BASI MOLECOLARI (OTU112)

1. language

Italian.

2. course contents

Coordinator: Prof. DI PIETRO LORENA
Year Course: 1
Semester: First semester
UFC: 5
Modules and lecturers:
- BIOCHEMISTRY (OTU05A) - 2 UFC - ssd BIO/10
Prof. Andrea Silvestrini
- APPLIED BIOLOGY (OTU06A) - 1 UFC - ssd BIO/13
Prof. Lorena Di Pietro
- APPLIED PHYSICS (OTU04A) - 1 UFC - ssd FIS/07
Prof. Massimiliano Papi
- MEDICAL STATISTICS (OTU07A) - 1 UFC - ssd MED/01
Prof. Gennaro Capalbo

3. BIBLIOGRAPHY

Biochemistry: Ferrier, D.R., Le basi della Biochimica, Zanichelli, 2015; Nelson D., Cox M., Introduzione alla biochimica di Lehninger, Zanichelli 2018
Applied biology: Solomon et al., Elementi di Biologia, settima Edizione EdiSES (chapters 4, 5, 6, 8, 10, 12, 13, 14); alternatively, Sadava, Elementi di Biologia e Genetica, V edizione, Zanichelli (chapters 4, 5, 6, 7, 9, 11, 13, 14, 16).
Applied Physics: D. Scannicchio, E. Giroletti, “Elementi di Fisica Biomedica”, Edises, Napoli (chapters 1, 2, 4, 5, 6, 7, 15, 16, 17, 21)
Medical statistics: Streiner, N., Biostatistica. Quello che avreste voluto sapere. Ed. italiana. Casa Editrice Ambrosiana, Milano, 2000., Sezione Prima (from page 2 to page 56).
It is necessary that the students have a reference textbook for each module, to be chosen from those recommended or other textbook after the lecturer's approval. Additional material will be provided if necessary for in-depth study of specific topics.

4. LEARNING OBJECTIVES

The objective of the course is to provide the student with basic knowledge, related to biochemistry, applied biology, applied physics and medical statistics, necessary for the understanding of biological phenomena and preparatory for the study of other biomedical and clinical disciplines.

The Biochemistry module aims to provide the student with the basic knowledge to understand the chemical and physical properties, structural organization and functions of biological macromolecules, main metabolic pathways and biochemical mechanisms that regulate cell metabolism.
The Applied Biology module aims to provide the student with the fundamental information to understand the basics of cell biology and the morpho-functional organization of cells.
The Applied Physics module aims to provide the student with the basic knowledge to understand the physical and biophysical mechanisms underlying the main functions of living organisms with translational potential in the diagnostic and therapeutic fields.
The Medical Statistics module aims to provide the student with the basic knowledge of statistics useful in the collection, processing and dissemination of data of health care interest.
Knowledge and understanding - At the end of the course the student must demonstrate to acquire the knowledge necessary for understanding:

- the structure-function relationship of biological macromolecules, the main pathways of glucose, lipid and amino acid metabolism and the main cellular mechanisms of metabolic integration and regulation;
- the morphological and functional organization of prokaryotic and eukaryotic cells and the mechanisms of organization, expression and transmission of genetic information;
- the physical principles underlying phenomena characteristic of applied physics in the biomedical context;
- the main official statistical sources at the international, national and regional levels.

Applied knowledge and understanding - At the end of the course the student should be able to apply the knowledge acquired to:

- interpret and explain the metabolic functions of cells, organs and tissues;
- interpret and explain the morpho-functional organization of the cell and the processes of duplication, gene expression and protein synthesis;
- adequately interpret and understand the possible applications of the physical principles presented and their translational potential;
- interpret tables and graphs with reference to frequency distributions and indicators.

Making judgements - At the end of the course the student must demonstrate that he/she has developed autonomous abilities to integrate the knowledge and skills acquired from the four different modules in order to identify the main molecular mechanisms involved in physiological and/or pathological conditions.
Communication skills - At the end of the course, the student should be able to describe/communicate the acquired knowledge even to non-expert interlocutors (such as patients), with language properties and correct scientific terminology.
Learning skills - At the end of the course, the student should be able to keep up-to-date and expand his or her knowledge by autonomously drawing on scientific texts and articles, and online scientific databases.

5. prerequisites

Basic school knowledge of mathematics, physics and chemistry is required.

6. TEACHING METHODS

The course is organized into lecturers aimed at providing both the basic knowledge and the applicative perspectives. The teaching methods integrate active learning activities, as "problem-based learning", to standard teaching. Lectures will include the use of multimedia materials such as slides in PowerPoint, images and/or movies to promote learning. Students will be engaged with questions and considerations designed to assess both their level of learning and the development of critical reasoning for solving specific problems regarding the topics of study or practical examples related to specific clinical conditions. For medical statistics, practical exercises and simulations are planned in addition to theoretical lectures.

