Update date: 6/9/23

Winter Semester 24/10/2023-30/01/2024

Course number: **338014 Advanced Topics in BME**
Course's name: **Biomedical applications at the molecular level**

Course teaching staff

Main teacher:
Name: Prof. Yuval Garini, Biomedical Engineering Faculty, Technion
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More teachers:
1. Name: Prof. Amit Meller, Biomedical Engineering Faculty, Technion, Email: ameller@bm.technion.ac.il
2. Name: Prof. Oded Kleifeld, Biology Faculty, Technion Email: okleifeld@technion.ac.il
3. Name: Dr. Ramez Daniel, Biomedical Engineering Faculty, Technion Email: ramizda@bm.technion.ac.il
4. Name: Prof. Maartje Bastings, EPFL Email: maartje.bastings@epfl.ch
5. Name: Prof. Andreas Bausch, Technical University of Munich Email: abausch@mytum.de
6. Name: Prof. Oliver Lieleg, Technical University of Munich Email: oliver.lieleg@tum.de

Syllabus and Details

Academic Credits: 2 ECT
Teaching Language: English
Pre-required courses: Math & Biology
When: 15-20/10/2023
Where: Room 202, BME faculty

Syllabus:

1. **Synthetic Biology:**
   a) Synthetic biological parts
   b) Gene circuits, Bio-inspired computing systems
   c) Applications: Bacterial biosensors and Therapeutic living cells
2. **Biopolymers meet DNA nanotechnology:**
   a) The molecular concept of multivalent interactions (including super-selectivity) and how these are crucial for biomedical applications of materials
   b) Examples of synthetic multivalent systems, and why we should care about flexibility vs rigidity
   c) How to engineer rigidity on the molecular level? And what techniques to measure (experimental and computational)
   d) State of the art examples of what can be achieved with the full molecular control of rigidity and multivalent interactions, in cell adhesion, targeting, and immune engineering

3. **Single molecules biophysics methods:**
    a) Fundamental concepts, random walk, Langevin and Smoluchwski equations for analyzing the time-evolution properties of single molecules
    b) Analyzing random walks using diffusion properties
    c) Using single molecule methods in macro-scale biological systems,
    d) Nano-pores and lab-on-a-chip devices for DNA and protein analysis
4. **self-organizing principles in biological systems**
    a) Principles of self-organization from the molecular to the cellular scale.
    b) Macromolecular coatings of medical devices to improve their interaction with soft tissues.
5. **Advanced proteomics workflows to study proteolysis:**
    a) Proteases and their roles in proteolysis
    b) Fundamentals of mass spectrometry-based proteomics
    c) Positional proteomics workflows tailored to explore proteases and their substrate repertoires
6. **Harnessing enzyme biocatalysis for next generation biomedical nanocarriers:**
    a) Motility at the nanoscale
    b) Enzyme catalysis to power nanomachines
    c) Interplay between design properties and functionality of biocatalytic micro- nanomotors
    d) Biomedical applications of biocatalytic micro- nanomotors

Teaching Methods

The course is based on frontal lectures by the tutors. Some of the lectures will follow prepared presentation slides and other will combine the development of mathematical formalism on the boards. Students will be asked to take part in explanations along the lectures.

Assessment Methods

The grade will be given based on participation of the students, which is compulsory for all lectures. Each subject will have home works that will assess the understanding of the students.

Grade structure:

Class attendance and participation % of final grade: 90
Homework % of final grade: 10
**The final grade of the course will be listed as passed or didn't pass.*