BIO-411

Topics in life sciences engineering

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Cursus	Sem.	Type
Life Sciences Engineering	MA1, MA3	Obl.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
Lecture	2 weekly
Exercises	2 weekly
Number of positions	

Summary

Students will acquire fundamental knowledge and skills regarding how genomes can be engineered, how their function can be deciphered, as well as how their dynamic outputs can be analyzed and modeled.

Content

First, students will be introduced to approaches that enable engineering of the genome and of the corresponding proteome, including mutagenesis, RNAi, CRISPR/Cas9, transgenesis and viral technologies. Second, students will learn how forward genetics, functional genomics and chemical genomics can serve to systematically decipher gene function; moreover, they will understand how these approaches can be utilized in model and non-model organisms to analyze biological questions. Third, students will learn about gene expression dynamics, including single cell analysis and transcriptional noise; furthermore, they will be introduced to chronobiology and related data modeling techniques, as well as gene expression changes related to data sexual dimorphism and aging. At the end of the course, students will have acquired a comprehensive understanding of genome biology, from engineering through functional probing to systems physiology, enabling them to tackle a wide range of questions in the life sciences.

Keywords

Genomics, genome engineering, mutagenesis, RNAi, CRISPR/Cas9, transgenesis, viral technologies, forward genetics, functional genomics, chemical genomics, protein manipulation, model systems, gene expression dynamics, single cell analysis, RNA velocity, human systems genomics, mathematical modeling.

Learning Prerequisites

Required courses

None

Recommended courses

None

Important concepts to start the course

Basic knowledge of gene expression (DNA>RNA>protein>function). A good place to start in case this knowledge is lacking is the textbook "Molecular biology of the cell" by Alberts et al.", Norton (e.g. the brand new 7th edition, but former editions are fine as well and available from the EPFL library).
The SSV section recommends that this foundational course is taken in MA1 rather than in MA3.

Learning Outcomes

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

- Contextualise methods of genome engineering.
- Design approaches to perturb gene expression.
- Explain how genome function can be probed.
- Identify pros and cons of methods aimed at probing genome function.
- Assess / Evaluate strengths and weaknesses of different model systems and approaches.
- Implement simulate and analyze models of gene expression dynamics.
- Analyze multi-level gene expression data.
- Interpret and critique outcome of experiments from the literature.

Transversal skills

- Evaluate one's own performance in the team, receive and respond appropriately to feedback.
- Continue to work through difficulties or initial failure to find optimal solutions.
- Demonstrate the capacity for critical thinking
- Take feedback (critique) and respond in an appropriate manner.
- Access and evaluate appropriate sources of information.
- Write a scientific or technical report.

Teaching methods

The course will have three integrated modules, lasting four weeks each: Engineering the genome, Deciphering genome function and Modeling genome output. Each week, the two hours of lecture will be held on Thursday, whereas the two hours of exercise will be held on the following Monday. The latter will be in part through interactive computer based exercises, as well as a brief graded written assignment for each of the three modules (see also assessment method section below).

Expected student activities

Students are expected to participate actively in all four hours of class each week. In addition, as for any 4 ECTS class, four hours of personal study per week are expected on average.

Assessment methods

In the last two weeks of the exercise session of each module, groups of four students produce a written document that each contributes 15% of the final grade (i.e. 45% in total). The remaining 55% of the final grade come from a continuous control held in Week 14 (Monday).

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes
Others	Office hours: by email or appointment. Forum: Moodle FAQ

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

The source of the illustrations will be indicated in the lecture slides.

Notes/Handbook

The lectures slides will also be made available through Moodle.

Moodle Link

- https://go.epfl.ch/BIO-411

Prerequisite for

NA