

OAKLAND UNIVERSITY
College of Arts and Sciences
Department of Biological Sciences

COURSE: Tissue Engineering

COURSE #: BE 4400

DAY/TIME: Monday, Wednesday and Friday

YEAR: 2018

PROFESSOR: Luis G. Villa-Diaz, D.V.M., M.Appl.Sc, Ph.D. Assistant Professor,
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COURSE DESCRIPTION:

Tissue homeostasis is dictated by the interaction of cells with the surrounded microenvironment, which consist in neighboring cells and extracellular matrix, and which local mechanical, physical and chemical interconnections are integrated via signaling pathways. Micro-scale engineering and materials science have enabled precise control of this interface between cells and surfaces. In this class, students 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 OBJECTIVES:

This course satisfies the following program objectives (PO's):

-Apply knowledge of biological and physical sciences, mathematics, and engineering to solve problems at the interface of engineering and biology (student outcome "a, h, j, m, and n" in ABET accreditation protocol).

-Design a Biomedical Engineering system, component, and/or process that meets specific needs (student outcome "b, l and m" ABET in accreditation protocol).

- Demonstrate understanding of relevant technical, professional, and ethical issues (student outcome "f" in ABET accreditation protocol).

-Communicate effectively in verbal, written, and graphical formats (student

outcome “f and g” in ABET accreditation protocol).

At the end of this course the students should be able to:

- 1) Describe what is meant by the term "tissue engineering (TE)"
- 2) Explain basic principles of host response and tissue integration
- 3) Give examples of cell sources and cite their specific characteristics
- 4) List different strategies to modify and/or design TE constructs
- 5) Describe how TE constructs are fabricated and produced
- 6) Explain what biodegradability is and how it affects tissue integration
- 7) Describe specific applications of TE constructs
- 8) Read, understand and assimilate papers, publications and lectures pertaining to the field of TE and have broad understanding of TE research

ABET Program Outcomes

- 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 multidisciplinary 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.
- l. Applying principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations) and statistics;
- m. Solving bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems;
- n. Analyzing, modeling, designing, and realizing bio/biomedical engineering devices, systems, components, or processes; and
- o. Making measurements on and interpreting data from living systems.

REQUIRED TEXTBOOK:

"Tissue Engineering, 2nd Edition" Senior Editor Clemens Van Blitterswijk, Elsevier Inc. (Available online)

OFFICE HOURS: Monday-Wednesday-Friday, 1:00-2:30 pm., or just drop by my office and if I have time at that moment I will be happy to assist you. **NOTE:** I encourage you to contact me in person in my office hours, and **NOT** by email, because due to high volume of emails that I get, I might miss yours and not response to you.

Office hours are to be used to ask questions about course material. As a general rule, office visits should be no longer than 15 minutes, which will allow other students to have access as well. You should prepare for the meeting by making a list of specific questions. Those questions should be about the scientific content of the course, and not about what material will appear on an exam.

CREDITS: 4

PREREQUISITES/COMMENTS: BIO 1200; BIO 1300 or 2600; CHM 1440 and CHM 1470. Each course must be completed with a grade of 2.0 or higher.

EXAMS: There will be 2 mid-term exams and a final exam on the dates given in the course schedule. Use of personal computers, electronic planners, and telephones are **forbidden** during the exams.

YOU WILL NEED TO PRESENT YOUR *OU ID* TO TURN IN ALL EXAMS

GRADING CRITERIA:

Each of the two mid-term exams during the semester will be worth 150 points and the final is worth 200 points for a total of 500 points for the course. Your grade will be determined by the percent of total points earned on the following scale:

%	grade	%	grade	%	grade	%	grade	%	Grade
100	4.0	89	3.4	79	2.7	69	2.0	59	1.3
99	4.0	88	3.4	78	2.6	68	1.9	58	1.2
98	4.0	87	3.3	77	2.6	67	1.9	57	1.1
97	4.0	86	3.2	76	2.5	66	1.8	56	1.1
96	3.9	85	3.1	75	2.4	65	1.7	55	1.0
95	3.9	84	3.1	74	2.4	64	1.6	54	0.0
94	3.8	83	3.0	73	2.3	63	1.6		
93	3.7	82	2.9	72	2.2	62	1.5		
92	3.6	81	2.9	71	2.1	61	1.4		
91	3.6	80	2.8	70	2.1	60	1.4		
90	3.5								

There is not curve grading. Please be aware that your grade is what you earn based on your performance. The 4.0 grade starts at 97%.

