CH-413

Nanobiotechnology and biophysics

Fierz Beat

Cursus	Sem.	Type
Bioengineering	MA2, MA4	Opt.
Biomedical technologies minor	E	Opt.
Biotechnology minor	E	Opt.
Chimiste	MA2	Opt.
Ing.-chim.	MA2, MA4	Opt.
Microtechnics	MA2	Opt.
Sciences du vivant	MA2, MA4	Opt.

Language of teaching	English
Credits	3
Session	Summer
Semester	Spring
Exam	Written
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Summary

This course concerns modern bioanalytical techniques to investigate biomolecules both in vitro and in vivo, including recent methods to image, track and manipulate single molecules. We cover the basic principles of the respective methods and discuss examples from the current scientific literature.

Content

Techniques to monitor the function of single biomolecules and complexes

1. single molecule fluorescence spectroscopy (FRET, confocal and total internal reflection fluorescence microscopy
2. - Force spectroscopy to monitor function of single proteins and cells
3. - Microscopy beyond the diffraction limit: Super-resolution microscopy

Surface sensors to elucidate and quantify molecular interactions:

- Immobilizing biopolymers on surfaces
- Optical & electrical detection techniques

Development and application of microfluidic and nanofluidic sensor devices:

- Miniaturisation of analytical techniques: lab on a chip
- Chemical and biochemical sensors
- Next generation DNA sequencing approaches

Engineered biomolecules to manipulate cells or as drug delivery vehicles

- Nano-containers for drug delivery vectors
- DNA based self-assembly and nanofabrication of complex structures

Keywords

Nanobiotechnology, biophysics, sensors, single-molecule, fluroescence, FRET, drug delivery, DNA origami, lab-on-a-chip, super-resolution microscopy, force spectroscopy

Learning Prerequisites

Required courses

Biochemistry I and II
Molecular and Cellular Biophysics I and II

Important concepts to start the course

Biomolecular absorption and fluroescence
General biochemistry

Learning Outcomes

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

- Explain the fundamental principles of nano-biotechnological and biophysical methods
- Distinguish the advantages and disadvantages of the respective biophysical and nano-biotechnological methods
- Discuss the limits of nanobiotechnological methods
- Choose appropriate methodologies to tackle a specific biological problem
- Analyze the current scientific literature on nanobiotechnological applications
- Design approaches to robustly sense and measure specific biomolecules using integrated devices
- Propose strategies to image and track molecules in cells and study their interactions
- Apply concepts of nanoparticles and self-assembly to design drug delivery methodologies

Transversal skills

- Make an oral presentation.
- Write a literature review which assesses the state of the art.
- Use a work methodology appropriate to the task.
- Communicate effectively with professionals from other disciplines.

Teaching methods

Ex cathedra, presentations by students and paper discussions

Expected student activities

Discussion of recent literature in the form of presentations

Assessment methods

Written exam

Supervision

Assistants	Yes
Others	Moodle

Resources

Bibliography

Nanobiotechnology, Niemeyer & Merkin (Wiley 2004)
Introduction to bioMEMS, Folch (CRC press, 2012)

Ressources en bibliothèque

- Introduction to bioMEMS / Folch
- Nanobiotechnology / Niemeyer

Notes/Handbook

Handouts and literature references distributed in class

Websites

- http://scgc.epfl.ch/telechargement_cours_chimie