

Introduction to Biophysics

Code: 100165
ECTS Credits: 5

| Degree | Type | Year | Semester |
|-----------------|------|------|----------|
| 2500097 Physics | OT | 3 | 1 |

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

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 on 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 their 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 frontier 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 advanced courses related to biology, biotechnology, bioinformatics or complex systems.

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- 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
- Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, and before both specialist and general publics

- 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.
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- 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
- Work independently, have personal initiative and self-organisational skills in achieving results, in planning and in executing a project

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. Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, in front of both specialist and general publics.
4. Correctly apply the equations of passive and active transport to the propagation of nerve signals in excitable membranes.
5. Describe the bases to synchrotron radiation and its application to protein structure.
6. Describe the basic ideas of learning in neural networks and the principal morphological and functional characteristics of the brain.
7. Describe the basic steps in protein synthesis and the genetic code.
8. Describe the fundamentals of certain medical imaging techniques (MRI, PET, CT).
9. Describe the principal basic techniques of medical physics.
10. 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).
11. Develop an understanding of the bases to biomedical observation techniques (electrocardiography, electroencephalography and magnetoencephalography).
12. Distinguish the fields of application for different types of microscope (optical, electronic, tunneling or atomic force).
13. Establish the basic concepts of physics membranes and active and passive transport, and apply these to the action potential in the nervous system.
14. Establish the basic physical aspects of proteins and nucleic acids.
15. Explain the explicit or implicit code of practice of one's own area of knowledge.
16. Identify situations in which a change or improvement is needed.
17. Identify the social, economic and environmental implications of academic and professional activities within ones own area of knowledge.
18. Model various biological processes (growth of tumors, cardiac excitation waves, learning in neural networks, immune system).
19. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
20. Work independently, take initiative itself, be able to organize to achieve results and to plan and execute a project.
21. Work on problems of the dosimetry of ionizing radiation and its biological effects for subsequent training in medical physics.

Content

Program

1. Chemical foundationn of biophysics.

2. Physics of macromolecules.
3. The central dogma of biology.
4. Introduction to cellular physics.
5. Introduction to neurophysics.
6. Morphogenesis, evolution and ecosystems.
7. Biomechanics and bioenergetics.

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 radioactivity and its biological effects.

Activities

| Title | Hours | ECTS | Learning Outcomes |
|----------------------------------|-------|------|---|
| Type: Directed | | | |
| Practical classes | 14 | 0.56 | 4, 1, 2, 18 |
| Theoretical classes | 27 | 1.08 | 11, 8, 5, 7, 10, 6, 9, 12, 14, 13, 19, 21 |
| Type: Autonomous | | | |
| Mentoring sessions | 5 | 0.2 | 18 |
| Project and autonomous exercises | 18 | 0.72 | 1, 2, 10, 18, 21 |
| Study | 53 | 2.12 | 11, 8, 5, 7, 10, 6, 9, 12, 14, 13 |

Assessment

Partial exams: Two partial exams during the course, the second having a larger weight on the final mark (since the quantity of contents in it will be also larger).

Presentation project: It consists of a project (in groups of two students, with a different topic for each group) about a topic of current relevance in biophysics. This activity will have the form of an oral presentation to be recorded by the students in video (equipments and resources necessary for it will be available).

Written report: It consists of a report where the student have to develop ideas and concepts studied during the course in connection to a current topic of interest in biophysics chosen by the teacher (the topic will be the same for all students).

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 referral exam. This exam will be unique for all students, so there is no the possibility to re-assess the two parts of the course by separate.

The Presentation prject and the Written report cannot be re-assessed.

Assessment Activities

| Title | Weighting | Hours | ECTS | Learning Outcomes |
|----------------------|-----------|-------|------|--|
| Partial exam 1 | 35/100 | 2 | 0.08 | 4, 1, 2, 11, 8, 5, 7, 10, 6, 9, 12, 14, 13, 18, 19, 21 |
| Partial exam 2 | 40/100 | 2 | 0.08 | 4, 1, 2, 11, 8, 5, 7, 10, 6, 9, 12, 14, 13, 18, 21 |
| Presentation project | 15/100 | 2 | 0.08 | 4, 1, 2, 21 |
| Written report | 10/100 | 2 | 0.08 | 3, 15, 17, 16, 19, 20 |

Bibliography

Main references

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