Universitat Autònoma de Barcelona

2021/2022

Biophysics

Code: 102962
ECTS Credits: 7

Degree	Type	Year	Semester
2502442 Medicine	FB	1	A

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.

Errata

There has been changes in the responsible of the subject, now is the teacher Alex Peralvarez Marin (alex.peralvarez@uab.cat)

Contact

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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
David Garcia Quintana
Josep Bartomeu Cladera Cerda
Alex Peralvarez Marin
Maria Isabel Marin Garcia
Nuria Benseny Cases

Prerequisites

To profit the most of the course, the student should have the theoretical knowledge and the problem-solving competences corresponding to higher secondary school courses in Physics and Mathematics.

A basic knowledge in trigonometry and geometric optics applied to spherical dioptres and thin spherical lenses is mandatory.

Objectives and Contextualisation

Biophysics is one of the basic, mandatory courses in the first year of the Degree in Medicine. The objective of the course is to offer basic knowledge of the main physical phenomena of relevance to the structure and the function of the human organism in health, as well as some pathological scenarios.

The course examines the application of the laws of physics in the analysis of biological phenomena. In some cases, explanations at the molecular level are offered.

Also, the physical basis is set for other Medical courses such as Biochemistry and Molecular Biology, Medical Physiology, and Clinical Radiology.

Finally, tools will be offered to address the resolution of numerical problems and the critical assessment of the obtained results.

Competences

- Communicate clearly, orally and in writing, with other professionals and the media.
- Critically assess and use clinical and biomedical information sources to obtain, organise, interpret and present information on science and health.
- Demonstrate a sufficient command of English, both oral and written, for effective scientific and professional communication.
- Demonstrate knowledge of the principles and physical, biochemical and biological processes that help to understand the functioning of the organism and its disorders.
- Demonstrate understanding of the basic sciences and the principles underpinning them.
- Demonstrate understanding of the mechanisms of alterations to the structure and function of the systems of the organism in illness.
- Demonstrate understanding of the structure and function of the body systems of the normal human organism at different stages in life and in both sexes.
- Demonstrate, in professional activity, a perspective that is critical, creative and research-oriented.
- Formulate hypotheses and compile and critically assess information for problem-solving, using the scientific method.
- Use information and communication technologies in professional practice.

Learning Outcomes

1. Communicate clearly, orally and in writing, with other professionals and the media.
2. Demonstrate a sufficient command of English, both oral and written, for effective scientific and professional communication.
3. Demonstrate, in professional activity, a perspective that is critical, creative and research-oriented.
4. Explain the physical bases of the structure and function of the systems of the human organism.
5. Formulate hypotheses and compile and critically assess information for problem-solving, using the scientific method.
6. Identify alterations to the structure and function of the biomolecules involved in vision.
7. Identify the basic processes of life on various levels of organisation: molecule, tissue, organ and individual.
8. Identify the physical principles that help to understand the functioning of the organism, at both cell and tissue level.
9. Identify the rules that govern energy transfer in the chemical processes of the human organism.
10. Use information and communication technologies in professional practice.
11. Use specific bibliographic sources and databases on biophysics to work independently on acquiring further knowledge.

Content

DISTRIBUTION BLOCKS

A. Biomechanics of the locomotor system.

B. Physico-chemistry of the cellular molecular systems or tissue of living beings (diffusion phenomena, osmosis, dialysis).

C. The physical basis of radiation and radioactivity. Medical applications.

D. Physical bases of the operation of devices and systems of the human organism (vision, voice and hearing, circulation of the blood, breathing)

PROGRAM

Unit 1. INTRODUCTION TO BIOMECANICS AND TO ELASTICITY

Statics

Balance of a body. Balance conditions. Mechanical advantage of levers.

Gravity and balance

Effects of gravity on the human body. Gravity centre and body balance. Gravitational line and support base.

Action of forces in solids

Elasticity. Hooke's Law. Energy of elastic deformation. Inelastic bodies. Residual deformation. Viscoelasticity. Traction, compression, shearing, torsion and bending.

Physical properties of the bones

Bone elasticity and resistance. Architecture of the bones.

