

CH-413

**Nanobiotechnology and biophysics**

Fierz Beat

| Cursus                          | Sem.     | Type |
|---------------------------------|----------|------|
| Biomedical technologies minor   | E        | Opt. |
| Biotechnology minor             | E        | Opt. |
| Chimiste                        | MA2, MA4 | Opt. |
| Ing.-chim.                      | MA2, MA4 | Opt. |
| Life Sciences Engineering       | MA2, MA4 | Opt. |
| Microtechnics                   | MA2, MA4 | Opt. |
| Physics of living systems minor | E        | Opt. |

|                            |                 |
|----------------------------|-----------------|
| Language of teaching       | English         |
| Credits                    | 3               |
| Session                    | Summer          |
| Semester                   | Spring          |
| Exam                       | Written         |
| Workload                   | 90h             |
| Weeks                      | 14              |
| <b>Hours</b>               | <b>3 weekly</b> |
| Courses                    | 2 weekly        |
| Exercises                  | 1 weekly        |
| <b>Number of positions</b> |                 |

**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, fluorescence, 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 fluorescence  
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](http://scgc.epfl.ch/telechargement_cours_chimie)

#### Moodle Link

- <https://go.epfl.ch/CH-413>

