Universitat Autònoma de Barcelona

2021/2022

Biophysics

Code: 101892
ECTS Credits: 6

Degree	Type	Year	Semester
2501230 Biomedical Sciences	FB	1	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

Name: Mireia Duñach Masjuan
Email: Mireia.Dunach@uab.cat

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

Mireia Duñach Masjuan
Ramón Barnadas Rodríguez
Josep Bartomeu Cladera Cerda
Nuria Benseny Cases

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

- Describe biomedical problems in terms of causes, mechanisms and treatments.
- 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.
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.

- Read and critically analyse original and review papers on biomedical issues and assess and choose the appropriate methodological descriptions for biomedical laboratory research work.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- 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.
- Work as part of a group with members of other professions, understanding their viewpoint and establishing a constructive collaboration.

Learning Outcomes

1. Describe the biophysical bases for molecular interactions and balances in healthy or pathological states.
2. 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.
3. Discern the effects of the interaction of radiations and particles with living beings, in accordance with physical bases.
4. Estimate the importance of the scientific method in the analysis of a complex system like the human body.
5. Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
6. Recognise and identify the mechanisms and physical bases of the technologies that use radiations and particles in diagnosis and therapy.
7. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
8. 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.
9. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
10. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
11. 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.
12. Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
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. Frequance 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 THE CIRCULATORY SYSTEM (5 h theory + 1 h classroom practices + 2.5 h laboratory)

4.1. Fundamental principles of fluid statics and dynamics.

4.2.Energetics of laminar flow. Bernoulli equation.

4.3 Laws of circulation of real liquids. Traffic regimes. Viscosity. Pressure loss. Poiseuille Law. Hydrodynamic resistance.

4.4. Tension in the vascular wall. Laplace's law.

4.5. Effect of gravity on blood circulation.

5. BIOPHYSICS OF THE RESPIRATORY SYSTEM. (5 hours of theory + 1 hour of classroom practices)

5.1 Structure of the respiratory tract.

5.2 Types of breathing. Effects of the external environment on respiration. Temperature and relative humidity regulation.

5.4 Respiratory mechanics.

5.5 The pulmonary surfactant.

5.6 Alveolar diffusion. Henry's law. Fick's law. Oxygenation of the blood in the states of health and disease.

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.

"***Unless the requirements enforced by the health authorities demand a prioritization or reduction of these contents."***

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 closef 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 maced for problem seminars (2 groups) and for laboratory taeching (3 groups).

"The proposed teaching methodology may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities."

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			
Laboratory teaching	10	0.4	14, 1, 2, 3, 4, 6

Problems seminars	9	0.36	14, 1, 2, 3, 4, 6
Theory lectures	35	1.4	14, 1, 2, 3, 4, 6
Type: Supervised			
Programmed mentoring sessions	8	0.32	13, 4
Type: Autonomous			
Individual study. Bibiolgraphy handling.	49	1.96	14, 13, 1, 2, 3, 4, 6, 15
Problem resolution	30	1.2	14, 13, 1, 2, 3, 4, 6, 15

Assessment

Evaluation and qualification of the course

The course will be evaluated continuously throughout the course in two partial exams (P1 and P2) eliminatory of matter. It is necessary to obtain a grade equal to or greater than 4.5 in each partial to be able to do average. Each of these exams will have the same weight in the final grade of the course: 50% P1 + 50% P2. To pass the course, an average score of the 2 partial exams equal to or greater than 5.0 is required.

The characteristics of these exams will be similar and will consist of two different types: a multiple choice test where theoretical knowledge and short-resolution problems will be evaluated; and another written part where the knowledge acquired in laboratory practices and problem solving will be evaluated. The qualification of each of these parts will be:

- Evaluation of the multiple-choice typology: 60%. It will consist of multiple-choice questions, with 4 answers, of which 1, 2 or 3 may be true. The wrong answers will subtract proportionally.

- Evaluation of the written typology of the knowledge acquired in the laboratory and in problem solving: 40%.

Final recovery exam: In the case of not passing the course through continuous evaluation, there will be a final recovery evaluation of the partial exam with a grade lower than 4.5, mandatory to make average. Students with a mark higher than 4.5 and lower than 5.0 may choose to make the partial (or partials) they consider, knowing that, to pass the course, the final average must reach a minimum mark of 5.0. This exam will have similar characteristics to the ones carried out during the course. The student can perform this recovery exam as long as he has been previously evaluated for at least one of the partial exams. In this recovery exam, a score equal to or greater than 4.5 is necessary to average P1 and P2. In the case of recovering the entire course (P1 and P2), a grade $\geq$ 5.0 must be achieved to pass it.Students, who have passed the two eliminatory tests and want to improve their grade, will be able to take a final exam of the entire course (P1 and P2). In this case, the final grade will always be the one obtained in the last exam.

Evaluation result: Numerical note with one decimal, from 0 to 10. Qualification: failed, approved, remarkable, outstanding, honors.

Non-evaluable student: the student who does not meet the requirements to recover will be classified as "non-evaluable". The qualifications of "not evaluable" will be obtained when the student has not taken any of the partial evaluation exams (P1 or P2).

From the second enrollment: the student has the option of taking the final recovery exam directly, with no partials.

Exam review procedure: one day will be scheduled after each exam to review it. The review will be done individually with the students who request it.

"The proposed evaluation may undergo some modification depending on the restrictions imposed by the health authorities."

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Partial and recovery exams of the knowledge acquired in the laboratory practices and in solving written problems	40%	4	0.16	14, 1, 2, 3, 4, 6, 15
Partial and recovery tests: theory and problems	60%	5	0.2	12, 14, 13, 1, 2, 3, 4, 5, 11, 10, 9, 7, 8, 6, 15

Bibliography

- BIOFÍSICA (tercera edició) A.Aurengo, T. Petitclerc. (2008), McGrawHill and digital version

- BIOFÍSICA (3a edició) A.S. Frumento. (1995), Mosby/Doyma Libros.

- FíSICA P.A. Tippler. (1992), Ed. Reverté.

- FÍSICA E INSTRUMENTACIONES MÉDICAS Juan R. Zaragoza. (1992), Ed. Masson.

- 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

Software

No specific software is required.