BIOENG-320 **Synthetic biology**

Barth Patrick

Cursus	Sem.	Type
Biotechnology minor	E	Opt.
Computational and Quantitative Biology		Opt.
Ing.-chim.	MA2, MA4	Opt.
Life Sciences Engineering	BA6, MA2, MA4	Opt.
Minor in life sciences engineering	E	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Lecture	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This advanced Bachelor/Master level course will cover fundamentals and approaches at the interface of biology, chemistry, engineering and computer science for diverse fields of synthetic biology. This class requires critical and analytical thinking at the frontiers of multiple disciplines

Content

1. Gene network engineering: Methods for reconstructing gene networks from genome annotation. Computational approaches for synthetic gene circuits.
2. Protein engineering: state of the art computational and experimental approaches to protein design, their application to the engineering of novel molecular tools for synthetic biology (e.g. biocatalysts) and biomedicine (e.g. biosensors for cancer immunotherapies) will be covered.
3. Chemical biology engineering: this component will focus on cutting-edge chemical biology tools that address pressing problems in human health, ##from identifying druggable molecular targets and novel mechanism-of-action, to engineering modern small-molecule-based targeted therapies.
4. Signalling pathways and cell engineering: recent progress and challenges in the rational design of signaling pathways toward the reprogramming of cellular functions in diverse cell types including bacteria, yeast and vertebrate cells will be discussed.

Keywords

Gene networks, metabolic pathways, biological circuits, chemical biology engineering, protein design, cell engineering, computer simulation.

Learning Prerequisites

Required courses

Basic bachelor courses of Mathematics, Physics, Molecular Biology, Biological Chemistry, Computer programming, and for SV Bachelor students the following specific class: Dynamical systems in Biology (BIO-341)

Recommended courses

Genetics & Genomics (BIO-373) and Cell and Developmental biology for engineers (BIO-221)

Important concepts to start the course

Gene expression & regulation, cell metabolism, chemical & structural biology of proteins, enzyme catalysis, biomolecular sensing, thermodynamics, kinetics, numerical analysis, informatics, signal processing

Learning Outcomes

By the end of the course, the student must be able to:

- Understand and interpret the designs of natural cellular networks
- Apply softwares for modeling and designing genetic circuits and metabolic pathways
- Devise and apply effective experimental/ computational protein design strategies for reprogramming and engineering cellular functions
- Understand modern chemical biology tools for selective reprogramming, perturbing, and probing cellular functions
- Choose the appropriate method to tackle a problem

Transversal skills

- Set objectives and design an action plan to reach those objectives.
- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Continue to work through difficulties or initial failure to find optimal solutions.
- Assess progress against the plan, and adapt the plan as appropriate.
- Use both general and domain specific IT resources and tools
- Write a scientific or technical report.

Teaching methods

Half of the course is based on lectures, while in the other half exercises / projects (computational) are provided to the students

Expected student activities

Attending lectures, completing exercises, reading assignments

Assessment methods

Written exam during the exam session

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

Resources

Bibliography

Synthetic Biology: Parts, Devices and Applications (Eds: Christina Smolke Sang Yup Lee Jens Nielsen Gregory Stephanopoulos) 2018 Wileyâ##VCH Verlag GmbH & Co. KGaA
Systems Biology: Simulation of Dynamic Network States 1st Edition (by Bernhard Palsson) 2011 Cambridge University Press
Systems Biology: A Textbook 2nd Edition (by Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald) Wiley-Blackwell; 2 edition (June 27, 2016)
Papers assigned during the course

Ressources en bibliothèque

- Systems Biology: Simulation of Dynamic Network States
- Synthetic Biology: Parts, Devices and Applications (
- Systems Biology: A Textbook

Moodle Link

- https://go.epfl.ch/BIOENG-320