

COURSE GUIDE

**Physics of Biological Systems (2001112)**

Approval date:  
 Departamento de Física Aplicada: 19/06/2023  
 Departamento de Física Teórica y del Cosmos: 22/06/2023

<b>Grado (Bachelor's Degree)</b>	Grado en Biología	<b>Branch</b>	Sciences
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<b>Module</b>	Materias Básicas Instrumentales para la Biología	<b>Subject</b>	Física
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<b>Year of study</b>	1 <sup>o</sup>	<b>Semester</b>	2 <sup>o</sup>	<b>ECTS Credits</b>	6	<b>Course type</b>	Core course
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**PREREQUISITES AND RECOMMENDATIONS**

Having prior knowledge of Mathematics and Physics at secondary level is highly beneficial. Given the special nature of the group, a good proficiency in English is strongly recommended.

**BRIEF DESCRIPTION OF COURSE CONTENT (According to the programme's verification report)**

- The relation between Physics and Biology
- Force, work and energy
- Fluid Mechanics
- Diffusion and osmosis
- Electric field and electric current
- Sound waves. Sound and hearing
- Electromagnetic radiation and radioactivity. Applications in Biology

**SKILLS**

**GENERAL SKILLS**

- CG01 - Organisational and planning skills
- CG02 - Teamwork
- CG03 - Applying knowledge to problem solving
- CG04 - Capacity for analysis and synthesis
- CG06 - Critical reasoning

**SUBJECT-SPECIFIC SKILLS**

- CE37 - Analysing the physical laws governing biological processes
- CE75 - Knowing the physical and chemical principles of Biology



## LEARNING OUTCOMES

Learning and developing the basic concepts and laws in Physics for their subsequent application to relevant phenomena in Biology:

- Using the concepts of torque and centre of gravity, learning how the levers that appear in the main joints of animals work
- Understanding the meaning of energy conservation laws and their importance in Biology
- Understanding the physical properties of fluids, the characteristics of the surface of a liquid in contact with solids or gases, transport processes in fluids and their application to blood circulation, sap ascent in plants and gas transport through blood capillaries
- Studying the basic concepts of electricity required to understand ion transport through the cell membrane
- Understanding the physical basis of hearing and vision
- Studying the high-energy radiations that are used in various biological and medical applications

## PLANNED LEARNING ACTIVITIES

### THEORY SYLLABUS

#### INTRODUCTION

- **UNIT 1:** The relation between Physics and Biology. Measurement standards and unit systems. Dimensional analysis. Size, form and life. Scaling laws. Vectors

#### FORCE AND STABILITY. WORK AND ENERGY

- **UNIT 2:** Newton's Laws. Fundamental and derived forces. Torque. Centre of gravity. Equilibrium. Forces in muscles and joints
- **UNIT 3:** Work done by a force. Kinetic energy and potential energy. Conservation of energy. Power. Efficiency. Metabolic rate. Elasticity. Muscle energy

#### FLUID MECHANICS

- **UNIT 4:** Hydrostatics: Density and pressure. Hydrostatic pressure. Archimedes' principle. Hydrostatic examples in Biology
- **UNIT 5:** Hydrodynamics of an ideal fluid. Continuity equation. Bernoulli's equation. Biological examples
- **UNIT 6:** Hydrodynamics of a real fluid: Viscosity. Poiseuille's Law. Blood circulation. Stokes' Law. Sedimentation
- **UNIT 7:** Surface phenomena: Surface tension. Laplace's law. Contact angle and capillarity. Biological examples

#### DIFFUSION AND OSMOSIS

- **UNIT 8:** Flux. Fick's laws. Mean squared displacement. Osmosis. Osmotic pressure. Transcapillary substance transfer

#### ELECTRIC FIELD AND ELECTRIC CURRENT

- **UNIT 9:** Coulomb's law. Electric field. Electric potential. Electric dipole. Capacitors. Current intensity. Resistance. Ohm's law. Electric properties of membranes. Ion transport through membranes. Action potential. Nerve impulse

