

**Physics**

Code: 100810  
ECTS Credits: 6

Degree	Type	Year	Semester
2500250 Biology	FB	1	2

## Contact

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## Teaching groups languages

You can check it through this [link](#). To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

## Prerequisites

It is recommended to take the propaedeutic course on Physics offered by the Faculty, which makes more accessible the understanding of the matter. The main requirement is a strong will of learning and a commitment to work; to know addition, subtraction, multiplication, division, writing, and working with logarithms and exponential functions. Having a genuine interest in biological systems. In fact, the course requires only a very elementary knowledge of Physics, and it is focused on illustrating the application of simple physical concepts to the understanding of biological problems.

## Objectives and Contextualisation

- To achieve an understanding of the utility of physics as a way of exploration and comprehension of biological systems, and the instruments used to observe it.
- To identify some topics in biophysics and in medical physics in order to get a true appreciation of the relation between physics and biology as one of the most active current frontiers of knowledge.
- To introduce some quantitative elements in the analysis of several biological situations, as for instance nervous signals, vision, audition, cellular motion, circulatory system, membrane transport, biological effects of radiations,...

## Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Be able to analyse and synthesise
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.

- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
- Understand and interpret the physicochemical bases of the basic processes of living beings

## Learning Outcomes

1. Analyse a situation and identify its points for improvement.
2. Be able to analyse and synthesise.
3. Critically analyse the principles, values and procedures that govern the exercise of the profession.
4. Describe how physics theories serve to formulate problems in biology with greater precision.
5. Explain the basic ideas of physics.
6. Identify some present-day frontiers in biophysics.
7. Propose new methods or well-founded alternative solutions.
8. Read, understand, summarise and explain popular-science articles on the application of physics to biology.
9. Solve simple physics problems referring to situation of biological interest.
10. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
11. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
12. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
13. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
14. Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
15. Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.

## Content

### Block 1: Physics of the biological cell

1. Review of elementary concepts of mechanics. Application to molecular machines.
2. Scaling laws. Size and form. Some physiological and evolutionary consequences.
3. Hydrostatics. Fluids at rest. Pressure distribution and circulatory system.
4. Viscous fluids. Stokes law. Sedimentation. The motion of organisms in fluids.
5. Poiseuille equation. Blood flow. Membrane permeability.
6. Diffusion. Fick's law and Brownian motion. Membrane transport.
7. Electric potential and field. Membranes as capacitors.
8. Ohm's law. Ionic channels. Membrane depolarization.
9. Membrane ionic transport. Nernst potential. Active transport. Molecular pumps.
10. Nervous current. Physics of action potential: form, duration and speed. Synapse. Neural networks.

## Block 2: Biofísica de los sentidos

1. Propagation waves. Standing waves.
2. Acoustics. Speed of sound. The intensity of sound. Decibel scale.
3. Audition. External, medial, and internal ear.
4. Physical optics. Interference. Diffraction. Polarization.
5. Geometrical optics. Refraction. Lenses. Microscopes.
6. Vision. The eye: focusing; defects; visual acuteness.

## Block 3: Ionizing radiations

1. Quantum physics. Einstein-Planck and de Broglie relations. Energy levels.
2. Physical and biological dosimetry. Biological effects of ionizing radiation.
3. Radioactive decay. Half-life.
4. Elementary ideas on nuclear physics: bond energy, nuclear levels, nuclear decays.

## Methodology

Each class is motivated by some questions of biological interest. The objective of the course is to learn through simple physical equations, that physics is useful to know more biology.

The development of the subject is based on interactive face-to-face activities in the classroom as well as on the virtual campus through homework assignments, exercises, and participation in the forums. The activities will be directed, supervised, and autonomous.

For the problems solving classes, the students will prepare some of them on their own before each session. The professor will solve the key problems and will assist the students with doubts and difficulties.

Among the supervised activities, a research work based on the study of a physical phenomenon is proposed which will be analyzed and presented in small groups in the form of a written review and an oral presentation.

In all cases, will be used support material, where the student can consult the contents, the programming of activities for both continuous assessment and directed learning, and the list of references.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

## Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Theory classes	35	1.4	3, 4, 5, 6, 7, 13, 12, 9, 2
Type: Supervised			
Problem solving classes	15	0.6	6, 12, 9
Research project	5	0.2	4, 5, 6, 8, 12, 11, 10, 2

Personal study, problems solving, classwork, participation in forums on the virtual campus	86	3.44	3, 4, 6, 8, 13, 10, 9, 2
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## Assessment

The correct achievement of the competencies by the students will be assessed through 3 types of assessment activities, each with a specific weight in the final grade, and with specific requirements, a fourth activity will be for students who have failed some of the midterm exams.

