Universitat Autònoma de Barcelona

2019/2020

Biophysics

Code: 100996
ECTS Credits: 6

Degree	Type	Year	Semester
2500502 Microbiology	OT	4	0

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 Cerda
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

- Communicate orally and in writing.
- Develop critical reasoning skills in the field of study and in relation to the social context.
- Interpret, on a molecular scale, microbial mechanisms and processes.
- Obtain, select and manage information.

- Recognise the different levels of organization of living beings, especially animals and plants, diversity and bases of regulation of vital functions of organisms and identify mechanisms of adaptation to the environment.
- Use bibliography or internet tools, specific to microbiology or other related disciplines, both in English and in the first language.
- Work individually or in groups, in multidisciplinary teams and in an international context.

Learning Outcomes

1. Communicate orally and in writing.
2. Describe the fundamental physical principles that throw light on the functioning of the organism, both on the cell scale and the tissue scale.
3. Develop critical reasoning skills in the field of study and in relation to the social context.
4. Display knowledge of the biophysical principles behind molecular interactions and equilibria in health and in pathologies.
5. Know and understand the physical principles behind the functioning of organs and systems of the human organism in health, such as vision, speech and hearing, respiration and blood circulation.
6. Know the effects of the interaction of radiation and particles with living beings and relate these to their physical bases.
7. Know underlying physiopathological causes of the most prevalent non-infectious diseases in the human population.
8. Obtain, select and manage information.
9. Use bibliography or internet tools, specific to microbiology or other related disciplines, both in English and in the first language.
10. Work individually or in groups, in multidisciplinary teams and in an international context.

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 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 Poiiseuille. 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 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).

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory teaching	35	1.4	6, 5, 4, 2

Theory lectures	10	0.4	5, 4, 2, 3, 1, 10
Type: Supervised			
Problem resolution	9	0.36	6, 5, 4, 3, 8, 1, 10, 9
Type: Autonomous			
Individual study.	8	0.32	6, 5, 8, 10, 9
Preparation of practical sessions and bibliography handling	38	1.52	6, 5, 8, 1, 10, 9
Problem resolution	50	2	6, 5, 7, 4, 2, 8, 9

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

The characteristics of these tests will be similar and each test will consist of two different parts: a test piece where

- Evaluation of the type type test: 60%

- Evaluation of the written typology of the knowledge acquired in the laboratory and in the resolution of problems:

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 whet

Recovery: that student who has not passed the subject can participate in a recovery test that will include all the s

Evaluation results: Numeric note with a decimal, from 0 to 10. Qualification: suspense, approved, remarkable, ex

Exams Review Procedure: One day will be scheduled for the review of the exam after each test. The review will b

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Partial and final practical teaching tests	40%	0	0	6, 5, 4, 8, 10, 9
Partial and final theory tests	60%	0	0	6, 5, 7, 4, 2, 3, 8, 1

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