Universitat Autònoma de Barcelona

2018/2019

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 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.

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 teachingprogram**.
- 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.