



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## COURSE SYLLABUS

### Scienze Propedeutiche

1819-1-H4101D252

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#### Aims

#### CHEMISTRY AND PROPAEDEUTIC BIOCHEMISTRY

The student must achieve the knowledge on: Atomic structure, Chemical bonds, Solutions. Chemical reactions and catalysis. Energy aspects of chemical reactions. Acids and bases and buffer solutions. Organic compounds and functional groups: structural properties of organic molecules and chemical reactivity. The compounds of life: carbohydrates, amino acids,

nucleotides, lipids. Proteins. Polysaccharides. Nucleic acids.

#### MEDICAL PHYSICS and BIOPHYSICS

Physics of radiation; X-Rays. Radioactive decays: alpha, beta, gamma and nuclear reactions. Radiation-matter interaction. Biomechanics: Moment of a force and statics of the rigid body. Equilibrium of a rigid body. Thermodynamics: thermology, thermodynamics, temperature and heat. Internal energy and enthalpy. The first and second law of thermodynamics, and entropy.

#### PRINCIPLES OF PROTEOMICS

The student must achieve the knowledge for the purification, isolation and characterization of the proteins

## Contents

The primary goal of the course is to provide the tools for the understanding of the complex reactions that represent the molecular basis of life and to give to the student the basis to identify the cause-effect relations of the most important 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.

Primary goal of the course is to provide theoretical and practical basic knowledge to study and to characterised the human proteome

## Detailed program

### CHEMISTRY AND PROPAEDEUTIC BIOCHEMISTRY:

BALANCE REACTIONS - Chemical equilibrium - Position of equilibrium, equilibrium constant and factors influencing it - The kinetics of chemical reactions - Speed of reaction and factors influencing it CATALYSIS OF CHEMICAL TRANSFORMATIONS - catalysts: how they modify the speed of chemical reactions - Enzyme catalysts and their activity and specificity

ENERGY ASPECTS OF CHEMICAL REACTIONS - Elements of electrochemistry: potential redox and spontaneity of redox reactions - Thermodynamic elements: state of a system, status functions and thermodynamic variables, thermodynamic transformations. - Thermodynamic elements: interpretation of the spontaneity of chemical reactions through the functions of state (entropy, enthalpy, free energy) -Spontaneity of equilibrium reactions

ACIDS AND BASES - Acid-base balances: acid and base definitions, strength of acids and bases in water; approximate pH calculation - Acidity and basicity of salt solutions – Solutions buffer and their buffering power - Blood buffer systems

CLASSIFICATION, GENERAL PROPERTIES OF ORGANIC COMPOUNDS FINALIZED TO THE INTERPRETATION OF BIOCHEMICAL PROCESSES - Physico-chemical properties - Structural isomerism and stereoisomerism - Optical isomers and geometric isomers - Structure of coordination compounds and their biological importance

STRUCTURE, NOMENCLATURE AND REACTIVITY OF ORGANIC COMPOUNDS - Hydrocarbons, alcohols, thioalcohols and analogues; Amines, Carbonyl compounds Carboxylic acids and carboxylic acid derivatives, Polyfunctional compounds

COMPOUNDS OF RELEVANT BIOLOGICAL INTEREST - Lipids, Carbohydrates, Amino Acids, Nucleotides

BIOLOGICAL POLYMERS Polysaccharides, Peptides and Proteins, Nucleic Acids

### MEDICAL PHYSICS and BIOPHYSICS

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

BIOMECHANICS - Moment of a force. - Balance of a body with exemplifications of Human Body. - Levers. - Mechanics of locomotion. - Statics of the body. - Young's modulus and elasticity. - Compression module. - Deflections, twists, fractures.

**THERMODYNAMICS:** - Systems and thermodynamics states - Phase transitions - Perfect gas transformations - 1st principle of thermodynamics - 2nd principle of thermodynamics and entropy - Enthalpy and free energy.

**ELECTRODYNAMICS:** - Interaction between electric charges. - Electrical field and electrostatic potential. - Distribution of electric charges: electric dipole and dipole layer. - Meaning of the dielectric constant. - The capacity of a capacitor. - Electrical circuits. - Laws of Ohm. - Concept of stationary current and of transient current. - Charge and discharge of a capacitor.

**MECHANICS OF FLUIDS:** - Stevino's Law - Principle of Archimedes - Theorem of Bernoulli – Poiseuille equation. Properties of real liquids and viscosity- Concept of hydraulic resistance. - Surface tension in liquids. - Surfactants; phenomena of adhesion and capillarity. - Laplace law

**OPTICS:** - Spectrum of electromagnetic radiation. - Absorption of the radiation - Light and image formation - Lenses and geometrical optics - Construction of images according to geometrical optics - Eye as an optical system - Optical defects of the eye - Theory of the color perception

## **PRINCIPLES OF PROTEOMICS**

Description of the properties of the proteins that can be used for their isolation. Description of the techniques available for their extraction and purification (solubility, chromatographic techniques such as ion-exchange chromatography, gel filtration, mono and two-dimensional electrophoresis, capillary electrophoresis). Description of the human proteome, of the main proteomics techniques, of its objectives, of the information that can be obtained and the methods used to acquire these information with example of applications in medical science.

## **Prerequisites**

In order to standardize the basic knowledge of the class, the School of Medicine organizes lectures and tutorials in physics and chemistry preliminary to the course

## **Teaching form**

Lectures, exercises, laboratories

It is required 70% course attendance

## **Textbook and teaching resource**

### **CHEMISTRY AND PROPAEDEUTIC BIOCHEMISTRY**

A. Fiecchi, M. Galli Kienle, A. Scala Chimica e Propedeutica Biochimica Ed. Edi Ermes.

E. Santaniello, M. Alberghina, M. Coletta, S. Marini Principi di Chimica Generale e Organica Ed. PICCIN

F.A. Bettelheim, W.H. Brown, M.K. Campbell, S.O. Farrell Chimica e Propedeutica Biochimica Edises

## **MEDICAL PHYSICS and BIOPHYSICS**

F. Borsa, A. Lascialfari Fisica Medica Ed. Edises

## **PRINCIPLES OF PROTEOMICS**

Voet D, Voet JG. BIOCHIMICA Zanichelli; Voet D, Voet JG, Pratt CW, FONDAMENTI DI BIOCHIMICA (2005) Zanichelli; Educational materials provided by the teacher

## **Semester**

First semester

## **Assessment method**

No ongoing tests

The evaluation will consist of a written test that will be used to ascertain the level of knowledge and ability to understand the topics covered during the course and to be able to solve problems. Being an integrated course, the evaluation Will cover all three modules.

Therefore the student will have to answer:

## **CHEMISTRY AND PROPAEDEUTIC BIOCHEMISTRY and PROTEOMICS**

4 Open Response Questions (also with numerical exercises) concerning the topics of general chemistry, organic chemistry, biological compounds and proteomics, respectively

15 Single-answer quiz with 5 answers, of which only one is correct

## **MEDICAL PHYSICS and BIOPHYSICS**

5 Open Response Questions (with numerical exercises)

Through this written test, the expositive and synthesis skills will be evaluated.

Oral examination on the evaluation of the teachers (discussion of the written test) The oral test will serve to clarify critical issues emerged from the written test and to verify the communication skills of the student and will focus on the topics covered by the written test.

## **Office hours**

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