



Syllabus

1. Solutions – definition and types. Molecular and ionic solutions, solubility. Types of concentration (percent concentration, molarity, normality, osmolarity).
2. Brønsted-Lowry theory of acids and bases. Acid ionization constant (K_a). Base ionization constant (K_b). Lewis' theory of acids and bases.
3. Self-ionization of water, ionic product of water. The pH scale, methods of measuring pH. Buffers – definition, buffer action. Calculation of the pH of buffers – Henderson-Hasselbalch's equations. Buffers in the human body.
4. Chemical kinetics – reaction rate, rate law. Order of chemical reactions. Activation energy. Arrhenius Equation. Mechanism and molecularity of the chemical reaction.
5. Catalysis. Homogeneous and heterogeneous catalysis. Autocatalysis. Biocatalysts. Chemical equilibrium - basic conceptions, principle of Le Chatelier's. Factors influencing on the chemical equilibrium.
6. Chemical thermodynamics. The first and second laws of thermodynamics. Energy, enthalpy, entropy, free energy. Endergonic and exergonic reactions. High energy bonds – types. High energy compounds and their significance in metabolism (ATP, creatine phosphate, phosphoenolpyruvate, thioesters, acylphosphates).
7. Oxidation-reduction reactions-definitions. Disproportionation and comproportionation reactions – definition and examples. Biological oxidation and reduction, redox potentials. Redox pair in biological oxidation and reduction. Catabolic and anabolic reactions. Respiratory chain.
8. Coordination compounds – definition, classification, structure. Stability constant. Chelates. Chelates formed with amino acids, polypeptides and proteins (carboxypeptidase) and polyols. Chelates with protoporphyrins – hemoglobin, chlorophyll, cytochrome c. Vitamin B12.
9. Alcohols and phenols – types, isomers. Chemical properties – acid base properties, esterification, oxidation of alcohols and phenols. Reactions of the aromatic ring, dehydration, formation of chelates. Biological oxidation of alcohols (methanol, ethanol, 1,2-ethandiol, glycerol). Thioalcohols - definition and chemical properties. Examples: coenzyme A, lipoic acid - biological functions.
10. Carbonyl compounds – aldehydes and ketones. Chemical properties of aldehydes and ketones – nucleophile addition reactions, addition-elimination reactions, reactivity of α -carbon atom (tautomerism, aldol condensation). Cannizzaro reaction, oxidation of carbonyl compounds. Substitution reactions. Biologically active substances with quinone structure - coenzyme Q, K vitamins. Glycerolaldehyde, 11-cis retinal. Ketone bodies.
11. Carboxylic acids-classification. Chemical properties of aliphatic and aromatic mono-carboxylic acids. Biological oxidation of long chain carboxylic acids (β -oxidation). Esters of phosphoric acid and esters of nitric acid – biological significance.
12. Saturated and unsaturated carboxylic acids – properties: oxalic acid, malonic acid, succinic acid, glutaric acid and adipic acid. Fumaric acid and maleic acid-isomerism and significance in metabolism. Esters of acrylic and methacrylic acids - application in dental practice (dental composites).
13. Hydroxycarboxylic acids and ketocarboxylic acids – overview. Comparison of their chemical properties. Important compounds of this group and their biological significance – lactic acid, salicylic acid, malic acid, tartaric acid, citric acid; pyruvic acid, acetoacetic acid, oxaloacetic acid, α -ketoglutaric acid.
14. Amines-definition, structure and chemical properties. Examples. Sulfonamides. Biogenic amines GABA, histamine, serotonin, catecholamines: dopamine, noradrenaline, adrenaline.



15. α -Amino acids - types. Chemical properties of α -amino acids. Chemical aspects of amino acid metabolism – deamination of α -amino acids; ketogenic and glucogenic amino acids. Peptides and proteins – classification, structure, properties. Peptide hormones – examples and functions.
16. Biocatalysts – definition and structure of enzymes. Classification of the enzymes. Factors affecting enzyme activity – temperature, pH; influence of substrate concentration on the rate of enzymatic reaction – MichaelisMenten constant. Zymogenes and isoenzymes. Specificity and regulation of enzyme activity - competitive and irreversible inhibitors.
17. Carbohydrates. Monosaccharides – structure, optical isomerism and chemical properties. Examples of aldoses and ketoses. Cyclic forms of monosaccharides. Glycolysis – basic concept. Disaccharides – examples, polysaccharides – examples.
18. Classification of lipids. Hydrolyzable lipids-examples. Chemical aspects of biological oxidation of fats and oils. Phospholipids – types and biological significance.
19. Classification of lipids. Non-hydrolyzable lipids. Terpenes and steroids. Examples of biologically significant compounds: β -carotene, retinol (vitamin A). Retinal – visual perception in humans. Cholesterol and D group vitamins. Sex hormones.
20. Heterocyclic compounds-classification. Five-membered heterocyclic compounds with one hetero atom– furan, thiophene, and pyrrole - structures. Biologically active substances containing pyrrole ring.
21. Five-membered heterocyclic compounds with two hetero atoms - pyrazole, imidazole and thiazole - structures. Biologically active derivatives of the above mentioned compounds.
22. Six-membered heterocyclic compounds with one hetero atom (pyridine, pyran, thiopyran): structure. Biologically active substances containing pyridine ring NAD⁺ , vitamin B6, niacin, medicines, and alkaloids; vitamin E.
23. Pyrimidine, piridazine, pirazine-structure. Biologically active substances with pyrimidine ring – pyrimidine bases, nucleotides, vitamins and enzymes.
24. Heterocyclic compounds with fused rings. Indole and some of its derivatives – structure and functions. Purine and its derivatives – purine bases, uric acid (tautomers), caffeine, theobromine - structure. Biological activity of purine and its derivatives. Nucleic acids – structure (nucleosides and nucleotides).

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