1. *Midterm exams (70%)*: Throughout the course, there will be 2 written partial exams (theory and problems). The first midterm exam must evaluate Block 1 and will have a weight of 40%, the second midterm exam must evaluate Blocks 2 and 3 and will have a weight of 30%. You will need to get an average of 4 out of 10 from each of the two midterm exams to average with the remaining grades.
2. *Continuous assessment activities (15%)*: Throughout the semester, additional activities will be proposed, such as solving exercises other than those in the problem class, moodle quizzes, classwork exercises, forums (for each thematic block). These activities will be evaluated, and their average will have a weight of 15% in the overall grade. There are no minimum grade requirements but there is a restriction for exercise deliveries, they must be individual.
3. *Research work (15%)*: In groups of max. 5 students, a topic will be developed based on the study of a physical phenomenon using one or more scientific articles. This work will have two submissions and one re-submission of the written document where the comments suggested (by tutorials and feedback) must be applied. An extra submission will be required with the slides for the final presentation.
4. Final exam (recovery of the failed exams, or the possibility of increasing the grade, keeping the previous grade in case the final exam is lower). Only students who have taken the two midterm exams at the time will be able to take this exam.

The overall grade will be calculated as:

$$\text{Overall Grade} = \text{First midterm exam} \times 0,40 + \text{Second midterm exam} \times 0,30 + \text{Research Project} \times 0,15 + \text{Classwork and exercises} \times 0,15$$

The subject will be considered passed when the overall grade is equal to or higher than 5 points out of 10

Repeaters will be required to do the same assessment activities as newly enrolled students.

The Honor grade may only be awarded to students who have obtained a final grade equal to or greater than 9. A maximum of 1 for every 20 enrolled students may be awarded.

This subject does not include the single assessment system.

## Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Classwork and exercises	15%	1	0.04	15, 3, 1, 5, 6, 8, 13, 9, 2
First midterm exam	40%	2.5	0.1	4, 5, 7, 9, 2
Research project	15%	1	0.04	15, 14, 4, 5, 6, 8, 12, 11,

submission				10, 9, 2
Retake exam	Allows to raise the grade obtained in the midterm exams	2.5	0.1	4, 5, 7, 12, 9, 2
Second midterm exam	30%	2	0.08	4, 5, 7, 9, 2

## Bibliography

Different reference books are proposed for most of the topics, including some of a basic nature for general consultation and others advanced for students who would like to expand their knowledge. In addition, access links for some of them are provided. Many concepts as mathematical as they are physical or physicochemical are introduced intuitively and illustrated with numerous practical examples. These books allow you to delve into the most important topics of the course.

- D. Jou, J E Llebot i C Pérez-García, Física para las ciencias de la vida, Second edition, Mc Graw Hill, 2009
- J. W. Kane i M. M. Sternheim, Física, Reverté, 1989
- R. Cotterill, Biophysics: An Introduction, John Willey & Sons, LTD. 2002.
- P. Davidovits, Physics in Biology and Medicine, Third Edition, Elsevier-Academic Press, 2008.
- B. Rubin. Compendium of Biophysics. Wiley, 2017. Online access: <https://onlinelibrary.wiley.com/doi/book/10.1002/9781119160281>
- T. A. Waigh. The Physics of Living Processes - A Mesoscopic Approach. Wiley, 2015. Online access: <https://onlinelibrary.wiley.com/doi/book/10.1002/9781118698310>
- T. Bécherrawy. Vibrations and Waves. Wiley, 2011. Online access: <https://onlinelibrary.wiley.com/doi/book/10.1002/9781118586525>
- M. W. McCall Classical Mechanics - From Newton to Einstein - A Modern Introduction 2e. Wiley, 2010. Online access: <https://onlinelibrary.wiley.com/doi/book/10.1002/9780470972502>

### Advanced

- R. Phillips, J. Kondev, J. Theriot, H. G. Garcia, Physical biology of the cell, Garland Science (Taylor and Francis Group), Londres, 2013
- D. and H. Yevik. Fundamental Math and Physics for Scientists and Engineers. Wiley, 2014. Online access: <https://onlinelibrary.wiley.com/doi/book/10.1002/9781118979792>

## Software

### Online Simulators

- Light diffraction -[https://www.walter-fendt.de/html5/phes/singleslit\\_es.htm](https://www.walter-fendt.de/html5/phes/singleslit_es.htm)
- Wave Interference - [https://phet.colorado.edu/sims/html/wave-interference/latest/wave-interference\\_es.html](https://phet.colorado.edu/sims/html/wave-interference/latest/wave-interference_es.html)
- oPhysics: Interactive Physics Simulations - <https://ophysics.com/waves11.html>
- Resources and Services for Physics Education - <https://www.compadre.org/osp/EJSS/4441/235.htm>