**SUMMARY**

Advanced Bioengineering Methods Laboratories (ABML) offers laboratory practice and classroom data analysis. These active sessions present a variety of techniques employed in the bioengineering field and matching a quantitative and technological based approach.

**CONTENT**

The core of the course consists of 5/6 exercises that are meant to be performed in 2 weeks/sessions each for a total of 10/12 weeks.

The course also comprehends an introduction, instructions on how to write a notebook and on safe laboratory behavior to be held and discussed during the 1st and the last week.

- **Ex 1 Lab-on-a-chip (LOC):** it will introduce students to the fundamental elements of moving fluids in LOC systems such as flows, pressure driven flow, electroosmotic driven flow, capillary effects, surface forces, mixing and two-phase flow.

- **Ex 2 Brownian motion:** In the first part of this exercise, the students will replicate Perrin's work with modern equipment. Next they will investigate intracellular vesicle transport inside living cells and determine if the vesicle transport is accomplished by Brownian motion or by directed transport.

- **Ex 3 Optical trapping:** this is one of the most successful technology transfers from a physics lab to biology. The goal of this exercise is to provide hands on experience to the bioengineering students of one of the mostly used single molecule technique.

- **Ex 4 Surface design:** Modern bioanalytics is often based on surface detection of biomolecules. The exercise will explore different techniques for modification of most common biosensor and microbiosensors surfaces, such as gold and glass.

- **Ex 5 Surface plasmon resonance:** The exercise consists in the employment of label-free biosensors for the observation of binding kinetics. Real-time protein bindings will be observed for different molecules.

- **Ex 6 Atomic force microscopy:** Nanoscale resolution images will be recorded of bacterial surfaces and rat connective tissue using a state of the art AFM system. In the analysis section, you will learn how to properly process the raw AFM images, extract quantitative data, use 3D-image reconstruction and advanced image processing algorithms.

**Keywords**

Atomic force microscopy (AFM), Lab on the chip (LOC), Brownian motion, Optical trapping, Surface Plasmon Resonance, bioanalytics, surface design

**LEARNING PREQUISITES**

Required courses

Required background: Biophysics I, Biothermodynamics, Biomicroscopy I, + mandatory courses of M1

Recommended courses

Biophysics I, Biothermodynamics, Biomicroscopy I, + mandatory courses of M1

**LEARNING OUTCOMES**

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

- Demonstrate oral and written communication skills
- Perform experiments
- Coordinate experiments
- Make miniature chemical and bio-chemical analysis systems, also known as Lab-on-a-Chip systems, referring to the idea of shrinking a complete chemical analysis laboratory onto a small chip.
- Compute simulated and analyze Brownian motion trajectories of single particles in Matlab
- Analyze Brownian motion of single particles in Matlab
- Use bright field and darkfield microscopy, fluorescence microscopy
- Carry out measurements of the spring constant in an optical trap
- Modify surfaces to be functionalized with biochemically active molecules
- Characterize the binding kinetics of analytes to functionalized target surfaces
• Assess / Evaluate the quality of AFM images
• Carry out nanoscale characterization of bacterial surfaces and extracted rat tail tendon collagen fibrils

TEACHING METHODS
Except for an ex-cathedra introduction session, the teaching proceeds with weekly alternating sessions of laboratory practice and classroom data analysis. Both the laboratory practice and classroom data analysis sessions are supervised work in groups.
The textbook reading and laboratory notebook filling are an independent work, with available support from the teacher and assistants during specified office hours.

EXPECTED STUDENT ACTIVITIES
Beyond the work requested during the supervised sessions (practice and analysis), the student will have to:
• Read the introduction of each topic before the corresponding practice, and summarize this information in his laboratory notebook.
• Review the data analysis tools needed for the analysis sessions and prepare the required calculations ahead of the corresponding analysis session.
• Fill the laboratory notebook progressively along the semester.
The workload varies widely with the capabilities of each student. However, we expect, for each of the 6 topics investigated, an approximate working time of:
  • 2 h : Preparation of the practice session
  • 4 h : Practice session
  • 2 h : Preparation of the analysis session • 4 h : Analysis session
  • 2 h : Writing and filling of the laboratory notebook
Since most of the learning outcomes evaluated during the final exam are to be contained in the laboratory notebook, preparing for the exam should only require limited additional work.

Evaluation method
The students are evaluated by the grading of their laboratory notebooks (at the end of the semester) and through an individual written examination. The only authorized document for the exam is the student’s laboratory notebook.
A purely indicative, intermediate, evaluation of the notebooks is carried out during the semester.

ASSESSMENT METHODS
The students are evaluated by the grading of their laboratory notebooks (at the end of the semester) and through an individual written examination.
A purely indicative, intermediate, evaluation of the notebooks is carried out during the semester.

SUPERVISION
Office hours No
Assistants Yes
Forum No

RESOURCES
Bibliography
Handouts given during the course.
- Intermolecular and Surface Forces, J. Israelachvili, Academic press
- Surface Plasmon resonance Based Sensors, J. Homola et al., Springer
- Surface Design: Applications in Bioscience and Nanotechnology, R. Forch, H. Schonherr, A.T. Jenkins, Wiley

Ressources en bibliothèque
- Intermolecular and Surface Forces / Israelachvili
- Surface Plasmon resonance Based Sensors / Homola
- Surface Design: Applications in Bioscience and Nanotechnology / Forch
- Introduction to Error Analysis / Taylor
- Optical Trapping Review / Neuman
- Lab on a Chip Technology / Herold

Références suggérées par la bibliothèque
Notes/Handbook
Can be downloaded from http://lben.epfl.ch/Teaching
Websites
http://lben.epfl.ch/Teaching

PREREQUISITE FOR
MASTER

CREDITS AND WORKLOAD
Credits 4
Total workload 120h
Exam session Summer
Type of assessment During the semester