# Universitat de les Illes Balears

# Syllabus

## Subject

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

### Professors

| Lecturers | Office hours for students | | | | | |
|---|---|---|---|---|---|---|
| | **Starting time** | **Finishing time** | **Day** | **Start date** | **End date** | **Office / Building** |
| Tomás Miguel Sintes Olives<br>tomas.sintes@uib.es | 12:00 | 13:30 | Wednesday | 10/09/2018 | 30/06/2019 | IFISC - 207 / Ed. 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) .

Document automatically generated at 1001:58 of 12/12/2018

# Syllabus

## 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

### 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

Document automatically generated at 1001:58 of 12/12/2018

# Syllabus

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 Academic regulations, "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".

Date of publication: 01/07/2018

Document automatically generated at 1001:58 of 12/12/2018

# Syllabus

## 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.

Date of publication: 01/07/2018