**Syllabus**

**Biomedical Engineering**

**Tissue Engineering & Biological Substitutes (336529)**

**Spring semester 2021**

**(2.5 credits)**

## Description

This course introduces students to the main aspects of the multidisciplinary field of tissue engineering: (i) cell biology, (ii) material science and (iii) engineering.

Engineered tissues are created using cells grown on different materials. The first part of the course is dedicated to (i) understanding of the structure and dynamics of native tissues, (ii) understanding the cell component and (iii) the material component of engineered tissues. This part of the course would provide students with the fundamental principles for the design of engineered tissues. In the second part of the course several applications of tissue engineering (bone, skin and spinal cord regeneration) will be discussed.

Throughout the course tutorials, an emphasis will be put on the mathematical modeling of cell and material science topics discussed in the lectures. This is intended for students to build an understanding of engineering principles for the design of biological substitutes and engineered tissues.

## Prerequisites

- From cell to tissue (336022)
- Principles of medical materials (334221)
- Biological fluid mechanics (334009 or equivalent from other department)

## Instructor

Professor Shulamit Levenberg, shulamit@bm.technion.ac.il , Julius Silver (Biomedical Engineering) 169, +972-4-829-4810

Meetings: email and zoom

## Teaching Assistant

Abigail Newman, abigail.ne@campus.technion.ac.il, Julius Silver (Biomedical Engineering) 161, +9728295174

Meetings: email and zoom

**Textbook**

- Tissue Engineering (Clemens Van Bliterswijk)
- Tissue Engineering (Bernhard Palsson and Sangeeta Bhatia)
- Tissue Engineering (Palsson, Hubbell, Plonsey and Bronzino)

**Online Resources**

Moodle: Lecture and tutorial slides and recordings will be available there.

**Course Objectives**

- To teach students the fundamental principles for the design of engineered tissues.
- To teach students mathematical modeling and its application in the field of tissue engineering and regenerative medicine.
- To experience research proposal writing and scientific poster presentation, in order to implement the studied principles of tissue engineering.

**Course Topics**

**Introduction**

- **Synthetic and Biological Substitutes**
- **Cell Therapy and Tissue engineering**

**Part 1: Basic concepts in Tissue engineering**

- **Tissue Organization and Tissue Dynamics**
  i. Analytical models for cell populations (tutorial)
- **The cell component in tissue engineering**
  i. Cell types and their origin
  ii. Compartment models for cell differentiation (tutorial)
  iii. Cell nutrition
  iv. Diffusion (tutorial)
  v. Chemotaxis (tutorial)
  vi. Cryobiology – biological freezing
  vii. Fluid dynamics in tissue engineering (tutorial)
- **The material component in tissue engineering**
  i. Scaffolds in tissue engineering
  ii. Mechanobiology (tutorial)
  iii. Nano technology and tissue engineering

**Part 2: Applications of tissue engineering**

- Bone marrow stem cells and 3D scaffolds for bone tissue engineering
- Spinal cord regeneration
- Engineered skin substitutes
- 3D bioprinting of tissues and organs

**Course Expectations & Grading**

The course will include two hours of lecture and one tutorial per week.

Breakdown of course grading:

Homework: 20% (4 assignments throughout the semester)

Project: 20%

Final Exam: 60%

**Assignments & Readings**

- Weekly lecture and tutorial slides (available through Moodle).
- Homework and all supplementary material will be made available through Moodle.

**Ethics**

The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition.

Report any violations you witness to the instructor.

**Students with Disabilities**

Any student with a disability who may need accommodations in this class must obtain an accommodation letter from Technion International's guidance counselor, at counselor@int.technion.ac.il

**ABET Outcomes**

(a) Ability to apply knowledge of biology, science and engineering.

(b) Ability to design experiments, as well as to analyze and interpret data.

(c) Ability to design a system, component, or process to meet desired needs within realistic constraints such as health and safety, manufacturability.

(d) Ability to identify and solve engineering problems.

(e) Recognition of the need for, and an ability to engage in life-long learning.

(f) Knowledge of contemporary issues.

(g) Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.