Syllabus- Systems Biology (136037), Spring 2024

Through this course, we will learn how to **describe biological systems as information processing systems** and analyze them mathematically to understand their functions. We will explore a framework for analyzing biological network dynamics, study network motifs and their functions, and analyze sensory systems and covalent modification systems. Various biological processes will be discussed, including transcription regulation, signal transduction pathways, developmental patterning, neural information processing, and sensory adaptation, using examples from phages, bacteria, yeast, nematodes, fruit flies, and mammalian cells.

The course is given in English and is open for undergraduate and graduate students with background in biology, physics, chemistry, computer science, or engineering. Basic calculus knowledge is required. Matlab programming will be used but previous experience is not required. Students will be evaluated based on homework exercises (~30%) and a final exam (~70%).

Learning outcome

By the end of the course, students will:

- Have basic knowledge of Matlab programming, including how to numerically solve ODEs.
- Be familiar with various network motifs, such as positive/negative autoregulation, coherent/incoherent feedforward loops, positive/negative feedback loops.
- Be able to analyze network motifs both analytically and numerically
- Understand the functions of different network motifs, such as generating sign dependent delays, speeding up or slowing down responses, generating spikes, buffering input fluctuations, inducing bistability and more.
- Be familiar with models of signaling pathways.
- Know how to challenge models' assumptions and compare models' performances.
- Understand the implications of the learned models on biological systems and processes, such as transcription regulation in *e. coli* and mammalian cells, developmental patterning in *drosophila*, buffering input noise in yeast, toggle switches in lambda phage, information processing in *C. elegans* nervous system and robust exact adaptation of the *e. coli* chemosensory pathway.

Recommended literature

- Uri Alon, *An Introduction to Systems Biology: design principles of biological circuits* (second edition). CRC Press, Taylor & Francis Group, 2019.
- Ron Milo and Rob Phillips, *Cell Biology by the Numbers,* Garland Science, 2015
- Various research articles will be introduced throughout the course

Useful course information (updated 22/4/2-24. Note that this is a *tentative* schedule)

- Where: Biology Building, 2nd floor, Computer farm – Room 230 (in front of the Biology auditorium).
- Hours: lecture 11:30-13:30, tutorial 13:30-14:30
- Course Dates (Thursdays except for 1/7): 30/5, 6/6, 20/6, 1/7 (Monday), 4/7, 11/7, 18/7, 25/7, 1/8, 8/8, 15/8, 22/8.
- Exam dates: 27/8 moed A, 22/9 moed B.
- Contact: levysagi@technion.ac.il