UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Basic Sciences

1819-1-H4102D001

Aims

The primary goal of the course is to provide students with the tools for the understanding of the complex reactions that represent the molecular basis of life, and with the fundamentals to identify the cause-effect relations of the most important biochemical, chemical and physical processes for the curriculum and the work of a physician. This knowledge will form the primary basis for a rationale approach to the knowledge of medical sciences.

Contents

PHYSICS:
The student must know:
• The fundamental concepts of mechanics with particular reference to the balance of the human body
• The basic concepts of radiation physics, with particular emphasis on biomedical applications
• The basic concepts of fluid dynamics, with particular reference to the human circulatory system
• The basic concepts of electrodynamics with particular reference to the transport of the electrical signal in the nervous system

CHEMISTRY AND PROPEDEUTIC BIOCHEMISTRY:
In the first part of the course will be illustrated: the principles of chemical kinetics, chemical equilibrium, redox reactions and energy related to them in the general framework of thermodynamics and electrochemistry, and finally the self-ionization of water will be treated, acid / base properties and buffer solutions.
In the second part will be described: the reactivity of the main classes of organic compounds, including the isomerism and the stereoisomerism of organic molecules containing carbon atoms. The properties of the main classes of macromolecules of biological interest (proteins, lipids, carbohydrates and nucleic acids) will be illustrated. In addition, the basic knowledge of proteomics and imaging with MS used for clinical applications will be

provided.

BIOCHEMISTRY
Provide the concepts necessary to understand biological phenomena and energy changes connected to them
Explain the correlation between function and molecular structure, complex communication phenomena, interaction and control of cell and tissue functions;
Explain how organ functions can be regulated according to their particular biochemical processes, focusing on metabolic integration

Detailed program

RADIATION PHYSICS:
Overview of the physics of the nucleus.
Alpha, beta, gamma and nuclear reactions decay.
X-ray.
Radiation-matter interaction.
Biological effects of radiation

BIOMECHANICS
Moment of a force.
Balance of a body with exemplifications of the balance of the limbs of the human body.
Levers.
Static of the rigid body.
Young's modulus and elasticity.

ELECTRODYNAMICS:
Interaction between electrical charges.
Electrical field and electrostatic potential.
Dielectric constant.
The capacity of a capacitor.
Electric circuits in series and in parallel.
Laws of Ohm.

Stationary current and transient current.
Charge and discharge a condenser

FLUID MECHANICS:
Law of Stevino, Archimede, Bernoulli, Poiseuille
Properties of real liquids and viscosity
Hydraulic resistance of a conduit.
Surface tension in liquids.
Laplace's law

OPTICS:
Spectrum of electromagnetic radiation.
Absorption of radiation
Lenses and geometric optics
Construction of images according to geometric optics
Eye as an optical system
Optical defects of the eye
Theory of color perception

CHEMISTRY AND PROPEDEUTIC BIOCHEMISTRY:
General chemistry
Reactions and chemical balance; redox reactions; kinetics and thermodynamics (delta H and G) and spontaneity of a reaction
Acids, bases and buffer solutions; Henderson-Hasselback equation; pH of a buffer solution
Principles of electrochemistry
Bio-organic chemistry
Classification of organic compounds: Definition of functional groups; Structure, nomenclature and chemical-physical properties of organic compounds.
Alkanes and halogen derivatives: reactivity and nucleophilic substitution;
Alcohols, thio alcohols and amines: chemical properties and reactivity;
Alkenes and aromatic hydrocarbons: the double bond and its reactivity;
Carbonyl compounds: chemical reactions of aldehydes and ketones;
Carboxylic acids: acidity and reactivity of carboxylic acids; carboxylic acid derivatives: esters, thioesters, amides, anhydrides.
Main classes of molecules of biological interest
Lipids: structure and reactivity
Carbohydrates: structure, stereochemistry and the reactivity of monosaccharides / disaccharides; the loop closure mechanism of a non-cyclic carbohydrate; polysaccharides.
Nucleosides, nucleotides and nucleic acids: structure and properties of nucleosides and nucleotides
Amino acids and proteins: classification and nomenclature of amino acids; the amide bond and its chemical properties; protein structure.
Basic knowledge of clinical proteomics and imaging with MS.

BIOCHEMISTRY
Module 1: General Biochemistry
Themes
• Macromolecules: structure and function.
• Enzymes. Control of the metabolic pathways. Diagnostic use of enzymes and isoenzymes.
• energy and metabolism: the reactions of life
• Energy needs and expenses under different conditions. Bioenergetics and metabolism in physiological conditions
• carbohydrate metabolism: digestion, absorption. aerobic and anaerobic glycolysis. The metabolism of galactose and fructose. Glycogen, glycogenolysis.
• Lipids and steroids
lipid metabolism: digestion and absorption. Catabolism of lipids. Synthesis.
Metabolism of cholesterol and its derivatives. The metabolism of ketone bodies.

Plasma lipoproteins and their metabolism

• Amino acids and nucleotides: digestion of proteins, absorption and transport of amino acids. The metabolism of amino acids. nucleic acid urea cycle: The metabolism of purine and pyrimidine nucleotides.

Module 2) Aspects of human and metabolic sensory biochemistry

Themes

• Hormones: classification, biosynthetic mechanisms and their control. Hormonal regulation of metabolism. Hypothalamic and pituitary hormones. Thyroid hormones. The adrenal cortex. Hormones

• Systematic biochemistry. Integration of metabolism

- Blood glucose regulation in physiological conditions and in diabetes mellitus.
- Liver and systematic biochemical metabolism of the liver. Metabolism of ethanol taken with beverages. Metabolic detoxification of toxic compounds, drugs and xenobiotics.
- Collagen metabolism and related diseases.
- Calcium regulation and mineral metabolism.
- Structure, composition, role and metabolism of the different classes of plasma lipoproteins.
- Metabolism of erythrocytes, blood coagulation, transport of oxygen in the blood. Aspects of human and metabolic sensory biochemistry.
- Approaches based on nanomedicine in the therapeutic, diagnostic and regenerative fields.
- Nutritional aspects in physiological and pathological conditions.
- Technological aspects of the assay of different biochemical macromolecules involved in various metabolic processes.

Prerequisites

Basic knowledges of mathematics, physics, biology

Teaching form

Lectures and exercises

Textbook and teaching resource

Zinke-Allmang, Sills, Nejat, Galiano-Riveros, "Physics for the life sciences", Nelson Education

Inorganic Chemistry, 3rd or 4th Edition, Shriver and Atkins

A guidebook to mechanism in organic chemistry, 6th Edition, Sykes

Biochemistry with cklinical aspects, T. Devlin

Biochemistry, Berg et al, 5th Edition

Come ci cureremo domani. La scommessa della nanomedicina. M. Masserini

Semester

second semester

Assessment method

Written exam with oral discussion of the written and possible deepening of one or more topics. The questions proposed in the written exam will be constructed in order to evaluate the skills and competences acquired according to the objectives of the course. The final grade will be calculated as the average of the marks obtained in the individual modules (Chemistry, Biochemistry, Physics), weighed according to the number of credits of each module. Each module will require a written and oral exam.

Office hours

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