Universitat Autònoma de Barcelona

2019/2020

Introduction to Biophysics

Code: 100165
ECTS Credits: 5

Degree	Type	Year	Semester
2500097 Physics	OT	3	1

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

Juan Camacho Castro

Prerequisites

It is advisable to have some general knowledge aon chemistry and biology, at a high school level.

The fields of physics most employed during the course will be Thermodynamics, Elasticity, Electricity and Magnetism, and Physics of Radiations. So that, it is advisable to have followed courses on these topics in the previous years of the degree. In particular, students should have followed courses on theor second year the courses on 'Electromagnetism' and 'Matter Structure and Thermodynamics'.

Objectives and Contextualisation

This course tries to provide a panoramic, but not exhaustive, introduction to biophysics. The main goal is that physics students have a first touch of physical analysis of problems that lie at the fontier with biology (and, often, with biochemistry), and become aware of the richness of problems in biology for which the tools and methods from physics are extremely worthy. Likewise, the course introduces several ideas at a basic level that can help the students to face in the future more advances courses related to medical physics, bioinformatics or complex systems.

Competences

- Apply fundamental principles to the qualitative and quantitative study of various specific areas in physics
- Be familiar with the bases of certain advanced topics, including current developments on the parameters of physics that one could subsequently develop more fully
- Develop critical thinking and reasoning and know how to communicate effectively both in the first language(s) and others
- Develop independent learning strategies
- Develop the capacity for analysis and synthesis that allows the acquisition of knowledge and skills in different fields of physics, and apply to these fields the skills inherent within the degree of physics, contributing innovative and competitive proposals.

- Generate innovative and competitive proposals for research and professional activities.
- Respect the diversity and plurality of ideas, people and situations
- Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
- Use mathematics to describe the physical world, selecting appropriate tools, building appropriate models, interpreting and comparing results critically with experimentation and observation

Learning Outcomes

1. Apply the power-cord model to the description of the shape and speed of action potential in excitable membranes.
2. Calculate Nernsts potential in physical and biological systems.
3. Correctly apply the equations of passive and active transport to the propagation of nerve signals in excitable membranes.
4. Describe the bases to synchrotron radiation and its application to protein structure.
5. Describe the basic ideas of learning in neural networks and the principal morphological and functional characteristics of the brain.
6. Describe the basic steps in protein synthesis and the genetic code.
7. Describe the fundamentals of certain medical imaging techniques (MRI, PET, CT).
8. Describe the principal basic techniques of medical physics.
9. Describe the principal unresolved problems in biophysics (protein folding, physical sequencing of DNA, the physical bases of genetic and epigenetic code, molecular motors, neural networks).
10. Develop an understanding of the bases to biomedical observation techniques (electrocardiography, electroencephalography and magnetoencephalography).
11. Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
12. Develop independent learning strategies.
13. Distinguish the fields of application for different types of microscope (optical, electronic, tunneling or atomic force).
14. Establish the basic concepts of physics membranes and active and passive transport, and apply these to the action potential in the nervous system.
15. Establish the basic physical aspects of proteins and nucleic acids.
16. Generate innovative and competitive proposals for research and professional activities.
17. Model various biological processes (growth of tumors, cardiac excitation waves, learning in neural networks, immune system).
18. Respect diversity in ideas, people and situations.
19. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
20. Work on problems of the dosimetry of ionizing radiation and its biological effects for subsequent training in medical physics.

Content

Program

1. Chemical foundatiosn of biophysics.

2. Physics of macromolecules.
3. Biological information and synthesis of proteins.
4. Introduction to cellular physics.
5. Introduction to neurophysics.
6. Biomechanics and bioenergetics.
7. Morphogenesis, evolution and ecosystems.
8. Medical physics.

Methodology

We start the course by reviewing the essential properties of macromolecules, centering our attention on proteins and DNA (their elements, structure, and mechanical and electrical properties). Then we study some physical aspects of macromolecules, focused on molecular pumps and engines. At the cell level, we introduce basic ideas about metabolism, and the main structural and transport properties of the cell membrane, with a special emphasis given to the behavior of the neuronal system (individual neurons, networks, and the brain). Finally we introduce several basic ideas about evolution and the role that physics play in it, population dynamics of simple ecosystems, and a final presentation about radiactivity and its biological effects.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Practical classes	14	0.56	3, 1, 2, 17
Theoretical classes	27	1.08	10, 7, 4, 6, 9, 5, 8, 13, 15, 14, 19, 20
Type: Autonomous			
Mentoring sessions	5	0.2	11, 16, 17
Project and autonomous exercises	18	0.72	1, 2, 9, 12, 11, 16, 17, 18, 20
Study	53	2.12	10, 7, 4, 6, 9, 5, 8, 13, 15, 14

Assessment

Partial exams: Two partial exams during the course, each representing 4 points of the final mark (over 10).

Work: It consists of a project about a topic of current relevance in biophysics. This activity will include an assignment that will consist of an oral presentation to be recorded in video (the details will be agreed throughout the course).

To pass the course it is necessary to have a global mark of 5 (over 10) and having obtained a minimum mark of 3,5 in each of the two partial exams.

Those students that have taken the partial exams but have not obtained the minimum mark of 3,5 (or those who have not obtained a final mark of 5) have the option to attend a final exam for each of the parts by separate, or both.

Those students that do not take the partial exams will also lose their right to take the final exam.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Partial exam 1	40/100	2	0.08	3, 1, 2, 10, 7, 4, 6, 9, 5, 8, 13, 15, 14, 17, 19, 20
Partial exam 2	40/100	2	0.08	3, 1, 2, 10, 7, 4, 6, 9, 5, 8, 13, 15, 14, 17, 20
Project	20/100	4	0.16	3, 1, 2, 12, 11, 16, 18, 20

Bibliography

Main references

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