230479 - BIOF2 - Biophysics 2

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 748 - FIS - Department of Physics
Academic year: 2019
Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Teaching unit Compulsory)
ECTS credits: 6  Teaching languages: English

Teaching staff

Coordinator: BLAS ECHEBARRIA DOMINGUEZ
Others: ENRIQUE ALVAREZ LACALLE

Opening hours

Timetable: By appointment

Prior skills

Good knowledge of basic physics, including Mechanics, Electromagnetism, Thermodynamics, and Statistical Physics.

Requirements

The students should have taken the course on Biofísica 1

Degree competences to which the subject contributes

Specific:

2. Ability to analyze biological systems as complex systems.

1. Ability to describe in general the structure of living things, from cellular to systemic level. Ability to analyze the constraints imposed by the physics laws to the development of biological systems, and the biological solutions to engineering problems.

Generical:

4. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

Transversal:

1. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
2. EFFECTIVE USE OF INFORMATION RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.
3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
The goal is that, after completing the course, the students will have a general view of cellular biophysics. In particular, they should be familiar with the main components of the cell, and be able to apply the knowledge they have acquired in past physics courses (thermodynamics, statistical physics, mechanics and electromagnetism) to problems of biological relevance.

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 65h</th>
<th>43.33%</th>
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<tbody>
<tr>
<td></td>
<td>Self study: 85h</td>
<td>56.67%</td>
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### Teaching methodology

The weekly teaching hours are distributed in three theoretical and two practical classes. During the theoretical ones the main concepts and results are explained, with examples to help their understanding. During the practical lessons, typical problems are solved, as well as more conceptual questions.
## Content

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Learning time:</th>
<th>Description</th>
<th>Related activities</th>
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</table>
| 1.- Overview of molecular and cell biology                              | 18h            | Theory classes: 5h  
Practical classes: 1h  
Self study: 12h       | - Cell physiology.  
- Biological molecules.  
- Molecular devices.  
- Basic functions of the cell. |
| 2.- Energy and entropy in the cell                                      | 17h 30m        | Theory classes: 4h  
Practical classes: 3h  
Guided activities: 0h 30m  
Self study: 10h | - Thermodynamics. Biological applications.  
- Chemical forces. Osmotic pressure. Chemical reactions.  
- Biochemistry of respiration. |
| 3.- Properties of water and the cytosolic world                        | 19h            | Theory classes: 5h  
Practical classes: 4h  
Self study: 10h       | - Properties of water. The hydrogen bond.  
- The chemistry of water. Dissociation. Electrophoresis.  
- Self-assembly. Amphiphilic molecules, emulsions; micelles. |
<table>
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<tr>
<th>Module</th>
<th>Learning time:</th>
<th>Theory classes:</th>
<th>Practical classes:</th>
<th>Guided activities:</th>
<th>Self study:</th>
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<tbody>
<tr>
<td>4.- Microscopic systems and enzyme kinetics</td>
<td>19h 30m</td>
<td>5h</td>
<td>4h</td>
<td>4h</td>
<td>10h</td>
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<tr>
<td>Description:</td>
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<tr>
<td>- Microscopic systems. Partition function and lattice models. Two-state systems.</td>
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<td>- Enzymes. Michaelis-Menten kinetics.</td>
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<td>- Cooperativity.</td>
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<td>Related activities:</td>
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<tr>
<td>Hand-in homework</td>
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| 5.- Conformation of macromolecules                           | 15h 30m        | 4h              | 3h                 | 0h 30m             | 8h          |
| Description:                                                |                |                 |                    |                    |             |
| - Elasticity of polymers.                                    |                |                 |                    |                    |             |
| - Thermal, chemical and mechanical switching. Helix-coil transition. |                |                 |                    |                    |             |
| - Allosteric interactions.                                   |                |                 |                    |                    |             |
| Related activities:                                         |                |                 |                    |                    |             |
| Handed-in homework                                          |                |                 |                    |                    |             |

| 6.- Diffusion and flow                                       | 15h 30m        | 4h              | 3h                 | 0h 30m             | 8h          |
| Description:                                                |                |                 |                    |                    |             |
| - Brownian motion. Diffusion.                               |                |                 |                    |                    |             |
| - Pasive flow through membranes. Electroosmotic effects.     |                |                 |                    |                    |             |
| Related activities:                                         |                |                 |                    |                    |             |
| Handed-in homework                                          |                |                 |                    |                    |             |
### 7.- Molecular motors. Active transport

**Description:**
- Molecular devices in cells. Mechanical machines.
- Molecular motors. Rectified Brownian motion. The diffusive and S-ratchet.

**Related activities:**
- Handed-in homework

**Learning time:** 15h 30m
- Theory classes: 4h
- Practical classes: 3h
- Guided activities: 0h 30m
- Self study: 8h

### 8.- Membranes. properties and function

**Description:**
- Membrane functions: receptors, signaling and active ion pumping.
- Electrical properties: The resting and action potential.
- The Hodgkin-Huxley equations. The cable equation.
- Nerve cells.

**Related activities:**
- Handed-in homework

**Learning time:** 17h 30m
- Theory classes: 4h
- Practical classes: 3h
- Guided activities: 0h 30m
- Self study: 10h

### 9.- Introduction to techniques and methods in biophysics

**Description:**
- Microscopy
- Genetic tools: Polymerase Chain Reaction, DNA typing, Gene cloning, Chromosome Conformation Capture, High-throughput sequencing
- Electroencephalography
- Magnetic Resonance Imaging
- Patch and Voltage Clamp

**Related activities:**
- Handed-in homework

**Learning time:** 12h
- Theory classes: 4h
- Self study: 8h
Qualification system

The students' evaluation will consist of a final exam (FE), a midterm exam (ME), and an evaluation of the student's participation in class through handed-in homework (HE). The final mark will be given by:

\[
\text{Max\{FE, 0.55*FE+0.35*ME+0.10*HE\}}
\]

Bibliography

**Basic:**


**Complementary:**


