

Biophysics

Code: 101892
 ECTS Credits: 6

Degree	Type	Year	Semester
2501230 Biomedical Sciences	FB	1	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: No

Some groups entirely in Spanish: No

Teachers

Mireia Duñach Masjuan

Ramón Barnadas Rodríguez

Josep Bartomeu Cladera Cerdà

Alberto Zurita Carpio

Maria Elena Alvarez Marimon

Alex Peralvarez Marin

Prerequisites

Students should have achieved a basic knowledge in general Physics, mastering concepts such as pressure, energy, power and intensity. It is important to have a previous knowledge of mechanical waves and optics. That is, to have acquired the theoretical knowledge and problem solving capacity as it is implemented for Physics in the 'Batxillerat' (Spanish/Catalan) program.

Objectives and Contextualisation

First year Biophysics for Biomedical Sciences students aims at explaining the structure-function of living organisms, especially the human body in its health and disease states, from the point of view of the application of the fundamental laws and principles of Physics. Emphasis is made on the use of tools to solve numerical problems and for the acquisition of a critical capacity to evaluate scientific results.

Competences

- Contribute to public discussions on cultural matters.
- Describe biomedical problems in terms of causes, mechanisms and treatments.
- Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
- Develop independent learning habits and motivation to continue training at postgraduate level.
- Develop independent learning strategies.

- Develop scientific knowledge, critical reasoning and creativity.
- Display knowledge of the bases and elements applicable to the development and validation of diagnostic and therapeutic techniques.
- Display knowledge of the basic life processes on several levels of organisation: molecular, cellular, tissues, organs, individual and populations.
- Generate innovative and competitive proposals for research and professional activities.
- Identify and understand the advances and challenges of research.
- Read and critically analyse original and review papers on biomedical issues and assess and choose the appropriate methodological descriptions for biomedical laboratory research work.
- Work as part of a group with members of other professions, understanding their viewpoint and establishing a constructive collaboration.

Learning Outcomes

1. Contribute to public discussions on cultural matters.
2. Describe the biophysical bases for molecular interactions and balances in healthy or pathological states.
3. Describe the physical bases for the functioning of the organs and systems of the healthy human organism such as: sight, speech and hearing, respiration and blood circulation.
4. Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
5. Develop independent learning habits and motivation to continue training at postgraduate level.
6. Develop independent learning strategies.
7. Develop scientific knowledge, critical reasoning and creativity.
8. Discern the effects of the interaction of radiations and particles with living beings, in accordance with physical bases.
9. Estimate the importance of the scientific method in the analysis of a complex system like the human body.
10. Generate innovative and competitive proposals for research and professional activities.
11. Identify and understand the advances and challenges of research.
12. Recognise and identify the mechanisms and physical bases of the technologies that use radiations and particles in diagnosis and therapy.
13. Understand and critique scientific articles on physics.
14. Understand the functioning of the organism, at both cell and tissue level, its physicochemical bases and its physical bases.
15. Work as part of a group with members of other professions, understanding their viewpoint and establishing a constructive collaboration.

Content

- 1. ELECTROMAGNETIC RADIATION AND RADIOACTIVITY (5 H THEORY + 1 h numerical problems)
 - 1.1. Nature and properties. X-rays. Production: the Coolidge tube. X-ray absorption. Radioactive emission. Exponential decay. Activity. Nuclear processes. Dose.
 - 1.2. Interaction with living organisms. Radiolysis of water. Radiolysis of macromolecules. Biological effects. Biological dose. Relative Biological Efficiency.
 - 1.3. Biomedical applications.
- 2. VOICE PRODUCTION AND AUDITION (5 H THEORY + 1 h numerical problems)
 - 2.1. Sound quality: intensity, tone and timbre.
 - 2.2. Voice production.
 - 2.3. Auditory transmission mechanisms. The middle ear as an impedance adaptor. Frequency discrimination and localization in the inner ear. Sound sensation thresholds.
- 3. BIOPHYSICS OF VISION (5 H THEORY + 1 h numerical problems + 3.5 h lab teaching)
 - 3.1 The eye as an optical system. Ocular Dioptric. Resting eye power. Accommodation. The crystalline. Image formation in the retina. Presbyopia. Refraction defects: Myopia, hypermetropia. Correction. Visual acuity.
 - 3.2 The eye as a sensory receptor.

