available free as an electronic resource through the Purdue Library.

*Tissue Engineering*, Clemens van Blitterswijk *et al.*, Academic Press Series in Biomedical Engineering, 2015. Available free as an electronic resource through the Purdue Library.

Supplemental Textbooks:

*Tissue Engineering*, Bernhard O. Palsson and Sangeeta Bhatia, Prentice Hall, 2004. On reserve in Library of Engineering and Science.

*Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues*, W. Mark Saltzman, Oxford University Press, 2004. Available free as an electronic resource through the Purdue Library.

**Grading**

Students are expected to attend class, participate in discussions, read all handout materials, and do homework (due at the beginning of lecture). It is possible that the whole homework assignment may be graded or that only specific problems on a homework assignment may be graded. As part of a 3-4 member team, students will drive the critical review of a primary journal article and will also teach topics related to the article to the class. Articles will be suggested by the instructors, but students may choose their own article as long as it is approved by the instructors. The article presentation is designed to train students how to collect, analyze, and utilize information on a research topic and to improve their presentation skills. Throughout the semester, students will work in teams to prepare an R21-based project proposal or business pitch. Students will turn in a written report and give a presentation at the end of the semester. The proposal will be critiqued by the instructor as well as by other students in the class. The proposal topic will be selected by the students and approved by the instructors. Missed or late work will not be accepted. Any requests for regrade must be made in writing and within a week after the assignment was available to be handed back to students. For group activities, we will collect from each group member a peer evaluation on the degree of participation of all group members, the results of which will be used to adjust the grade you actually receive for that group activity.

Assignments	Due	Weighting
Participation in class discussion	Throughout the semester	5%
Homework assignments	Throughout the semester	15%
Article Presentation	Throughout the semester	30%
Final Project Report and Presentation	Presentations: April 23, 28, & 30, 2020 Report: April 30, 2020	50%

The final grades will be assigned based primarily on the absolute performance and secondarily on the relative performance. The following grading scale is guaranteed but may be modified based on relative student performance:

A+	98%-100%	C	74-76%
A	94-97%	C-	70-73%
A-	90-93%	D+	67-69%
B+	87-89%	D	64-66%
B	84-86%	D-	60-63%
B-	80-83%	F	<60%
C+	77-79%		

## **Attendance Policy**

Students are expected to attend all classes. Sometimes an unavoidable situation may occur and excuse a student from attending the class. In that situation, please consult with the instructors before class or, if due to an emergency, immediately afterwards. Any unexcused absences will negatively impact your class participation grade and result in a zero for scheduled presentations or assignments due during that class period.

## **E-mail**

Occasionally, important class announcements will be disseminated through the class e-mail list. It is your responsibility to regularly check your e-mail every day and to read the e-mails regarding BME 595/CHE 597 to receive important class information. If you e-mail Profs. Solorio or Liu with questions or a request to make an appointment, please allow a minimum of 24 hours for a response during the week (or a response by Monday evening if the e-mail is sent on the weekend).

## **Academic Integrity**

The highest standards of academic honesty are expected. The Purdue Honor Pledge is: “As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue.” Purdue University’s policy on academic dishonesty states that “the commitment of the acts of cheating, lying, stealing, and deceit in any of their diverse forms (such as the use of ghost-written papers, the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest” (University Senate Document 72-18, December 15, 1972). In this course, cheating, plagiarism, or any act of dishonesty will not be tolerated.

Plagiarism means “to use and to pass off someone else’s ideas, inventions, writings, etc. as one’s own” (New Webster’s Dictionary and Thesaurus, 1992). This course will use SafeAssign to check for plagiarism. In this course, it is expected that you generate new ideas and new writing for the homework, writing assignments, in class presentations, and final project. This course will consider it academically dishonest to submit work that has been submitted for a grade in another course. In addition, this course will consider it academically dishonest to submit work that has been used previously in a manuscript or for a graduate exam (e.g., qualifying or preliminary exam, qualifying literature assessment). Any participation in an academically dishonest practice such as plagiarism may result in an F on the pertinent homework assignment or group assignment.

Any incidents of academic dishonesty will be reported to the Office of Student Rights and Responsibilities where university penalties, including removal from the university, may be considered. The first offense will result in an F on the pertinent homework assignment, recitation activity, project, exam, or lab report. A second offense will result in an F grade for the course.

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing or by calling 765-494-8778. While the information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern.

## **Students with Disabilities**

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let us know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at [drc@purdue.edu](mailto:drc@purdue.edu) or by phone: 765-494-1247.

In addition to the University policy, the Davidson School of Chemical Engineering has established procedures for students seeking accommodations. These can be found online at the ChE Undergrad Office website. Only those accommodation requests that conform to both University and ChE policy guidelines will be implemented.

Some important points from the CHE policy include: Please give letters of accommodation to Prof. Solorio, Prof. Liu, and your academic advisor. If you have your letter at the start of the term, we strongly recommend you give it to us within the first two weeks of the semester.

## **Bereavement Policy**

Purdue recognizes that a time of bereavement is very difficult for a student. The University therefore provides rights to students facing the loss of a family member through the Grief Absence Policy for Students (GAPS): [http://www.purdue.edu/studentregulations/regulations\\_procedures/classes.html](http://www.purdue.edu/studentregulations/regulations_procedures/classes.html). Students who find themselves in need of assistance in a time of bereavement should contact Profs. Liu and Narsimhan privately to discuss specific needs.

