Western Engineering

DEPARTMENT OF CHEMICAL AND BIOCHEMICAL ENGINEERING
CBE 4423B / BME 9526 – Tissue Engineering
Course Outline Winter 2026
Start Date – January 6, 2026

Description. Tissue Engineering integrates principles of engineering and life sciences towards the fundamental understanding of structure-function relationships in normal and pathological mammalian tissues. The course will cover the applications of engineering design concepts and molecular cell biology to design biological substitutes to restore, maintain or improve tissue and organ function.

Course Structure. This is an upper year Chemical Engineering undergraduate course toggled with BME 9526, a graduate-level course in Biomedical Engineering. Undergraduate and Graduate students attend the same lecture and write the same exam. However, graduate students will work for an extra individual oral exam as part of the graduate course requirement.

Objectives. Modern chemical engineers need a strong fundamental understanding of engineering principles applied to medicine and life sciences. The application of engineering design principles, combined with basic knowledge of molecular cell biology and materials science will be covered in this course to provide students with a broad overview of the field of Tissue Engineering. The objectives of the course are to introduce:

- the application of engineering principles combined with basic knowledge of molecular cell biology and materials science to provide the students with a broad overview of the field of tissue engineering.
- the basics of tissue engineering, including cell-matrix interaction, cell migration and growth, mechanical regulation, and bioreactors. Due to the exponential growth this field has had over the last decade, it is impossible to cover detail aspects of tissue engineering, but applications of tissue engineering will be shown through selected examples from literature.
- applications of mass transport to tissue engineering strategies.
- methods in analyzing and designing targeted engineered tissue products, evaluation of tissue from a design perspective, scaffolding of cells using synthetic and natural materials, genetic engineering techniques, and cell seeding and transplantation. Engineered tissues for replacing vascular vessels, cartilage, bone, skin etc. will be presented and discussed throughout the course.

Prerequisites.
Completion of 3rd year of Engineering in Chemical, Electrical, Civil, Mechanical and Materials, Biology 1222 or 1223. Contact me if you have specific questions regarding prerequisites, or potential special permissions requests.

Unless you have either the requisites for this course or written special permission from your dean to enroll in it, you will be removed from this course, and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

Corequisites. None
Antirequisites. None

Contact Hours. 3 lecture hours, 1 tutorial/office hour, 0.5 course.
Monday (12.30-2.30pm; lecture at SH3305), Tuesday (10.30-11.30am; lecture at UCC54B), Tuesday (12.30-1.30pm; tutorial at SEB2094).

Instructor. Dr. Amin Rizkalla (TEB # 337)
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Undergraduate Assistant. Brandy Hunter, TEB 477,
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Required Texts. None

Course Notes. Most of the notes will be provided by the instructor through the OWL website.

Reference Texts.
- Jan de Boer, Clemens A. van Blitterswijk, Jorge Alfredo Uquillas, Nusrat Malik, Tissue Engineering 3rd Edn. 2023.
- Bernhard Palsson and Sangeeta Bhatia. Tissue Engineering, Pearson Prentice Hall, 2004.
- Ronald Fournier. Basic Transport Phenomena in Biomedical Engineering. 4th Edn. CRC Press. 2017.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter. Molecular Biology of the Cell. Taylor and Francis. 4th Edition, 2002.

Laboratory. None

Units. SI and other engineering units.

General Learning Objectives

Knowledge Base	x	Individual Work		Ethics and Equity	x
Problem Analysis		Teamwork		Economics and Project Management	
Investigation		Communication	x	Life-Long Learning	
Design		Professionalism			
Engineering Tools		Impact on Society			

Tentative Topics to be covered
- Introduction to tissue engineering
  - Definitions and applications of tissue engineering
- Elements of tissue engineering
  (i) Cells (primary, stem cells, cell lines)
  - Cell growth kinetics (exponential vs non-exponential models)
  - Cell encapsulation and cell therapy approaches
  (ii) Scaffolds

- Structure-function of the native scaffold (i.e. the extracellular matrix)
- Degradable *vs.* non-degradable scaffolds
- Synthetic *vs.* natural scaffold materials
- Scaffold fabrication and analyses
- Tissue repair (replacement) by cell-seeded and cell-free scaffolds
- Use of nanomaterials

(iii) Growth factors (biochemical signals)

- Growth factor presentation strategies.
- Growth factors release rate/kinetics (diffusion controlled, reaction controlled, osmosis controlled)
- Steady and unsteady state diffusion

(iv) Biomechanical factors (tissue engineering bioreactors)

- Conventional and unconventional mechanical signals
- Diffusive and convective mass transport in tissue engineering bioreactors

- Emerging Technologies in tissue engineering, nanomaterials and regenerative medicine

Evaluation

Following is a tentative score breakdown for the course. The evaluation weighing will be finalized within the first week of class start:

- Participation and critical analysis: 10%
- One Group Project Report Assignment (1): 5%
- One Group Project Report Assignment (2): 20%
- One Group Presentation: 25%
- One Written examination: 40% (In-person)

Only non-programmable calculators will be permitted, if needed at all. The written exam will be closed book.

Note:

1) Make-up exam rule: If you (both CBE 4423B and BME 9526) are unable to attend the exam for medical or compassionate reasons, you must provide the appropriate documentation, and the weighting will be adjusted accordingly with an additional Oral Exam. For example, if a CBE 4423B student misses the exam, the student will have to take an oral exam to make up for the missed exam. Failure to provide adequate documentation will result in a mark of 0.

Use of English

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work except for the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Attendance

Any student who, in the opinion of the instructor, is absent too frequently from class or laboratory periods in any course, will be reported to the Dean (after due warning has been given).

On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular examination in the course.

Cheating
University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning (see Scholastic Offence Policy in the Western Academic Calendar).

Plagiarism
Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar).

The University of Western Ontario has software for plagiarism checking. Students may be required to submit their work in electronic form for plagiarism checking.

Conduct
Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others.

Sickness and Other Problems
Students should immediately consult with the instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented. The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

Notice
Students are responsible for regularly checking their Western email and notices posted on Instructors' doors.

Consultation
Students are encouraged to discuss problems with their teaching assistant and/or instructor by appointment. Office hours will be arranged for the students to see the instructor and teaching assistants. Other individual consultation can be arranged by appointment with the appropriate instructor.

Accreditation (AU) Breakdown

Life Science	=	50%
Engineering Science	=	50%