Faculty of Science

BERN08, Computational Science: Theoretical Biophysics, 7.5 credits

Beräkningsvetenskap: Teoretisk biofysik, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by The Education Board of Faculty of Science on 2024-05-22. The syllabus comes into effect 2024-05-22 and is valid from the spring semester 2025.

General information

The course is an elective course at second cycle level for a degree of Master of Science (120 credits) in Computational Science or Applied Computational Science.

The course may be included as optional course in a bachelor's or master's degree in Science (120 credits).

Language of instruction: English

Main field of study	*Specialisation*
Computational Science	A1N, Second cycle, has only first-cycle course/s as entry requirements
Applied Computational Science	A1N, Second cycle, has only first-cycle course/s as entry requirements
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

The general aim of the course is that the students should acquire knowledge about physical questions encountered in biology, both from a theoretical, mathematical perspective and through computer simulations. The course also aims to give students the general biological knowledge required to understand such questions.

Knowledge and understanding

On completion of the course, the students shall be able to:

- on a general level give an account of basic cell and molecular biology
- independently give an account of statistical mechanics models for fundamental biophysical phenomena
- independently and in detail give an account of models and equations that descibe the dynamics in cells and the motion of liquids in biophysical systems

Competence and skills

On completion of the course, the students shall be able to:

- apply physical laws in order to make rough estimates of biologically relevant quantities
- use simple statistical mechanics models in biological applications with an understanding of the underlying assumptions
- independently formulate and use model equations for the dynamics of biophysical systems on the basis of underlying assumptions

Judgement and approach

On completion of the course, the students shall be able to:

- assess how physical models best can be applied to biological phenomena
- critically discuss the possibilities and limitations of physical models in biology

Course content

The course covers:

- The structure of the cell with organels and other components
- central molecular biology processes
- basic genetics
- length scales and time scales in biological systems and processes
- basic statistical mechanics concepts within biophysics
- Debye screening of electric charges in ionic solutions
- basic structure formation of proteins and DNA
- physical properties of polymer chains
- elasticity of biological membranes
- the Navier-Stokes equations for describing liquids in motion
- the Reynolds number and its interpretation
- the Hagen-Poiseuille law for viscous flows in vascular networks
- Brownian motion, random walks and diffusion
- Stokes' law and the relation between diffusion and viscosity
- cellular uptake mechanisms and other applications of diffusion within biology
- the law of mass action and the dynamics of chemical interaction networks
- photosynthesis, molecular machines and nerve signals

Course design

The teaching consists of lectures and compulsory computer exercises.

Assessment

Examination takes place in the form of individual written reports on the computer exercises during the course, a group assignment with oral presentation during the course, and an individual oral exam at the end of the course.

Students who fail the ordinary examination are offered a re-examination shortly thereafter.

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.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction

For a grade of Pass on the whole course, the student must have passing grades on the oral exam, written reports and group assignment. These three parts are scored and the scores are the basis for the grades of the three parts.

The grading scale for oral exam, reports and group assignment are Fail, Pass.

The final grade is decided through a weighted sum of scores on the oral exam (weight 50%), reports (weight 40%) and group assignment (weight 10%). The score limits are 60% for Pass and 80% for Pass with distinction.

Entry requirements

Admission to the course requires English 6/B and 90 credits of science studies, including knowledge equivalent to BERN01 Modelling in Computational Science, 7.5 credits or FYSB23 Basic Statistical Physics and Quantum Statistics, 7.5 credits.

Further information

The course replaces BERN05 Theoretical Biophysics, 7.5 credits and FYTN05 Theoretical Biophysics, 7.5 credits, and cannot be included in a degree together with any of these courses.

The course is offered at the Centre for Environmental and Climate Science.