

MEDICAL CHEMISTRY EXAMINATION TOPICS 2008

GENERAL MEDICINE

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 1st order and the 0th order reactions, catalysts.
- 6 Chemical equilibrium, the equilibrium constant, the relationship between K and ΔG° . Factors influencing equilibrium.
- 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 and percent ionization α_c . Strong electrolytes, concentration versus activity of ions, ionic strength.
- 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 Titration curves, differences between titration curves of strong and weak acids.
- 15 Hydrolysis of ions.
- 16 Buffer solutions, the action of buffers. The relation between the buffer composition and pH value, buffer capacity, its relation to the titration curve.
- 17 Buffer systems in the human body.
- 18 Precipitation, solubility product constant K_S , soluble and insoluble carbonates and phosphates.
- 19 Coordination compounds (structure, stability, examples and nomenclature), chelation.
- 20 Oxidation and reduction, oxidizing and reducing agents, electrode potential of the half-cell E° and E . Decisions about the direction of a redox reaction considering the ΔE . The relationship between ΔE and ΔG .
- 21 Redox pairs of biological significance (substrates, coenzymes of dehydrogenases, ascorbic acid).
- 22 Elements in the human body (essential macroelements and microelements).
- 23 English chemical nomenclature of inorganic compounds; Latin nomenclature of pharmaceuticals (oxides, hydroxides, inorganic and organic acids and salts).
- 24 Oxygen, composition of air, ozone, reactive oxygen species, hydrogen peroxide, water.
- 25 Halogens, biological significance of halides, blood plasma chloride.
- 26 Sulfur compounds, selenium - biological significance.

- 27 Nitrogen, inorganic nitrogen compounds in nature (the nitrogen cycle), biological importance.
- 28 Phosphorus as biogenic element (phosphates, diphosphates, phosphate esters important in metabolism).
- 29 Biological significance of carbon compounds (oxides, carbonates, cyanides), nutrients, carbon cycle in the nature.
- 30 Si, B, Al - compounds applicable in medicine (antacids, boric acid and borax).
- 31 Magnesium, alkaline earth metals, biological role of Ca^{2+} and Mg^{2+} ions, significant compounds, water containing $\text{Ca}+\text{Mg}$ ions, insoluble calcium compounds.
- 32 Na, K – human intake of these minerals, biological role of Na^+ and K^+ ions, blood plasma concentration, significant sodium and potassium compounds.
- 33 Fe - biochemical significance, forms of iron occurrence in the body, some important iron compounds.
- 34 Toxic inorganic compounds (ozone, SO_2 , nitrites, HCN, CO, As, Pb, Ba, Cd, Hg, asbestos).
- 35 Constitution of organic compounds, structural isomerism (examples). Tautomerism (types, examples). Conformation of alkanes and cycloalkanes (cyclohexane, decalin, sterane).
- 36 Stereoisomerism (*cis-trans* isomerism, optical isomerism). Notation of chiral molecules configuration (Fischer projection formulas, *R/S* convention), enantiomers, racemates, diastereomers.
- 37 Important and useful arenes (benzene, toluene, styrene), biotransformation of arenes, polycyclic aromatic hydrocarbons.
- 38 Alcohols - types, general properties, reactions, ethanol and methanol.
- 39 Polyhydric alcohols (glycols, glycerol, alditols, inositol), enols.
- 40 Phenols, general properties. Quinones (*ubiquinone, 1,4-naphthoquinone). Ethers.
- 41 Esters of inorganic acids, biological significance (nitrates, sulfates, phosphates, organophosphates).
- 42 Organic compounds of sulfur (thiols, alkyl sulfides, sulfonic acids).
- 43 Reactions of carbonyl compounds, biologically important aldehydes and ketones (acetone, pyridoxal, malondialdehyde, allysine, *retinal, the biochemical term "ketone bodies").
- 44 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.
- 45 Carboxylic acid derivatives (acid anhydrides, mixed anhydrides, esters, thioesters, amides).
- 46 Derivatives of carbonic acid (carbamates, urea, guanidine, creatine, phosphocreatine, creatinine, arginine).
- 47 Aliphatic and aromatic hydroxy acids (structures and names, products of oxidation, lactones).
- 48 Oxo carboxylic acids of biochemical importance, the term "ketone bodies".
- 49 *p*-Aminobenzoic acid, the relation of PABA to folic acid. The principle of sulfonamides action.
- 50 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).
- 51 Amines - general properties, basicity, reaction with aldehydes and ketones, origins of amides, oxidative deamination of amines.
- 52 Biogenic amines, catecholamines, phenethylamines.
- 53 Quaternary ammonium salts exhibiting biological significance (choline, *myorelaxants, carnitine, cationic surfactants).
- 54 Halogenated organic compounds (solvents, PCBs, chlorofluorocarbons, herbicides, dioxins), halogenated anesthetics. Nitro compounds.

