

## MEDICAL CHEMISTRY EXAMINATION TOPICS

Some names of compounds are marked by an asterisk (\*). It denotes that the complete presentation of the structural formula is not required. Nevertheless, the structural formula should be recognized as well as the proper names given to the important substructures.

- 1 Basic chemical terms: expression of amounts of substances, molar quantities.
- 2 Intermolecular forces, the resulting properties of matter. Similia similibus solvuntur – typical examples, the biological significance.
- 3 Energetics of chemical reactions: enthalpy, entropy, and Gibbs free energy changes, their relationship. The driving force of chemical reactions.
- 4 High-energy compounds, structures, energetic coupling of reactions, the biological significance.
- 5 Reaction rate. Kinetic equations, progress curves for the 1<sup>st</sup> order and the 0<sup>th</sup> order reactions, catalysts.
- 6 Chemical equilibrium, the equilibrium constant, the relationship between  $K$  and  $\Delta G^\circ$ .
- 7 Liquid dispersions, types and fundamental properties, expressing of concentration.
- 8 Colligative properties of solutions, osmotic pressure, osmolarity, isotonic solutions, the osmolality of blood plasma.
- 9 Liquid colloidal dispersions (hydrophilic colloidal solutions - molecular and micellar). Factors stabilizing and destabilizing liquid colloidal dispersions (ionic strength, electric charge, solvation shell, surfactants).
- 10 Adsorption, application of polar and non-polar adsorbents, adsorption chromatography.
- 11 Surfactants - structural types, formation of micelles, solubilizing and emulsifying effects.
- 12 Weak electrolytes, the ionization constant  $K_c$ . Strong electrolytes.
- 13 Acids and bases, conjugate pairs, weak acids and bases,  $pK_A$  and  $pK_B$ . The pH values of aqueous solutions of strong and weak acids and bases.
- 14 Hydrolysis of ions.
- 15 Buffer solutions, the action of buffers. The relation between the buffer composition and pH value, buffer capacity, its relation to the titration curve.
- 16 Buffer systems in the human body.
- 17 Precipitation, solubility product constant  $K_S$ , soluble and insoluble carbonates and phosphates.
- 18 Oxidation and reduction, oxidizing and reducing agents, electrode potential of the half-cell  $E^\circ$  and  $E$ . Decisions about the direction of a redox reaction considering the  $\Delta E$ .
- 19 Redox pairs of biological significance (substrates, coenzymes of dehydrogenases, ascorbic acid).
- 20 Elements in the human body (essential macroelements and microelements).
- 21 Latin nomenclature of pharmaceuticals (oxides, hydroxides, inorganic and organic acids and salts).
- 22 Oxygen, composition of air, ozone, reactive oxygen species, hydrogen peroxide, antioxidants.
- 23 Halogens, biological significance of halides, blood plasma chloride.
- 24 Sulfur compounds, selenium - biological significance.
- 25 Nitrogen, inorganic nitrogen compounds in nature (the nitrogen cycle), biological importance.
- 26 Phosphorus as biogenic element (phosphates, diphosphates, phosphate esters important in metabolism).
- 27 Biological significance of carbon compounds (oxides, carbonates, nutrients, carbon cycle in the nature).
- 28 Magnesium, alkaline earth metals, biological role of  $Ca^{2+}$  and  $Mg^{2+}$  ions, significant compounds, water containing  $Ca+Mg$  ions, insoluble calcium compounds.