Note: Do not be deceived by this grading scale. The fact that 97% earns a 4.0 does not mean that is easy to get a good grade, and the fact that 55% is passing does not mean that it is easy to pass. The exams are designed to be challenging so that a student who scores 97% really deserves a 4.0, and likewise for the rest of the grade scale.

There will be no dropping of scores or individual extra credit assignments.

CLASS POLICIES:

ATTENDANCE AND ABSENCE POLICY:

This is a fast paced course with a large amount of material being covered and you are strongly encourage to read in advance prior to class to familiarize yourself with the material.

Attendance in class is necessary and students are responsible for all material presented and announcements made in class.

Students who must reschedule exams and or assignments due to religious observances or other personal matters should notify the instructor in advance. Students with disabilities who require special accommodations during classes or examinations should contact the Office of Services to Students with Disabilities to ensure that appropriate arrangements are made.

Assignments and examinations will be graded and returned to students as soon as possible after being handed in. Students should check the grading carefully. Any grade appeals must be made within one week of the return of the assignment or exam.

The chapter lecture slides will be available from the BIO 309 OU Moodle site. Make sure you do so prior to coming to class, since handouts of the lecture slides will NOT be provided.

At any time during lecture I may expand on the topic at the blackboard. When I do, this material may ends up on exams, so it's in your best interest to attend every class session.

Unexcused absence from exams will results in a grade of 0 for the exam. In the case of unexpected absence due to illness, **a note from a physician is required to make up the exam.**

Make up exams will be in the oral form.

-Unethical and non-courteous conduct is not tolerated.

-Unethical conduct should be avoided during an exam otherwise, unethical conduct during an exam will result in the forfeiture of the exam and a grade of 0.0.

-Talking is not allowed during exams. At the discretion of the instructor any case of academic misconduct can be taken to the Academic Misconduct Committee for

disciplinary action. Students can consult the college catalog for a definition of academic integrity.

-There is no eating during class, but non-alcoholic drinks are permitted.

-Please turn off beepers and cell phones to prevent disruptions during class and please show some courtesy by removing your hats/caps. This last rule is especially in place during exams.

Academic conduct policy: All members of the academic community at Oakland University are expected to practice and uphold standards of academic integrity and honesty. Academic integrity means representing oneself and one's work honestly. Misrepresentation is cheating since it means students are claiming credit for ideas or work not actually theirs and are thereby seeking a grade that is not actually earned. Following are some examples of academic dishonesty:

- a. **Cheating on examinations.** This includes using materials such as books and/or notes when not authorized by the instructor, copying from someone else's paper, helping someone else copy work, substituting another's work as one's own, theft of exam copies, or other forms of misconduct on exams.
- b. **Plagiarizing the work of others.** Plagiarism is using someone else's work or ideas without giving that person credit; by doing this students are, in effect, claiming credit for someone else's thinking. Whether students have read or heard the information used, they must document the source of information. When dealing with written sources, a clear distinction should be made between quotations (which reproduce information from the source word-for-word within quotation marks) and paraphrases (which digest the source of information and produce it in the student's own words). Both direct quotations and paraphrases must be documented. Even if students rephrase, condense or select from another person's work, the ideas are still the other person's, and failure to give credit constitutes misrepresentation of the student's actual work and plagiarism of another's ideas. Buying a paper or using information from the World Wide Web or Internet without attribution and handing it in as one's own work is plagiarism.
- c. **Cheating on lab reports** by falsifying data or submitting data not based on the student's own work.
- d. Falsifying records or providing misinformation regarding one's credentials.
- e. Unauthorized collaboration on computer assignments and unauthorized access to and use of computer programs, including modifying computer files created by others and representing that work as one's own.

Add/Drops: The university policy will be explicitly followed. It is the student's responsibility to be aware of deadline dates for dropping courses.

Special Considerations: Students with disabilities who may require special accommodations should make an appointment with campus Disability Support Services, 106 North Foundation Hall, phone 248 370-3266. Students should also bring their needs to the attention of the instructor as soon as possible by providing the "Letter of Accommodations" created by DSS. For academic help, such as study and reading

skills, contact the Academic Skills/Tutoring Center, 103 North Foundation Hall, phone 248 370-4215.

