Last update: 06-05-2019

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.

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Teaching methodology

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

Learning objectives of the subject

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 adquired in past physics courses (thermodynamics, statistical physics, mechanics and electromagnetism) to problemas of biological relevance.

Study load

Total learning time: 150h	Hours large group:	65h	43.33%
	Self study:	85h	56.67%

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Content

1.- Overview of molecular and cell biology

Learning time: 18h

Theory classes: 5h
Practical classes: 1h
Self study : 12h

Description:
- Cell physiology.
- Biological molecules.
- Molecular devices.
- Basic functions of the cell.

2.- Energy and entropy in the cell

Learning time: 17h 30m

Theory classes: 4h
Practical classes: 3h
Guided activities: 0h 30m
Self study : 10h

Description:
- Thermodynamics. Biological applications.
- Chemical forces. Osmotic pressure. Chemical reactions.
- Biochemistry of respiration.

Related activities:
Handed-in homework

3.- Properties of water and the cytosolic world

Learning time: 19h

Theory classes: 5h
Practical classes: 4h
Self study : 10h

Description:
- Properties of water. The hydrogen bond.
- The chemistry of water. Dissociation. Electrophoresis.
- Electrostatic interactions. Bjerrum, Debye and Gouy-Chapman lengths.
- Self-assembly. Amphilic molecules, emulsions; micelles.

Related activities:
Handed-in homework

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4.- Microscopic systems and enzyme kinetics

Learning time: 19h 30m

Theory classes: 5h
Practical classes: 4h
Guided activities: 0h 30m
Self study : 10h

Description:
- Probabilities. The Boltzmann distribution. Activation barriers and reaction rates.
- Microscopic systems. Partition function and lattice models. Two-state systems.
- Enzymes. Michaelis-Menten kinetics.
- Cooperativity.

Related activities:
Hand-in homework

5.- Conformation of macromolecules

Learning time: 15h 30m

Theory classes: 4h
Practical classes: 3h
Guided activities: 0h 30m
Self study : 8h

Description:
- Elasticity of polymers.
- Thermal, chemical and mechanical switching. Helix-coil transition.
- Allosteric interactions.

Related activities:
Handed-in homework

6.- Diffusion and flow

Learning time: 15h 30m

Theory classes: 4h
Practical classes: 3h
Guided activities: 0h 30m
Self study : 8h

Description:
- Brownian motion. Diffusion.
- Pasive flow through membranes. Electroosmotic effects.

Related activities:
Handed-in homework

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7.- Molecular motors. Active transport

Learning time: 15h 30m

Theory classes: 4h
Practical classes: 3h
Guided activities: 0h 30m
Self study : 8h

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

Related activities:
Handed-in homework

8.- Membranes. properties and function

Learning time: 17h 30m

Theory classes: 4h
Practical classes: 3h
Guided activities: 0h 30m
Self study : 10h

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

9.- Introduction to techniques and methods in biophysics

Learning time: 12h

Theory classes: 4h
Self study : 8h

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

Related activities:
Handed-in homework

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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:

Max{FE, 0.55*FE+0.35*ME+0.10*HE}

Bibliography

Basic:

Nelson, P. Biological physics: energy, information, life. Updated 1st ed. New York: W.H. Freeman, 2008. ISBN 9780716798972.

Cotterill, R. Biophysics: an introduction. John Wiley & Sons, 2002. ISBN 9780471485384.

Phillips, R.; Kondev, J.; Theriot, J.; Garcia, H. Physical biology of the cell. 2nd ed. Garland Science, 2012. ISBN 9780815344506.

Complementary:

Glaser, R. Biophysics: an introduction. 2nd ed. Heidelberg: Springer, 2012. ISBN 9783642252112.

Nölting, B. Methods in modern biophysics. 3rd ed. Berlin: Springer Verlag, 2010. ISBN 9783642030215.

Jackson, M.B. Molecular and cellular biophysics. Cambridge University Press, 2006. ISBN 9780521624701.

Claycomb, J.R.; Tran, J.Q.P. Introductory biophysics: perspectives on the living state. Jones & Barlett Publishers, 2010. ISBN 9780763779986.