Unit 2. BIOPHYSICS OF VOICE PRODUCTION AND AUDITION

Producción y características de la voz. Fonación. Explicación aerodinámica-mioelástica. Sonidos complejos. Armónicos. Espectro de frecuencias y estímulo coclear. Resonancias al tracto vocal y formantes vocálicos.

Percepción de la intensidad: La escala de decibelios. Umbrales auditivos. Intensidad y sonoridad o volumen. Curvas isofónicas. Frecuencia y tono. Timbre.

Bases físicas de las alteraciones auditivas. El audiograma. Umbral de daño a largo plazo. Bases de las hipoacusias más prevalentes. Reclutamiento.

Bases físicas del funcionamiento del aparato auditivo. Oído externo: frecuencia de resonancia en el canal auditivo externo. Oído medio: adaptación de impedancias. Oído interno: organización tonotópica de la membrana basilar y análisis de sonidos complejos; transducción de la señal en el órgano de Corti.

Seminario: Simulación de la audición en pacientes con algunas de las hipoacusias más prevalentes; discusión de las consecuencias. Simulación de la audición a través del implante coclear.

Unit 3. PHYSICAL FOUNDATIONS OF RADIATION AND RADIOACTIVITY - MEDICAL APPLICATIONS

Nature and properties of electromagnetic waves (OEM)

The electromagnetic spectrum. Production and general properties of X-rays.

Fundamentals of radiology

Radioactive emission. Activity. Types of particles. Interaction with matter.

Ionization. Biological effects. Dose. Survival curves.

Medical applications

Gammagraphy. DXA (Dual energy X-ray absorptiometry). PET (Proton emission tomography).

Unit 4. BIOPHYSICS OF VISION

The eye as an optical system

Optical parameters of the eye. Lens and mechanism of accommodation. Maximum power and minimum power. Near point and remote point. Amplitude of accommodation. Presbyopia.

Image formation in the retina

Imaging abnormalities. Ametropies: myopia, farsightedness. Correction of the different ametropies. Astigmatism.

Visual acuity

Variation of visual acuity in the retina.

The eye as a sensory receptor and color vision

Distribution of photoreceptors. Organization of the retina. Visual pigments: rhodopsin and iodopsins.

Visual phototransduction. Adaptation to light and to darkness.

Retinalsensitivity in photopic andscotopic vision. Absorption curves of iodopsins. Color vision abnormalities.

Unit 5. DIFFUSION PHENOMENA - OSMOSIS AND DIALISIS

Physical bases of diffusion phenomena

Simple diffusion, kinetic-molecular theory. Fick's Law. Diffusion coefficient. Diffusion through membranes.

Osmosis, characteristics and applications.

Dialysis, features and applications.

Unit 6. BIOPHYSICS OF BLOOD CIRCULATION

Pressures. Blood pressures.

The basic heart cycle.

Viscosity. Laminar and turbulent flows.

Hydrodynamic resistance. Poiseuille's law. Local control of blood flow.

Flow and continuity equation. Bernoulli equation.

Vascular tension. Laplace's law. Vascular compliance, capacity and distensibility.

Seminar: Work applied to cases of the theoretical bases studied. Presentation of the physical bases of Doppler echocardiography and electrocardiogram (ECG).

Unit 7. BIOPHYSICS OF BREATHING

Pressures. Blood pressures.

The basic heart cycle.

Viscosity. Laminar and turbulent flows.

Hydrodynamic resistance. Poiseuille's law. Local control of blood flow.

Flow and continuity equation. Bernoulli equation.

Vascular tension. Laplace's law. Vascular compliance, capacity and distensibility.

Seminar: Work applied to cases of the theoretical bases studied. Presentation of the physical bases of Doppler echocardiography and electrocardiogram (ECG).

Henry's Law. Fick's Law. Blood oxygenation in health and pathological disorders.

Seminar: Physical bases of mechanical ventilation.

Methodology

The teaching methodology and evaluation proposed in the guide may undergo some modification depending on the restrictions on attendance that the health authorities impose.

Theory classes (TE): Master classes that will be taught either remotely (in the format chosen by each instructor, which will be indicated in advance) or in person, following the indications by the University authorities depending on the health situation throughout the course.

Specialized Seminars (SEM): Learning based on medical cases and problems in groups of 20 students. Preparatory work by the students, either individual or in team, is essential before the face-to-face sessions. Nine 1-hour sessions.

