BIO-315

Structural biology

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Cursus	Sem.	Type
Biocomputing minor	E	Opt.
Computational science and Engineering	MA2, MA4	Opt.
Life Sciences Engineering	MA2, MA4	Opt.
Physics of living systems minor	E	Opt.

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

Summary

The focus of this course is on the molecular interactions defining the structure, dynamics and function of biological systems. The main experimental and computational techniques used today in structural biology, as well as molecular modeling and engineering will be introduced and practiced.

Content

In this course the most relevant approaches for structural biology will be introduced and discussed. After an overview on the physical and chemical principles governing the molecular interactions of biological systems, the following modules will cover the main computational and experimental techniques today used in the field of structural biology:
1. Molecular modeling and simulations
2. Machine learning methods for protein structure prediction and design
3. X-ray crystallography
4. Nuclear magnetic resonance (NMR)
5. Cryo-electron microscopy
For each module the foundations of these approaches will be described and hands-on experiences (on the computer and in the wetlab) will be offered to start practicing the principles of these techniques. A final mini-project on one of the discussed topics will be also developed by the students at the end of the course.
In summary, the content of this course will give the students the necessary bases to study and understand the structure, dynamics and function of biological systems at the molecular scale. It will be discussed how this structural approach can be used to advance fundamental biology and to open new opportunities in medicine and biotechnology.

Keywords

Structural biology, X-ray crystallography, cryo-EM, NMR, AlphaFold, SAXS, integrative modeling, molecular modeling, molecular mechanics, molecular simulation, protein structure prediction, protein folding, protein design, drug discovery, machine learning.

Learning Prerequisites

Required courses

None in particular, but some are recommneded (see below)

Recommended courses

Basic bachelor courses on Maths, Physics, Molecular Biology and Biochemistry

Important concepts to start the course

Structural biology and biochemistry of biomolecules. Classical mechanics, themodynamics, and

electrostatics (Physics I, II, III), Organic Chemistry.

Learning Outcomes

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

- Explore the structure of biomolecules (and their interactions)
- Predict the structure and dynamics of proteins
- Design the structure of proteins
- Visualize biomolecules
- Interpret structural data
- Choose the appropriate method to tackle a problem
- Design a project in structural biology
- Make a scientific report and presentation

Transversal skills

- Make an oral presentation.
- Write a scientific or technical report.
- Use a work methodology appropriate to the task.
- Demonstrate the capacity for critical thinking
- Use both general and domain specific IT resources and tools

Teaching methods

Half of the course is based on lectures, while in the other half practical experiences and projects (computational and experimental) are provided to the students.

Expected student activities

Attending lectures, completing practical experiences, reading assignments, presenting a scientific paper, developing a project, writing a report, presenting the results of a project

Assessment methods

Assignments and projects assessment during the semester

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

Resources

Moodle Link

- https://go.epfl.ch/BIO-315