- Visual fototransduction. Cones and rods. Rhodopsin and iodopsines. Transduction and signal amplification. Membrane hyperpolarization. Retina sensibility. Photopic and Scotopic vision. Sensibility curve. Light/darkness adaptation.
- 3.3 Color vision. Visual trivariance. Iodopsines absorption curves. Color vision anomalies.
- 4. BIOPHYSICS OF CIRCULATION (5 H THEORY + 1 h numerical problems + 2.5 h lab teaching)
 - 4.1. Fundamental principles of static and fluid dynamics. Hydrostatic pressure. Flow. Equation of Continuity. Venturi effect.
 - 4.2. Laminar flux energetics. Bernoulli's equation. Hydrostatic pressure, kinematic pressure and height load.
 - 4.3. Laws of circulation of real liquids. Laminar flow. Viscosity. Loss of pressure. Law of Poiseuille. Hydrodynamic resistance.
 - 4.4. Flow in turbulent regime. Velocities distribution. Number of Reynolds.
 - 4.5. Influence of vascular distensibility in the blood flow. Capacitance and vascular distensibility. Tension to the vascular wall. Law of Laplace. Balance pressure-tension in the vessels. Critical closing pressure. Aneurism. Viscosity of the blood vessels.
 - 4.6. Effect of gravity on blood circulation.
- 5. BIOPHYSICS OF RESPIRATION. (5 H THEORY + 1 h numerical problems)
 - 5.1 Introduction to the anatomy of the lungs.
 - 5.2 Structure of the respiratory tract.
 - 5.3 Types of respiration. Effects of the external environment on respiration. Regulation of temperature and relative humidity.
 - 5.4 Respiratory mechanics. Dead anatomical volume. Respiratory mechanics of inspiration and expiration. Pulmonary compliance. Resistance of the respiratory tract.
 - 5.5 The pulmonary surfactant. Surface tension. Production, characteristics and effect of the pulmonary surfactant during the respiratory cycle.
 - 5.6 The alveolar diffusion. Law of Henry. Fick's law. Oxygenation of blood in health and disease states.
- 6. THE THERMODYNAMICS AND THEIR LIVING (4h theory + 2h numerical problems)
 - 6.1. Energy, heat and work. Heat capacity Useful work
 - 6.2. Kinetic-molecular theory. Molecular kinetic energy and temperature.
 - 6.3. Potential energy and chemical bond.
 - 6.4. Internal energy. Enthalpy. 1st principle of thermodynamics.
 - 6.5. Spontaneity. Entropy, disorder and probability.
 - 6.6. Free energy. 2nd principle of thermodynamics.
 - 6.7. Living organisms and the 1st and 2nd principles of thermodynamics.
- 7. TRANSPORT PHENOMENA (6h theory + 2h numerical problems + 4h lab teaching)
 - 7.1. Simple diffusion
 - 7.2. Diffusion through membranes.
 - 7.3 Osmosis and dialysis phenomena.
 - 7.4. Biomedical examples.
 - Laboratory teaching program.
 - Practice 1.- Optics of the eye. Formation of images in an eye model. Ametropic simulation: myopia, hypermetropia, presbyopia.
 - Practice 2.- Application of the laws of circulation of real liquids and elasticity to the blood circulation. Check for the loss of pressure throughout the circulatory system, blood pressure and venous, effect of the elasticity of the vessels on the arterial and venous pressures. Establish the relationships between the elasticity of the vessels, flow, pressure and hemodynamic resistance.
 - Practice 3.- Diffusion through membranes: dialysis and osmosis. Experimental verification of the laws of diffusion and osmosis.

Methodology

The student acquires the knowledge of the subject attending the theory lectures where it will be also guided on how and where to look for the formative complements to reach the objectives of the subject.

Through the seminars the student will be able to solve exercises and problems previously presented, with a close interaction with the teacher.