- 29 Na, K – human intake of these minerals, biological role of Na<sup>+</sup> and K<sup>+</sup> ions, blood plasma concentration, significant sodium and potassium compounds.
- 30 Fe - biochemical significance, forms of iron occurrence in the body, some important iron compounds.
- 31 Toxic inorganic compounds (ozone, SO<sub>2</sub>, nitrites, HCN, CO, As, Pb, Ba, Cd, Hg, asbestos).
- 32 Constitution of organic compounds, structural isomerism (examples). Tautomerism (types, examples). The term conformation.
- 33 Stereoisomerism (*cis-trans* isomerism, optical isomerism). Notation of chiral molecules configuration (Fischer projection formulas).
- 34 Alcohols - types, general properties, reactions, ethanol and methanol.
- 35 Polyhydric alcohols (glycols, glycerol, alditols, inositol), enols.
- 36 Phenols, general properties. Quinones (\*ubiquinone,).
- 37 Esters of inorganic acids, biological significance (nitrates, sulfates, phosphates, organophosphates).
- 38 Organic compounds of sulfur (thiols, alkyl sulfides, sulfonic acids).
- 39 Reactions of carbonyl compounds, biologically important aldehydes and ketones (acetone, pyridoxal, malondialdehyde, allysine, \*retinal, the biochemical term "ketone bodies").
- 40 Carboxylic acids - general properties. The most important saturated and unsaturated aliphatic and aromatic acids (mono- and dicarboxylic), the trivial and systematic names of those acids, ibuprofen.
- 41 Carboxylic acid derivatives (acid anhydrides, mixed anhydrides, esters, thioesters, amides).
- 42 Derivatives of carbonic acid (carbamates, urea, guanidine, creatine, phosphocreatine, creatinine, arginine).
- 43 Aliphatic and aromatic hydroxy acids (structures and names, products of oxidation, lactones).
- 44 Oxo carboxylic acids of biochemical importance, the term "ketone bodies".
- 45 *p*-Aminobenzoic acid, the relation of PABA to folic acid. The principle of sulfonamides action.
- 46 Biochemically significant interconversions of some aliphatic mono- and dicarboxylic acids (saturated acids to unsaturated and to hydroxy carboxylic and oxo carboxylic acids, transamination of amino acids).
- 47 Amines - general properties, basicity, reaction with aldehydes and ketones, origins of amides, oxidative deamination of amines.
- 48 Biogenic amines, catecholamines, phenethylamines.
- 49 Quaternary ammonium salts exhibiting biological significance (choline, \*myorelaxants, carnitine, cationic surfactants).
- 50 Derivatives of pyrrole, pyrrolidine, indole (porphin, \*porphyrins, haem, proline, tryptophan and derivatives of it).
- 51 Imidazole, thiazole, and their derivatives (histidine and histamine, \*biotin, \*thiamine)
- 52 Derivatives of pyridine (pyridoxal phosphate, nicotinic acid, nicotinamide).
- 53 Pyrimidine derivatives (bases in nucleosides, \*thiamine,).
- 54 Purine and its derivatives (purine bases, uric acid, allopurinol, methylxanthines).
- 55 Pteridine, isoalloxazine and derivatives (\*biopterin, \*folic acid, \*riboflavin).
- 56 Monosaccharides - definition, chirality in monosaccharides (expressing the configuration by Fischer projection), epimers, trivial names and the configurations of the most important monosaccharides.
- 57 Cyclic forms of monosaccharides (anomers, Haworth projection formulas, conformation formulas of pyranoses).

- 58 Reactions of monosaccharides (tests for reducing properties, products of oxidation and/or reduction of monosaccharides). Alditols and acids derived from monosaccharides (general structures, group names, significance).
- 59 Formation of glycosidic bonds, glycoside types (O-, N-, and ester glycosidic bonds).
- 60 Amino sugars (general structure, nomenclature, N-acetylation, importance for heteropolysaccharides, and deoxy sugars (general structure, D-deoxyribose as a constituent of nucleosides).
- 61 Disaccharides (reducing, non-reducing, structures, properties).
- 62 Homopolysaccharides (starch, glycogen, cellulose, inulin, dietary fibre).
- 63 Heteropolysaccharides (constituents, common types of \*glycosaminoglycans).
- 64 Nucleosides - structures, nomenclature.
- 65 Nucleotides - structural types (nucleoside triphosphates, cAMP, NAD<sup>+</sup>, FAD, coenzyme A).
- 66 Characterization of deoxyribonucleic acid structure (polarity of strands and bonds, B-form of the DNA double-helix, base pairing, denaturation and hybridization).
- 67 Main classes of RNA molecules, characteristics of the structures and of the functions (stems and loops, description of the \*tRNA).
- 68 Fatty acids (saturated, unsaturated, essential acids). Eicosanoids.
- 69 Triacylglycerols, properties, structure, products of hydrolysis, fats and oils in the nutrition.
- 70 Glycerophospholipids, structural classes, differences in polarity, significance.
- 71 Sphingophospholipids, glycolipids (neutral and acidic types, components, group names).
- 72 Steroids, the basic structure, numbering of carbon atoms, stereochemistry; cholesterol, bile acids, steroid hormones.
- 73 Twenty standard amino acids, classification based on chemical structure and polarity of a side chain. Ionization and the pH value, isoelectric point.
- 74 Proteins, qualitative differences between peptides and proteins, levels for characterization of the structures, three main classes of proteins (globular, fibrous, and membrane proteins).
- 75 Primary and secondary structures of proteins (definition of the terms, types of bonds).
- 76 Tertiary and quaternary structures of proteins (definition, stabilizing bonds, super-secondary motifs and domains, stability versus flexibility of the native protein conformations, protein denaturation).
- 77 Properties of proteins - solubility, ionization, salting out, denaturation, precipitation.
- 78 Hydrophilic vitamins.
- 79 Lipophilic vitamins.
- 80 Ceramic materials, metals and their melts in dental medicine – see lecture
- 81 Macromolecular compounds a plastic materials in dental medicine – see lecture