Excused Absence Policy: This policy for university excused absences applies to participation as an athlete, manager or student trainer in NCAA intercollegiate competitions, or participation as a representative of Oakland University at academic events and artistic performances approved by the Provost or designee.

Students shall inform me of dates they will miss class due to an excused absence prior to the date of that anticipated absence. For activities such as athletic competitions who schedules are known prior to the start of a term, students must provide during the first week of each term a written schedule showing days they expect to miss classes. For other university excused absences students must provide at the earliest possible time the dates that they will miss.

Make-up work

- It is the responsibility of the student to request an opportunity to complete missed assignments, activities, labs, examinations or other course requirements in a timely manner.
- Students are responsible for all material covered in classes that they miss, even when their absences are excused, as defined above.
- Missed classroom activities will be rescheduled at the discretion of the instructor.

Emergency Preparedness In the event of an emergency arising on campus, I will notify you of actions that may be required to ensure your safety. It is the responsibility of each student to understand the evacuation and “lockdown” guidelines to follow when an emergency is declared. These simple steps are a good place to start:

- OU uses an emergency notification system through text, email, and landline. These notifications include campus closures, evacuation, lockdowns and other emergencies. **Register for these notifications at oakland.edu/uts/emergencynotification**
- Based on the **class cellphone policy**, ensure that one cellphone is on in order to receive and share emergency notifications with the instructor in class.
- If an emergency arises on campus, call the OUPD at **248-370-3331**. Save this number in your phone, and put it in an easy-to-find spot in your contacts.
- Review protocol for evacuation, lockdown, and other emergencies via the classroom’s red books (hanging on the wall) and **oakland.edu/prepared**.
- Review with the instructor and class what to do in an emergency (evacuation, lockdown, snow emergency).

Faculty Feedback As a student in this class, you may receive “Faculty Feedback” in an e-mail if your professor identifies areas of concern that may impede your success in the class. Faculty Feedback typically occurs during weeks 2-5 of the Fall and Winter terms, but may also be given later in the semester and more than once a semester. A “Faculty Feedback” e-mail will specify the area(s) of concern and recommend action(s)

you should take. Please remember to check your OU email account regularly as that is where it will appear.

Schedule of lectures, reading assignments and exams. Topics and reading assignments may be revised as the semester progresses

Week #	Date	Topic	Chapter #
Week 1		Introduction to Tissue Engineering	1
		Pluripotent stem cells (embryonic and induced-pluripotent stem cells)	2
Week 2		Multipotent stem cells	2
		Stem cells in skin epithelia, intestine and central nervous system	2
		Differentiation, characterization by surface protein expression and gene expression	2
Week 3		Tissue formation during development	3
		Tissue formation during development	3
		Cellular signaling	4
Week 4		Native Extracellular Matrix	5
		ECM Scaffold preparation and constructive tissue remodeling	5
		Clinical Translation of ECM Bioscaffolds	5
Week 5		First Midterm Exam	
		Degradable Bioceramics	6
		Biodegradable polymers	6
Week 6		Cell Material Interactions: Surface chemistry	7
		Cell Material Interactions: Surface topography and mechanics	7
		Micro-fabrication techniques	9
Week 7		Scaffold Design and Fabrication	10
		Controlled Release Strategies in Tissue Engineering	11
		Controlled Release Strategies in Tissue Engineering	11
Week 8		Bioreactors	12
		Bioreactors	12
		Second Midterm Exam	
Week 9		Vascularization, Survival and Functionality of Tissue-Engineered Construct	14
		Vascularization, Survival and Functionality of Tissue-Engineered Construct	14
		Vascularization, Survival and Functionality of Tissue-Engineered Construct	14
Week 10		Mesenchymal stem cells	13
		Cartilage and Bone Regeneration	16
		Cartilage and Bone Regeneration	16
Week 11		Tissue Engineering of the Nervous System: Peripheral Nerve	17

		Tissue Engineering of the Nervous System: Spinal Cord	
		Tissue Engineering of the Nervous System: Retina	
Week 12		Cardiovascular Tissue Engineering: Cell sources and Biomaterials	18
		Cardiovascular Tissue Engineering: Biomaterials as vehicles for stem cells and molecule delivery	18
		Bioengineering Cardiac patches and their vascularization	18
Week 13		Organs-on-a-chip	20
		Organs-on-a-chip	20
Week 14		Final Exam	