Knowledge and understanding - The didactic tools aimed at achieving the results involve frontal teaching activities, guided reading followed by practical application, demonstrations of images, videos, diagrams, and clinical case discussions focused on understanding the molecular mechanisms covered by the course subjects.

Applied knowledge and understanding - The teaching tools aimed at achieving the results are the interpretation of scientific data, retrieval of bibliographic information and theoretical-practical insights as well as interactive discussions in order to test the student's ability to process the information received and obtain critical descriptions of the observed phenomena.

Making judgements - The student is guided in the critical and in-depth reflection of interpretive problems of the information provided by the courses and to develop autonomy of judgment in relation to orientation in the face of specific questions addressed in the coursework.

Communication skills - Communication skills will be acquired by the student in the context of individual courses and tested by requiring ability to express and describe specific issues independently in appropriate scientific language.

Learning skills - Lecturers encourage in-depth study of course subject knowledge through the use of advanced textbooks, bibliographic research, and interaction with qualified personnel.

7. OTHER INFORMATIONS

The lecturers are available for further information and clarifications regarding the learning modules' topics and any possible related issues for a quick request, at the end of the lessons or through an appointment fixed by e-mail.

8. METHODS FOR VERIFYING LEARNING AND FOR EVALUATION

The final exam planned for the course is designed to ascertain the student's knowledge regarding the entire program and the student's ability to understand as well as his/her communication and learning skills. The final grade is expressed in thirtieths. The final grade results from the weighted average of the partial scores obtained in the individual modules. To pass the exam it is necessary to obtain a minimum score of 18/30 in each module and in case of failure to pass the test related to a module, the test is considered failed. In order to obtain honors, the student must answer without any error or incompleteness all questions asked in the examination.

Biochemistry: The exam includes a written test at the end of the course consisting of 30 multiple-choice questions (some are mnemonic tests, others involve conceptual connections, and finally some require reasoning skills). The correct answer will be graded 1 point. There is no penalty for incorrect or no answer. The student will earn a grade of 30/30 by correctly answering 30 questions and will earn honors by correctly answering at least one additional question.
Applied biology: The exam includes a written test at the end of the course consisting of 20 multiple-choice questions and two open-ended questions. Each correct multiple-choice question will be graded 1 point whereas to each of the open-ended questions will be assigned a score between 1 and 5 points, for a maximum total score of 30/30. There is no penalty for wrong or no answers. Honors will be awarded, upon achievement of 30/30, to students who, in the formulation of the open-ended answers, have demonstrated a superior level of knowledge and depth of the subject with autonomy of study, appropriateness of language and excellent communication skills.
Applied physics: The exam consists of a written test composed of 31 multiple-choice questions to which 1 point will be awarded for each correct answer and 0 otherwise. Passing the examination with a minimum grade of 18 will give access to a possible oral test. The student who correctly answers all questions in the written test will achieve the maximum score (grade: 30/30 with honors). A student who achieves a sufficient result in the written test may still improve the result in the oral test.
Medical statistics: A final oral examination, consisting of 3 test questions and/or application exercises, is expected for this module. The final grade is the sum of the individual scores to the 3 questions (for each question grade from 1 to 10). Honors will be awarded in case of particularly brilliant exposition. The exam is intended to test not only theoretical knowledge of the discipline, but also expression skills and language property.

9. program

Biochemistry
SOLUTIONS (Solute Concentration, Osmolarity, Diffusion and Osmosis, Saline Solution). pH and Buffer Solutions (pH of major biological fluids, acidosis and alkalosis). Chemical composition of the human body: Water (chemical and physical properties and biological role) and Minerals (macro and microminerals; Iron metabolism).
CARBON AND ORGANIC COMPOUNDS. Functional groups (methyl, hydroxyl, ketone, aldehydic, carboxylic, sulfhydryl, amine, amide, phosphate) and their reactivity (esters, phosphate esters, thioesters, amides, phosphoanhydrides). Structure and Function of the major energy substrates found in foods and cells of the human body with the basic aspects of their metabolism. In particular:
CARBOHYDRATES: Monosaccharides (Glucose, Fructose, Galactose and Ribose), Disaccharides (Sucrose, Lactose and Maltose), polysaccharides (Amylose, Amylopectin, Glycogen, Heparin). Biochemical aspects of Carbohydrate digestion and absorption. Lactose Intolerance. Carbohydrate Metabolism: Pentose Phosphate Pathway (Glucose-6PDehydrogenase, roles of NADPH, recovery of hexoses from pentoses); Glycogenesis (role of UDP-Glucose) and Glycogenolysis (different role