Finally, the abilities related to this knowledge will be carried out in the practical teaching in the laboratory.

The theory lectures will be given with the whole group. Partitions of the group will be made for problem seminars (2 groups) and for laboratory teaching (3 groups).

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory teaching	10	0.4	14, 2, 3, 7, 5, 8, 9, 11, 12
Problems seminars	9	0.36	14, 2, 3, 8, 9, 12
Theory lectures	35	1.4	14, 2, 3, 8, 9, 12
Type: Supervised			
Programmed mentoring sessions	8	0.32	13, 7, 6, 5, 4, 9, 10
Type: Autonomous			
Individual study. Bibliography handling.	49	1.96	14, 13, 1, 2, 3, 7, 5, 4, 8, 9, 11, 12, 15
Problem resolution	30	1.2	14, 13, 2, 3, 7, 6, 5, 4, 8, 9, 10, 11, 12, 15

Assessment

Evaluation and qualification of the subject

The subject will be evaluated continuously throughout the course in three tests: two partial tests and a synthesis or final test that will include all the subject contents. Each one of these tests will have the same weight in the overall grade of the subject: 1/3 (1st part note) + 1/3 (partial note 2) + 1/3 (synthesis or final note).

The characteristics of these tests will be similar and each test will consist of two different parts: a test piece where the theoretical knowledge will be evaluated and also include short-term problems; and another part written in which the knowledge acquired in the laboratory practices and the resolution of problems will be evaluated. The qualification of each of these parts will be:

- Evaluation of the type test: 60%
- Evaluation of the written typology of the knowledge acquired in the laboratory and in the resolution of problems: 40%

Final grade of the subject: partial 1st note (33.3%) + partial note 2n (33.3%) + synthesis or final note (33.3%).

To pass the subject, score equal to or greater than 5.0. The student may approve the subject, regardless of whether any of the parties has not been exceeded with a mark equal to or greater than 5.0.

Recovery: that student who has not passed the subject can participate in a recovery test that will include all the subject contents. This test will have similar characteristics to the tests done during the course and the student will be able to do the test whenever it has previously been evaluated of two third parts of the total evaluation items.

Evaluation results: Numeric note with a decimal, from 0 to 10. Qualification: suspense, approved, remarkable, excellent, honorable enrollment. The "non-evaluable" qualification will be obtained when the assessment

activities carried out have a weighting of less than 67% in the final grade, that is, if it has only been submitted to one of the three evaluation tests or not has been submitted to none.

Exams Review Procedure: One day will be scheduled for the review of the exam after each test. The review will be done individually with the students who request it.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Partial and final practical teaching tests	40%	4	0.16	14, 1, 2, 3, 7, 6, 5, 8, 9, 10, 11, 12, 15
Partial and final theory tests	60%	5	0.2	14, 13, 2, 3, 7, 6, 5, 4, 8, 9, 11, 12

Bibliography

Bibliography.

- BIOFÍSICA (tercera edició) A.Aurengo, T. Petitclerc. (2008), McGrawHill
- BIOFÍSICA (3a edició) A.S. Frumento. (1995), Mosby/Doyma Libros.
- FÍSICA J.N.Kane, M.M.Sternheim. (1994), Ed. Reverté.
- FÍSICA P.A. Tippler. (1992), Ed. Reverté.
- FÍSICA E INSTRUMENTACIONES MÉDICAS Juan R. Zaragoza. (1992), Ed. Masson.
- QUÍMICA PER A LES CIÈNCIES DE LA NATURALESA I DE L'ALIMENTACIÓ J. Saña. (1993), Ed. Vicens Vives.
- FÍSICA PARA CIENCIAS DE LA VIDA (llibre de problemes) D. Jou, J.E. Llebot, C.Perez-García. (1994), Ed. McGraw-Hill.
- SPEECH SCIENCE PRIMER L.J. Raphael. (2007), Ed. Lippincott Williams & Wilkins.
- RADIOBIOLOGY FOR RADIOLOGIST E.J. Hall, AJ.Giaccia. (2006) Ed. Lippincott Williams & Wilkins