Systems and Synthetic Biology (SSB-801) **CHR 3-0**

Rationale

A millennial challenge in biology is to decipher how vast arrays of molecular interactions inside the cell work in concert to produce a cellular function. Systems biology, a new interdisciplinary field of science, brings together biologists and physicists to tackle this grand challenge through quantitative experiments and models. Molecular biology has provided us with a detailed understanding of the components that make up a cell – including the wealth of genes, RNAs, proteins and other macromolecules – as well as specific intracellular biochemical interactions. The diversity among species of specific cellular components in the context of broadly conserved chemical classes is one aspect of the beauty and elegance of biology. Systems biology is now revealing another elegant aspect of biology: when all these cellular components are integrated into a network of interactions, we find that there are common themes across a wide spectrum of organisms. There seems to be unifying principles that all organisms use to perform cellular functions.

Educational Objectives

The main objectives of this course are:

- To introduce students to the primary scientific literature and the process of finding/reading research papers
- To expose students to the new field of systems and synthetic biology
- To learn how to analyze papers to extract key points and to examine scientific papers critically
- To expose students to some of the interesting theories that have helped to make systems biology a remarkably interdisciplinary field

Course contents

- Engineering approaches to biology.

- Design, modelling and prediction of the behavior of biological synthetic parts, circuits and chassis.
- Noise in gene expression
- Structure of biological networks
- Experimental plans to engineer and test synthetic biological systems.
- Physical limits of gradient and concentration sensing
- Integrative concepts and technologies across disciplinary boundaries. Bacterial chemotaxis
- Economical and societal challenges of synthetic biology to plan future career paths.
- Simple synthetic networks
- Development of multicellular organisms under noisy conditions
- Circadian oscillations
- Noise in development

Recommended books

- A book review on Systems and Synthetic Biology by V. Singh, P. K. Dhar (2015). Berlin: Springer Science, 385. ISBN: 978-94-017-9513-5.

- Synthetic Biology: Methods in Molecular Biology (1073), Karen M. Polizzi and Cleo Kontoravdi (Editors), Springer Protocols, Humana Press, (2013).
- Synthetic biology volume1: Current Topics from the Encyclopedia of Molecular Cell Biology and Molecular Medicine, Robert A. Meyers, Wiley-Blackwell (2015).
- An Introduction to Systems Biology: Design Principles of Biological Circuits (Chapman & Hall/Crc Mathematical and Computational Biology Series) **ISBN** 1584886420 (ISBN13: 9781584886426)