- 55 Derivatives of pyrrole, pyrrolidine, indole (porphin, *porphyrins, haem, *corrin, proline, tryptophan and derivatives of it).
- 56 Imidazole, thiazole, and their derivatives (histidine and histamine, *biotin, *thiamine, the *skeleton of penicillins).
- 57 Derivatives of pyridine and chroman (pyridoxal phosphate, nicotinic acid, nicotinamide, *tocopherol, *coumarin).
- 58 Pyrimidine derivatives (bases in nucleosides, *thiamine, cytostatic analogs of pyrimidine bases).
- 59 Purine and its derivatives (purine bases, uric acid, allopurinol, methylxanthines).
- 60 Pteridine, isoalloxazine and derivatives (*biopterin, *folic acid, *riboflavin).
- 61 General characteristic of alkaloids. Examples of important alkaloids.
- 62 Toxic organic chemicals.
- 63 Monosaccharides - definition, chirality in monosaccharides (expressing the configuration by Fischer projection), epimers, trivial names and the configurations of the most important monosaccharides.
- 64 Cyclic forms of monosaccharides (anomers, Haworth projection formulas, conformation formulas of pyranoses).
- 65 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 - esp. of glucuronic acid and of *neuraminic acid).
- 66 Formation of glycosidic bonds, glycoside types (O-, N-, and ester glycosidic bonds).
- 67 Amino sugars (general structure, nomenclature, N-acetylation, importance for heteropolysaccharides, *neuraminic acid and *sialic acids) and deoxy sugars (general structure, D-deoxyribose as a constituent of nucleosides).
- 68 Disaccharides (reducing, non-reducing, structures, properties).
- 69 Homopolysaccharides (starch, glycogen, cellulose, inulin, dietary fibre).
- 70 Heteropolysaccharides (constituents, common types of *glycosaminoglycans).
- 71 Nucleosides - structures, nomenclature.
- 72 Nucleotides - structural types (nucleoside triphosphates, cAMP, NAD⁺, FAD, coenzyme A).
- 73 Characterization of deoxyribonucleic acid structure (polarity of strands and bonds, B-form of the DNA double-helix, base pairing, denaturation and hybridization).
- 74 Main classes of RNA molecules, characteristics of the structures and of the functions (stems and loops, description of the *tRNA).
- 75 Fatty acids (saturated, unsaturated, essential acids). Eicosanoids.
- 76 Triacylglycerols, properties, structure, products of hydrolysis, fats and oils in the nutrition.
- 77 Glycerophospholipids, structural classes, differences in polarity, significance.
- 78 Sphingophospholipids, glycolipids (neutral and acidic types, components, group names).
- 79 Terpenes, major classes with examples (*menthane, *phytol, squalene, *carotenes).
- 80 Steroids, the basic structure, numbering of carbon atoms, stereochemistry; cholesterol, bile acids, significance.
- 81 Steroid hormones: corticosteroids (cortisol, aldosterone), gestagens, androgens, estrogens (structural differences, sites of secretion, notion about their functions).
- 82 Twenty standard amino acids, classification based on chemical structure and polarity of a side chain.
- 83 Standard amino acids, ionization and the pH value, isoelectric point.

- 84 Peptides, groups of peptides possessing biological activity (glutathione, examples of hormones, antibiotics, toxins).
- 85 Proteins, qualitative differences between peptides and proteins, levels for characterization of the structures, three main classes of proteins (globular, fibrous, and membrane proteins).
- 86 Primary and secondary structures of proteins (definition of the terms, types of bonds).
- 87 Tertiary and quaternary structures of proteins (definition, stabilizing bonds, super-secondary motifs and domains, stability versus flexibility of the native protein conformations, protein denaturation).
- 88 Properties of proteins - solubility, ionization, salting out, denaturation, precipitation.
- 89 Glycoproteins – types of structures, significance, different types of glycosidic linkages to proteins in glycoproteins.
- 90 Hydrophilic vitamins.
- 91 Lipophilic vitamins.