University of the Balearic Islands

Teaching guide

Academic year	2014-15
Subject	11011 - Statistical Physics in Biological Systems
Group	Group 1, 2S
Teaching guide	A
Language	English

Subject identification

Subject	11011 - Statistical Physics in Biological Systems
Credits	0.72 de presencials (18 hours) 2.28 de no presencials (57 hours) 3 de totals (75 hours).
Group	Group 1, 2S
Teaching period	2nd semester
Teaching language	English

Professors

Lecturers	**Horari d'atenció alumnes**					
	Starting time	**Finishing time**	**Day**	**Start date**	**Finish date**	**Office**
Tomás Miguel Sintes Olives tomas.sintes@uib.es	09:30h	10:30h	Thursday	22/09/2014	24/07/2015	207 (Edifici Instituts Universitaris de Recerca)

Contextualisation

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

Recommendable

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).

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* 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).

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 rigoroulsy 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 contex 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

Theme content

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

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Molecular dynamics

Long range forces and the Ewald summation

Teaching methodology

In-class work activities

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 Campus Extens platform.

Distance education work activities

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

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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.

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