Course guide
230479 - BIOF2 - Biophysics 2

Last modified: 25/05/2023

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura

Others: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

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:
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.
2. Ability to analyze biological systems as complex systems.

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 INFORMATI0N 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.

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.

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

Type	Hours	Percentage
Hours large group	65,0	43.33
Self study	85,0	56.67

Total learning time: 150 h

CONTENTS

1.- Overview of molecular and cell biology

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

Full-or-part-time: 18h
Theory classes: 5h
Practical classes: 1h
Self study : 12h

2.- Energy and entropy in the cell

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

Related activities:
Handed-in homework

Full-or-part-time: 17h 30m
Theory classes: 4h
Practical classes: 3h
Guided activities: 0h 30m
Self study : 10h

3.- Properties of water and the cytosolic world

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

Full-or-part-time: 19h
Theory classes: 5h
Practical classes: 4h
Self study : 10h

4.- Microscopic systems and enzyme kinetics

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

Full-or-part-time: 19h 30m
Theory classes: 5h
Practical classes: 4h
Guided activities: 0h 30m
Self study : 10h

5.- Conformation of macromolecules

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

Related activities:
Handed-in homework

Full-or-part-time: 15h 30m
Theory classes: 4h
Practical classes: 3h
Guided activities: 0h 30m
Self study : 8h

6.- Diffusion and flow

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

Related activities:
Handed-in homework

Full-or-part-time: 15h 30m
Theory classes: 4h
Practical classes: 3h
Guided activities: 0h 30m
Self study : 8h

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

Full-or-part-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

Full-or-part-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 Confromation Capture, High-throughput sequencing
? Electroencephalography
? Magnetic Resonance Imaging
? Patch and Voltage Clamp

Related activities:
Handed-in homework

Full-or-part-time: 12h
Theory classes: 4h
Self study : 8h

GRADING 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{0.9*FE+0.1*HE, 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, 2011. ISBN 9780763779986.