

Syllabus

Subject

Subject / Group	11011 - Statistical Physics in Biological Systems / 1
Degree	Master's in Physics of Complex Systems
Credits	3
Period	2nd semester
Language of instruction	English

Professors

Lecturers	Office hours for students					
	Starting time	Finishing time	Day	Start date	End date	Office / Building
Tomás Miguel Sintés Olives tomas.sintes@uib.es	12:00	13:30	Wednesday	09/09/2019	31/07/2020	207 - Edifici dels Instituts Universitaris de Recerca

Context

The aim of this subject is to train potential researchers in the study the properties of biological molecules. structures and function from a statistical mechanics point of view. It will range from the basic molecular interactions between particles to biological membranes, including the modelization of their basic constituents: lipids and proteins. Specific computer simulation techniques to biological systems will be also presented.

Requirements

Recommended

It is recommended that students have taken statistical physics courses during their undergraduate studies.

Skills

Specific

- * Development and optimal application of numerical algorithms for the simulation of complex systems (E2)
- * To understand the critical and cooperative phenomena from the perspective of cross-disciplinary physics and complex systems (E4)
- * To understand and to model processes subject to fluctuations (E6)

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Generic

- * To acquire the capacity to develop a complete research plan covering from the bibliographic research and strategy to the conclusions (TG2).
- * To write and describe rigorously the research process and present the conclusions to an expert audience (TG3).
- * To acquire high power computation skills and advanced numerical methods capabilities in applications to problems in the context of complex systems (TG6).

Basic

- * You may consult the basic competencies students will have to achieve by the end of the Master's degree at the following address: http://estudis.uib.cat/master/comp_basiques/

Content

Range of topics

- Chapter 1. Introduction to proteins and biological membranes.
 - Membrane structure and function.
 - Molecular forces.
 - Principles of statistical mechanics of polymers.
- Chapter 2. A model membrane.
 - Self-assembly of surfactant molecules.
 - Microstructural transitions in surfactant systems.
 - Fluid-like structures: Micelles, bilayers and biological membranes.
- Chapter 3. Simple models for proteins and protein folding.
- Chapter 4. The lipid-protein interaction.
 - Protein segregation.
 - An application to prion disease.
- Chapter 5. Translocation of membrane proteins
 - Membrane curvature and voltage.
 - The hydrophobic effect.
- Chapter 6. Ion-channels
 - Basic models.
 - Self-gating and collective effects.
- Chapter 7. Molecular motors
- Chapter 8. Computer simulation techniques
 - Metropolis Monte-Carlo
 - Molecular dynamics

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Long range forces and the Ewald summation

Teaching methodology

In-class work activities (0.72 credits, 18 hours)

Modality	Name	Typ. Grp.	Description	Hours
Theory classes	Theoretical Lectures	Large group (G)	The students will acquire the knowledge and methodologies to study and understand the properties of biological molecules.	18

At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to whether the subject work plan will be carried out through the schedule or through another way included in the Aula Digital platform.

Distance education tasks (2.28 credits, 57 hours)

Modality	Name	Description	Hours
Group or individual self-study	Autonomous work	The students will apply the concepts and techniques learned during the lectures to solve specific problems. The students will present the results obtained in a rigorous way and will be evaluated.	57

Specific risks and protective measures

The learning activities of this course do not entail specific health or safety risks for the students and therefore no special protective measures are needed.

Student learning assessment

Frau en elements d'avaluació

In accordance with article 33 of Regulation of academic studies, "regardless of the disciplinary procedure that may be followed against the offending student, the demonstrably fraudulent performance of any of the evaluation elements included in the teaching guides of the subjects will lead, at the discretion of the teacher, a undervaluation in the qualification that may involve the qualification of "suspense 0" in the annual evaluation of the subject".

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Theoretical Lectures

Modality	Theory classes
Technique	Short-answer tests (non-retrievable)
Description	The students will acquire the knowledge and methodologies to study and understand the properties of biological molecules.
Assessment criteria	The participation of the students along the lecturing period will be evaluated, as well as solved proposed short problems.

Final grade percentage: 50%

Autonomous work

Modality	Group or individual self-study
Technique	Extended-response, discursive examinations (retrievable)
Description	The students will apply the concepts and techniques learned during the lectures to solve specific problems. The students will present the results obtained in a rigorous way and will be evaluated.
Assessment criteria	Public presentation of the results of a selected problems proposed by the professor.

Final grade percentage: 50%

Resources, bibliography and additional documentation

Basic bibliography

- J. Israelachvili, Intermolecular and Surface Forces. Academic Press 2011
P.G. de Gennes, Scaling Concepts in Polymer Physics. Cornell Uni. Press. 1979
M. Doi and S. F. Edwards, The theory of polymer dynamics. Oxford Sci. Pub.1988
R. Gennis, Biomembranes, molecular structure and function. Springer 1988
B. Hille, Ionic Channels of excitable membranes. Sinauer Assoc.2001
D. C. Rapaport, The art of molecular dynamics simulation, Cambridge Uni. Press. 2004

Other resources

Research papers will be provided by the professor along the lecturing period.