Course syllabus

Experimentell biofysik
Experimental Biophysics

FFFN20, 15 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED F/Pi
Date of Decision: 2023-04-18

General Information

Main field: Nanoscience.
Elective for: BME4-bf, F4, F4-nf, MFOT1, MNAV1, N4-nf, N4-nbm
Language of instruction: The course will be given in English

Aim

The overarching aim of the course is to give a specialisation in interdisciplinary work with a focus on experimental methods in biophysics. The course aims specifically at giving an introduction to the intersection of modern physics, nanotechnology, biomolecular chemistry and biology. Being based on current scientific articles, the course prepares the students for future research work.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to identify the complexity in the connections between dimensions in biology and the dimension of microelectronic devices and how this can be used when creating new tools for biomedical analysis.
- be able to explain basic concepts and problems within micro- and nanofluidics.
- be able to describe advanced imaging methods.
- be able to explain basic technologies for studies of single molecules.
- be able to explain the basics of membrane biophysics including current applications and relevant tools.
- be able to describe the interaction of cells with nano-structured surfaces relevant to nanosafety and for theranostic applications in medicine of

nanoparticles.
- be able to describe systems: lab on a chip, integration, nerve chip.

Competences and skills
For a passing grade the student must

- be able to independently seek information beyond the reading list.
- be able to assimilate and summarise scientific articles in an efficient and goal oriented way.
- be able to critically review sources of information for example by being aware of different forms of mechanisms that lead to bias.
- be able to develop simple experiments, i.e. evaluate and choose appropriate experimental technology for a specific issue.
- be able to plan a scientific project.
- be able to write well-structured project reports that summarise, explain and analyse experimental and/or theoretical work.
- be able to present own results in an oral presentation and actively participate discussions based on scientific arguments.

Judgement and approach
For a passing grade the student must

- be able to reflect on problem formulation in research-oriented projects.
- be able to critically discuss limitations and possibilities associated with miniaturisation of bioanalytical tools.
- be able to identify different approaches to optical problems in biophysics and biomedicine from a broad perspective ranging from individual molecules to tissue.

Contents

The course contains three modules:

Module 1, Theory, 4.5 credits: The teaching consists of lectures and discussion seminars. During this part, relevant topics according to the list below are treated and current articles are discussed. Especially during the seminar exercises, it is required that the students take active part in the discussions. An important aspect is to train efficient reading and extraction of information from scientific articles. A consistent theme within the course is micro- and nanostructures within biology and technology and their mutual connection.

Specific subjects that are included in the course:

- Order of magnitudes in biology and physics,
- Scientific critical approach,
- Micro and nanofluidics: fundamental mechanisms, relevant microtechnology, relevant applications inter alia separation and analysis of molecules and cells,
- Detection of individual molecules with optical, electronic and mechanical detection methods,
- Advanced imaging technologies for biological structures: mainly optical super resolution methods, but also photo acoustic microscopy and scanning-probe technologies,
- Lipid bilayers together with relevant technologies and current application areas,
- The interaction of proteins and cells with nano-structured surfaces from both a nanosafety perspective and an application perspective: manipulation and control of motor proteins, outgrowth of axons, antibody-antigen reactions for protein chip applications,
- System aspects: Methods for communication with the nervous system, lab-on-a-chip applications.

Module 2, Laboratory sessions, 4.5 credits: The second part consists of laboratory exercises, mainly in our research laboratories. The students will get aquainted with equipment that is actively used within the biophysics research at the division.

A selection of laboratory techniques is included from the following list based on available expertise and current topics in the literature:

- Basic fluorescence microscopy,
- The use of total internal reflection for detection and imaging of single molecules,
- Optical tweezers,
- Soft lithography and microfluidics,
- Applications of micro fluidics, for example particle sorting, microdroplets, etc,
- Surface based sensors.

Module 3, Project, 6.0 credits: The last part of the course is a project, where the students work individually or in small groups doing, preferably innovative but at the same time simple, experiments in a scientific environment somewhere within or outside the university. The work may have both experimental and theoretical character. In the latter case, it mainly is primarily simulations, but also about advanced data processing with relevance for furthermore experimental studies. The projects are defined jointly by course responsible, supervisor and student.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Examination of module 1 is in the form of written assignments during the time of the module. Examination in module 2 is arranged orally in the form of an individual examination in connection with laboratory sessions during the course. Examination in module 3 is arranged in writing in the form of a report from respective project group at the end of the course. The final grade of the student is based on theory (30%), laboratory work (30%) and project (40%).

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0113. **Name:** Theory.
Credits: 4,5. **Grading scale:** TH. **Assessment:** Written examination.
Code: 0213. **Name:** Laboratory Work.
Credits: 4,5. **Grading scale:** TH. **Assessment:** Oral examination.
Code: 0313. **Name:** Project.
Credits: 6. **Grading scale:** TH. **Assessment:** Written report and oral presentation.

Admission

Assumed prior knowledge: Compulsory courses of the first three years of the Engineering Nanoscience programme or equivalent.
The number of participants is limited to: 30
Selection: Completed university credits within the programme. Priority is given to students enrolled on programmes that include the course in their curriculum.
The course overlaps following course/s: TEK265

Reading list

- The course does not rely on any course text book. Instead it uses recent and relevant scientific papers from the literature, some of which are review papers.

Laboratory guides and question sets are available online. In addition all project reports are available as pdf files on the course website.

Contact and other information

Course coordinator: Prof Jonas Tegenfeldt, jonas.tegenfeldt@ftf.lth.se
Course homepage: https://biokurs.ftf.lth.se/