## **Nondiscrimination Statement**

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Purdue's nondiscrimination policy can be found at: [https://www.purdue.edu/purdue/ea\\_eou\\_statement.php](https://www.purdue.edu/purdue/ea_eou_statement.php)

Purdue University prohibits discrimination against any member of the University community on the basis of race, religion, color, sex, age, national origin or ancestry, genetic information, marital status, parental status, sexual orientation, gender identity and expression, disability, or status as a veteran. The University will conduct its programs, services and activities consistent with applicable federal, state and local laws, regulations and orders and in conformance with the procedures and limitations as set forth in Executive Memorandum No. D-1, which provides specific contractual rights and remedies. Any student who believes they have been discriminated against may visit [www.purdue.edu/report-hate](http://www.purdue.edu/report-hate) to submit a complaint to the Office of Institutional Equity. Information may be reported anonymously.

## **Emergency Preparation**

In the event of a major campus emergency, course requirements, deadlines, and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructors' control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors. You are expected to read your @purdue.edu email.

## **Mental Health Statement**

- If you find yourself beginning to feel some stress, anxiety, or feeling slightly overwhelmed, try WellTrack. Sign in and find information and tools at your fingertips, available to you at any time.
- If you need support and information about options and resources, please see the Office of the Dean of Students for drop-in hours (M-F, 8 am- 5 pm).
- If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office of the second floor of the Purdue University Student Health Center (PUSH) during business hours.

## **Violent Behavior Policy**

Purdue University is committed to providing a safe and secure campus environment for members of the university community. Purdue strives to create an educational environment for students and a work environment for employees that promote educational and career goals. Violent Behavior impedes such goals. Therefore, Violent Behavior is prohibited in or on any University Facility or while participating in any university activity.

## **Course Evaluation**

During the last two weeks of the course, students will be provided with an opportunity to evaluate this course and your instructor. Purdue uses an online course evaluation system. You will receive an official email from evaluation administrators with a link to the online evaluation site. You will have up to two weeks to complete this evaluation. Your participation is an integral part of this course, and your feedback is vital to improving education at Purdue University. I strongly urge you to participate in the evaluation system.

## **Use of Copyrighted Materials**

Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Thus, these materials cannot be posted online. Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.

Notes taken in class are, however, generally considered to be "derivative works" of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to

other students or to any commercial concern, for a course without the express written permission of the course instructor. To obtain permission to sell or barter notes, the individual wishing to sell or barter the notes must be registered in the course or must be an approved visitor to the class. Course instructors may choose to grant or not grant such permission at their own discretion, and may require a review of the notes prior to their being sold or bartered. If they do grant such permission, they may revoke it at any time, if they so choose.

### **Emergency Procedures**

In the event that the class would need to evacuate FRNY (e.g., in the event of a fire alarm), the class should proceed to exit the building and meet in front (i.e., on the fountain side of the MSEE Building) or, in the case of inclement weather, inside of MSEE. Do not leave the area as emergency responders will need to count to ensure that all persons have made it from the facility. In the event that we are required to shelter in place (e.g., due to a tornado warning), we will proceed to the appropriate shelter in place area within the lower levels of FRNY (i.e., immediately outside of B124).

### **Disclaimer**

This syllabus is subject to change. If any change occurs, it will be announced in the class.

## Tentative Course Outline

#	Date	Lecture Contents	Lecturer
1	1/14	Course Philosophy & History of Tissue Engineering	LS
2	1/16	Microscopy Techniques	LS
3	1/21	Developmental Biology and Cell Sources, Part 1	JL
4	1/23	Developmental Biology and Cell Sources, Part 2	JL
5	1/28	The ECM, Integrins, and Cell Migration, Part 1	JL
6	1/30	The ECM, Integrins, and Cell Migration, Part 2	JL
7	2/4	Polymeric Matrixes and Functionalization	LS
8	2/6	Microvascularization	LS
9	2/11	<b>Group 1/2:</b> Polymeric Materials and ECM Based Systems	
10	2/13	Models of Mass Transport	JL
11	2/18	Systems Biology and Microfluidics	LS
12	2/20	<b>Group 3/4:</b> Math Modeling and Mass Transport	
13	2/25	Controlled Release Part 1	JL
14	2/27	Controlled Release Part 2	JL
15	3/3	Mechanical Properties of Tissues	JL
16	3/5	<b>Group 5/6:</b> Microfluidics	
17	3/10	Mechanotransduction	LS
18	3/12	<b>Group 7/8:</b> Controlled Release and Cell Migration	
	<b>3/16-3/20</b>	<b>Spring Break</b>	
19	3/24	Role of YAP/TAZ on Mechanotransduction	LS
20	3/26	Effects of Viscoelasticity on Differentiation	LS
21	3/31	Disease Models, Part 1	LS
22	4/2	Disease Models, Part 2	LS
23	4/7	<b>Group 9/10:</b> Viscoelasticity and Mechanotransduction	
24	4/9	Immune Engineering	JL
25	4/14	Ethics Roundtable + <b>Group 11:</b> Disease Models	
26	4/16	<b>Group 12/13:</b> Immune Environments and Differentiation	



27	4/21	Tissue Engineering in Industry	Loran Solorio
28	4/23	Final Project Presentation	
29	4/28	Final Project Presentation	
30	4/30	Final Project Presentation	