in liver and muscle, Glucose-6P Phosphatase); Glycolysis (Preparatory Phase and Energy Recovery Phase, Phosphorylation at substrate level. Role of ATP); Anaerobic Fate of Pyruvate (Homolactic Fermentation, Role of Lactate); Mitochondrial Aerobic Fate of Pyruvate (Role of Acetyl-CoA); Gluconeogenesis (Energy Aspects, Precursors).
LIPIDS: Fatty acids (palmitic, stearic, oleic, linoleic, linolenic, arachidonic). Concept of essential fatty acids. Triacylglycerols. Cholesterol and its derivatives. Mention of amphipathic membrane lipids. Lipoproteins and their role in the transport of lipid molecules. Biochemical aspects of Lipid digestion and absorption.
Lipid Metabolism: Lipolysis; Mitochondrial Beta-Oxidation of Fatty Acids; Synthesis and utilization of Ketone Bodies (ketosis condition); Biosynthesis of Fatty Acids; Biosynthesis of Phosphatides and Triacylglycerols.
PROTEINS and AMINO ACIDS: Proteins (Primary, secondary, tertiary and quaternary structure; functional classification). Enzymes (Enzymatic catalysis and Role in clinical diagnostics). Chromoproteins (myoglobin, adult hemoglobin and fetal hemoglobin). Amino acids (chemical characteristics of the protein amino acid side chain, concept of essential amino acids for the human species). Biochemical aspects of Protein digestion and absorption of Amino acids. Amino Acid Metabolism: Metabolic Fate of Amine Group: Transamination (ALT, AST, role of Pyridoxal phosphate); Oxidative Deamination of Glutamate; Synthesis of Urea. Fate of the carbon skeleton of amino acids under different metabolic conditions (degradation for energy purposes, biochemical modifications for inclusion in gluconeogenesis, synthesis of ketone bodies, fatty acid synthesis).
Citric Acid Cycle (oxidation of Acetyl-CoA, substrate-level phosphorylation, production of reduced coenzymes) and Electron Transport Chain (constituent complexes, oxidation of reduced coenzymes, proton gradient formation, ATP production by oxidative phosphorylation).
Water-soluble Vitamins (B2, B3, B5, B6, B9 and B12) and fat-soluble Vitamins.
Biochemical Role of Hormones: Mechanism of Action of Hormones.

Applied biology

The cell theory and basic properties of cells. Organization of prokaryotic and eukaryotic cells. Biological membranes: structure and function. Mechanisms of transport across membranes: diffusion, active transport, passive transport, endocytosis and exocytosis. The extracellular matrix. The nucleus and the endomembrane system (smooth endoplasmic reticulum, rough endoplasmic reticulum, Golgi apparatus, lysosomes). Mitochondria. The cytoskeleton: microfilaments, microtubules and intermediate filaments. Cell communication: interactions between cells (cell junctions). Hints of signal transduction and transmembrane receptors. Cell death mechanisms. The flow of genetic information. DNA and chromosomes. DNA replication. From gene to protein: transcription and translation. The cell cycle: mitosis and meiosis. Cell differentiation. Hints on stem cells from perinatal tissues.

Applied physics

Physical quantities and their units of measurement. Kinematics of the material point. Velocity. Acceleration. Acceleration of gravity. Circular motion. Dynamics and Newton's laws. Weight force, mass. Friction. Fundamental equations of statics of rigid bodies. Levers. Elastic properties of

materials. Elastic deformations, tensile, compressive, shear and torsion stresses. Momentum and conservation principle. Work, energy and its conservation. Mechanical power. Fluid statics. Density and pressure. Stevino's law. Pascal's law. Archimedes' principle. Torricelli's experiment and pressure gauges. Measurement of blood pressure. Electrostatics. Electrical properties of matter. Coulomb's law. Electric field and electric potential. Electric current and measuring instruments. Electrical resistance. Ohm's law. Principle of operation of the electrocardiogram. Magnetic fields produced by electric currents. Electromagnetic radiation. Non-ionizing radiation. Ionizing radiation and interaction with biological matter. Magnetic resonance imaging.

Medical statistics

Objectives of medical statistics. Concepts and nomenclature in statistics. Population, statistical unit, statistical character, mode. Elementary data, synthetic data. Definition, objectives and scopes of epidemiology. Methodological tools. Frequency measures in epidemiology. Ratios, Proportions, Rates, Main Indicators in the health-disease continuum: Ratios, Proportions and Rates. Mortality and morbidity. Stages of a research study. Tabular representation (Single Entry Tables, Double Entry Tables) and frequency study (absolute, relative, percentage, cumulative). Graphical representations: Bar charts, Pie charts, Frequency histograms, Box plots (box-plots), Scatter plots, Linear plots, Data types and feasible graphs. Indices of central tendency (Mean, Median, Fashion). Scatter indices (Minimum-maximum range, Variance, Standard deviation, Standard error, Percentiles). Dedicated program for the production and management of spreadsheets: Microsoft Excel. Elements of Inferential Statistics. Normal distribution and its use; Shape, characteristics. Concept of probability and Probability Theory.