Laboratory practical classes (PLAB): Laboratory practices, in groups of 20 students, where the phenomena studied in the theory classes and seminars are visualized, and the acquired knowledge and skills are integrated and put into practice. 6 sessions.

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 practices (PLAB)	22	0.88	1, 4, 5, 7, 6, 8
Seminars (SEM)	9	0.36	1, 2, 5, 6, 11, 10
Theory classes (TE)	31	1.24	4, 5, 7, 6, 8
Type: Supervised			
Oral presentations in the seminar sessions	2	0.08	1, 4, 7, 6, 8, 9, 11
Type: Autonomous			
Study	58	2.32	
Work to prepare the cases and problems for the seminar sessions	41	1.64	4, 5, 8, 11

Assessment

Continuous evaluation:

The subject will be evaluated continuously during the course in three partial eliminatory tests (P1, P2, and P3). For each of them a mark equal to or greater than 4.5/10 must be reached.

The final grade of the course will be obtained from three partial grades (P1, P2, and P3). Each of the partial notes will be composed in 10% by the realization of the corresponding practices, and in 90% by an evaluation of the theoretical knowledges, of the specialized seminars and of the practices. Each assessment will be done through an objective test with multiple choice items, aimed at demonstrating the acquisition of skills and the integration of theoretical and practical learning. It will consist of test-type questions with 4 answers, of which 1, 2 or 3 may be true. Wrong answers will be subtracted proportionally. The percentage of the grade.

Each of the partial marks will have the following weighting in the final mark of the subject: P1 (30%) + P2 (30%) + P3 (40%).

In order to pass the whole subjet the final weighted average has to be 5 or more.

Referral test:

Students who fail to pass the continued evaluation may participate in a referral test for those partial tests with a mark lower than the 4.5 required to calculate the global mark. Students with partial marks higher than 4.5 and lower than 5.0 can also choose to re-evaluate that or those partials of their choice, knowing that the global mark must reach 5.0 to pass the course.

Two conditions must be met to qualify for the referral test: (1) having participated in at least 2 of the 3 previous partial tests, and (2) that the mark resulting from the continued evaluation (P1 (30%) + P2 (30%) + P3 (40%)) is equal to or greater than 2.5/10.

The referral test will evaluate the part or parts not passed by the student and that must be reach at least 4.5 to calculate the global mark. To pass the course the global mark must be equal to or greater than5.0/10.

Likewise, in those cases in which the three blocks are re-evaluated, the mark of the referral test must be equal to or greaterthan 5.0/10.

Students who passed the three partials but want to improve their mark, are allowed to participate in the referral test that includes the three blocks. In such case, the final mark for the course will be the one obtained now.

The referral test will be an objective test with multiple-choice items where theoretical knowledge, specialized seminars and practicals will be evaluated. It will consist of multiple choice questions with 4 answers, of which 1, 2 or 3 may be true.

Non-assessable

Student who do not qualify to participate in the referral test will be qualified as 'Non-assessable'.

Students in their second or later enrolment:

Students in their second or later enrolment may directly participate in the referral test, at their preference.

Exam reviewing:

One day and time will be announced for those students wishing to review their test. The review will be done individually.

Misconduct:

In case a student undergoes misconduct (cheating, plagiarising...) in an evaluation, that test will be marked 0. If a second irregularity occurs, the final mark will be 0 and the case will be reported to the Coordinator of the Degree.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Objective tests: Multiple choice and problem solving.	75%	9	0.36	4, 7, 6, 8, 11
Practical evaluation: Written evaluation of the practical competences.	25%	3	0.12	1, 2, 3, 4, 5, 6, 8, 9, 11, 10

Bibliography

1. GENERAL

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FíSICA. J.N. Kane, M.M.Sternheim. (1994), Ed. Reverté.

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2. SPECIFIC

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

FÍSICA PARA CIENCIAS DE LA VIDA (excercises book). 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 Radiologists. E.J. Hall, A.J. Giaccia. (2006), Ed. Lippincott Williams & Wilkins.

Principles and practice of Radiation therapy. C.M.Washington, D. Leaver. (2010), Mosby Elsevier.

Software

'Praat' software for the analysis of sounds in auditon laboratory work.