#### SOUND WAVES. SOUND AND HEARING

- **UNIT 10:** Properties of waves. Sound waves. Sound velocity. Stationary waves. Sound and its perception by living beings

#### ELECTROMAGNETIC RADIATION AND RADIOACTIVITY

- **UNIT 11:** Nature of light. Electromagnetic spectrum. Reflection and refraction. Snell's law. Lenses. Axes and principal planes. Focal and nodal points. The eye as an optical system. Fundamentals of optical instruments. Principles of radiation. Radioactive decay. Half-life. Interaction of radiation and matter. Biological effects. Usage of radioactive



## isotopes in Biology

### PRACTICAL SYLLABUS

#### SEMINARS / WORKSHOPS

- Problem solving of the different topics
- Seminars or presentations

#### LAB SESSIONS

Students will carry out 4 sessions out of the following:

1. Precision measurements
2. Static equilibrium. Torque
3. Newton's laws
4. Elastic constant
5. Archimedes' principle
6. Viscosity determination with the Stokes' method
7. Surface tension
8. Multimeter. Ohm's law
9. Determination of gravity's acceleration with a simple pendulum

### RECOMMENDED READING

#### ESSENTIAL READING

- "Physics for the life sciences", A.H. Cromer. McGraw-Hill
- "Physics in Biology and Medicine", P. Davidovits. Academic Press
- "General Physics", J.W. Kane and M.M. Sternheim. Wiley

#### COMPLEMENTARY READING

- "Physics for Scientists and Engineers", P.A. Tipler y G. Mosca. WH Freeman
- "Physics for Scientists and Engineers", R.A. Serway y J.W. Jewett. Cengage Learning
- "University Physics", Sears, Zemansky, Young y Freedman. Addison-Wesley-Pearson
- "Physics: Principles with Applications", D.G. Giancoli. Pearson
- "What is Life" E. Schrödinger. Cambridge University Press
- "Chance and necessity: an essay on the national philosophy of modern biology", J. Monod. HarperCollins

### RECOMMENDED LEARNING RESOURCES/TOOLS

- <https://en.khanacademy.org/science/physics>

### TEACHING METHODS

- MD01 - Lección magistral/expositiva
- MD03 - Resolución de problemas y estudio de casos prácticos
- MD04 - Prácticas de laboratorio y/o clínicas y/o talleres de habilidades



- MD11 - Realización de trabajos individuales

## ASSESSMENT METHODS (Instruments, criteria and percentages)

### ORDINARY EXAMINATION DIET

Assessment in the ordinary session will take place via two written tests, with problems and questions covering the relevant material that's been reviewed up to that date. The final marks in the continuous evaluation system of the ordinary session will have the following weights:

- First written test: 35-40%
- Second written test (same date as the ordinary exam session): 40-45%
- Lab sessions: 20%. In these, the competency will be assessed by a practical test and/or through the lab reports. In order to pass the whole subject, **it is mandatory to pass the lab sessions (5 or more points over 10), successfully complete all the sessions and submit all the corresponding reports**

Students will pass the subject by continuous evaluation when their final mark exceeds 5 points (out of 10) according to this weighting scheme.

### EXTRAORDINARY EXAMINATION DIET

In the extraordinary session there will be a single final exam representing 80% of the final mark and an additional exam covering the concepts of the lab sessions, weighting 20%. This lab exam will take place on the same date but at a different time than the written exam of the extraordinary session.

### SINGLE FINAL ASSESSMENT (evaluación única final)

Students who, in accordance with the UGR guidelines, terms and deadlines, opt for this form of evaluation, will take an exam covering the theoretical part of the subject. Another exam will be required in order to assess the practical part. The aforementioned weights will be applied to this evaluation, being again compulsory to pass the lab exam in order to pass the whole subject.

## ADDITIONAL INFORMATION

- Use of mobile phones is not allowed during lectures and lab sessions
- Following the advice from the CRUE and the diversity and inclusion office of the UGR, the assessment and learning evaluation will be designed following the principle of accessibility for everyone, making the necessary adaptations that enable the learning process and the demonstration of knowledge regardless of special needs and limitations of individuals

