



UNIVERSITÀ
degli STUDI
di CATANIA

DEPARTMENT OF GENERAL SURGERY AND MEDICAL-
SURGICAL SPECIALTIES
Master's Degree in Medicine and Surgery
Academic Year 2018/2019 - 1° Year

CHEMISTRY AND PROPAEDEUTIC TO BIOCHEMISTRY - channel 1

BIO/10 - 6 CFU - 1° Semester

Teaching Staff

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LEARNING OBJECTIVES

Knowledge of basic principles of general chemistry and organic chemistry

COURSE STRUCTURE

Traditional classroom lessons.

DETAILED COURSE CONTENT

General Chemistry.

Fundamentals of the atomic structure, atomic particles and model with orbitals. Mass number. Atomic number. Atomic weight. Isotopes. Radioactivity: characteristics of radiations and their biological effects. Stable and unstable isotopes and their importance in biology and medicine. Atomic properties (orbitals, quantic numbers, Aufbau, Pauli, Hund), electronic configurations and Periodic Table. Elettronegativity (Pauling).

Chemical bonding. Ionic, covalent, coordinative, hydrogen bond, Van der Waals forces. Valence bond. Chemical resonance. Geometry of simple molecules. Lewis structures. VESPR theory. Orbital hybridization. Coordination complexes and biological macromolecules (hemoglobin, cytochromes, vitamin B12, etc.).

Chemical systematics: acidic and basic oxides, hydroxides, acids; salts neutral, acidic and basic peroxides, hydrides.

States of matter: general properties of the solid, liquid and gaseous state. Laws of ideal gases and their importance in breathing. Phase transitions. Water phase diagram.

Solutions: water as a solvent. Molarity, normality, molality, molar fraction. Solubility product.

Concentrations of some electrolytes in biological matrices. Colligative properties: cryoscopy, osmotic pressure and its biological meaning. Hypertonic, isotonic and hypotonic solutions and their use in medicine. Osmole concept. Electrolytes, dissociation grade, ionic strength.

Chemical reactions. Kinetics and factors influencing the reaction velocity. Reaction order. Activation energy and catalysis. Chemical equilibrium: law of the mass action. Principle of mobile equilibrium. Arrhenius equation. Catalysis relevance in biology. Enzymatic catalysis: enzymes, models, enzymatic nomenclature, specificity, pH and temperature effects, kinetics, allosteric enzymes, regulation of enzymatic activity.

Simple concepts on thermodynamics: enthalpy, entropy and free energy. Hess's law. Bioenergetics: coupled reactions, compounds with high energetic potential (ATP, GTP, etc.).

Bioinorganic chemistry: fundamental notions on chemical compounds of elements of major biological interest: Na, K, Li, Ca, Mg, Cu, Mn, Fe, Co, H, O, C, N, S, P, Cl, Br.

Redox reactions and electrochemistry. Oxidation number. Electrolytic cells, voltaic cells. sodium chloride electrolysis, water electrolysis, Daniell cell. Redox potential and its measurement; variation as pH function. Nernst equation. Potentiometric measurement of pH. Redox reactions in live matter.

Acids and bases: definitions by Arrhenius, Bronsted and Lowry, Lewis. Water as electrolyte, pH. pH calculation. Acidic and basic strength. Equilibria in solution: hydrolysis, pK, buffer systems. Henderson-Hasselbalch equation. Titration curves of acids and bases, ampholytes. Importance of acid-base equilibrium in the organism. Breathing and regulation of acidic-base balance. Overview of arterial blood gas analysis.

Colloidal solutions: properties, classification, methodology of study.

Biochemical propedeutics: Free radicals: definition; products of partial oxygen reduction (superoxide anion, water peroxide and hydroxide radical). Dismutation reaction of superoxide anion, Haber-Weiss reaction, Fenton reaction. Nitric oxide and peroxynitrites. Lipids peroxidation and biologic membranes damage. Biological defence against free radicals; superoxide dismutase; glutathione peroxidase, glutathione reductase, catalase, vit. E.

Organic chemistry and biochemical propedeutics: classification of the compounds on the basis of functional groups. Classification of the organic reactions. Isomerism. Structural cis-trans isomerism, tautomerism, optical isomerism (stereochemical series); isomerism relevance on the properties of biological and medical compounds.

Electronic effects on organic molecules: inductive, mesomeric, steric. Electrophilic and nucleophilic reagents. Organic reactions: redox reactions; substitution reactions (SN1 e SN2); simple nucleophilic reaction of addition to carbonyl bond; electrophilic addition reaction followed by elimination reaction; electrophilic addition to alkenes and alkynes; electrophilic substitution reactions; orientation effects; polymerization reactions.

Organic compounds: Alkanes, alkenes, dienes, alkynes, cycloaliphatic hydrocarbons; nomenclature, physical and chemical properties. Arenes: nomenclature, physical and chemical properties. Alkyl and aryl halogenides: nomenclature, chemical properties. Aliphatic and aromatic alcohols, mono and polyvalent: nomenclature, classification, chemical properties. Thioalcohols. Phenols, ethers and thioethers: nomenclature, classification, chemical properties. Aliphatic and aromatic amines: nomenclature, classification, chemical properties; quaternary ammonium salts, amino-alcohols, diamines.

Test reactions. Aliphatic and aromatic aldehydes and ketones: properties; reactions of carbonyl carbon: hemiacetals, acetals, Schiff's bases; reactions of alpha carbon: aldol condensation. Aliphatic and aromatic acids: chemical properties, inductive effect on the acidity; mono and polycarboxylic acids, saturated, unsaturated; malonic synthesis, oxyacids (lactides and lactones), chetoacids; (keto-enol tautomerism), enolphosphates. Acid derivatives: phosphoric esters; amides, anhydrides: simple, mixed, cyclic; nitriles hydrazides: chemical properties and test reactions; acyl chlorides. Lipids: glycerides, fats, saponification; phospholipids and sphingolipids and their biological role. Aminoacids: electrolytic behavior; carbo-amidic bond. Peptides. Proteins and their structures. Glucides: nomenclature, solubility, classification; hexoses configuration, mutarotation, chemical properties; di- and polysaccharides; aminosugars. Heterocyclic compounds with 5 and 6 members, aromatic rings, acidity (furan, pyrrole, thiophene, thiazole, imidazole, oxazole, pyridine, pyrimidine, purine, indole, chinoline, isochinoline, nicotinic acid, isonicotinic acid). Purinic and pyrimidinic bases: their tautomerism. Nucleic acids. Assays of organic compounds with biological relevance in the clinical biochemistry analyses.

TEXTBOOK INFORMATION

F.A. Bettelheim, W.H. Brown, M.K. Campbell, S.O. Farrell - Chimica e Propedeutica Biochimica - EdiSES, Napoli 2012
