LIST OF QUESTIONS FROM MEDICAL CHEMISTRY AND BIOCHEMISTRY FOR THE EXAM

I. Fundamentals of physical, inorganic and organic chemistry

1. Types of chemical bonds, weak interactions.

2. Water and its physical and chemical properties, importance in the body.

3. Dispersion systems, solubility of substances, true and colloidal solutions, emulsions and suspensions.

4. Diffusion, osmosis, osmotic and oncotic pressure, dialysis, examples from biochemistry.

5. Energetics of chemical reactions, Gibbs energy and entropy, application to metabolic processes.

6. Chemical equilibrium, Guldberg-Waage law. Kinetics and energetics of subsequent and reversible reactions, applications in enzymology.

7. Basic methods for separation of macromolecules (electrophoresis, chromatography, isolation) and their application in clinical practice.

8. Spectrophotometry, principle and application in clinical biochemistry.

9. Electrolytic dissociation, dissociation constant, strong and weak electrolytes, examples from biochemistry.

10. Brönsted's theory of acids and bases, equilibrium in protolytic reactions, examples.

from biochemistry.

11. Ionic product of water, pH and its importance in medicine.

12. Ampholytes, their properties, examples from biochemistry.

13. Buffers, calculation of pH, importance in the body.

14. Oxidation and reduction, oxidation-reduction potential, dependence on concentration of reactants, examples from biochemistry. Coenzymes of oxidoreduction reactions.

15. Precipitation reactions, solubility product, complex formation, coordination compounds, examples and their importance in biochemistry and medicine.

16. Chemical properties of the main biogenic elements.

17. Oxygen and its inorganic compounds

18. Lipid peroxidation.

19. Toxicologically important elements, mechanism of action of selected toxic compounds (CO, KCN, HCN, H_2S, heavy metals).

20. Biological and metabolic significance of trace elements.

21. Structure of organic compounds, isomerism, examples from metabolic pathways.

22. Halogen- and nitro derivatives of hydrocarbons, examples of compounds of toxicological and medical importance.

23. Sulphur derivatives of hydrocarbons, examples of medically important compounds.

24. Amines, importance in biochemistry.

25. Alcohols, phenols, aldehydes and ketones, applications in metabolism. Substances used as disinfectants, their mechanism of action.

26. Carboxylic acids, functional and substituent derivatives of carboxylic acids, applications in biochemistry.

27. Nitrogen, oxygen and sulphur heterocycles, importance.

28. Structural characteristics of amino acids, partitioning, reactions, significance.

29. Peptides, peptide bonding, examples of biologically important peptides.

30. Proteins, structure primary, secondary, tertiary, quaternary. Suprasecondary structures, protein domains. Protein misfolding. Properties and functions of proteins.

31. Carbohydrates, distribution, structure, stereochemistry, biological significance.

32. Reactions and derivatives of monosaccharides, disaccharides, O- and N-glycosidic linkage, examples.

33. Homopolysaccharides and heteropolysaccharides, structure, occurrence and importance in the body.

34. Proteoglycans, glycoproteins, structure, properties, examples.

35. Lipids - classification, structure, properties, function in the organism.

36. Fatty acids.

37. Phospholipids and sphingolipids,

38. Sterols, bile acids and steroid hormones, structure, function and importance in the body.

II. Basics of metabolism

1. Structure of enzymes (simple and complex; apoenzyme and holoenzyme; cofactors: coenzymes, prosthetic groups, coactivators; oligomeric structure); multiple enzyme forms and isoenzymes. Classification of enzymes. Examples, significance.

2. Enzyme activity and its measurement, physicochemical factors affecting enzyme activity, regulation of enzymes (expression, covalent modification, allosteric effects). Application of enzymology in medicine.

3. Energetics of enzyme catalysis. Kinetics of monomeric and oligomeric enzymes, examples. Km, kcat, catalytic efficiency of the enzyme.

4. Inhibition of enzymes: competitive, non-competitive, covalent, allosteric. Use of enzyme inhibitors in medicine.

5. The respiratory chain. Oxidative phosphorylation. Electron transport across mitochondrial membranes.

6. "Macroergic" compounds, phosphorylation at the substrate level, driving endergonic reactions.

7. Citrate cycle, amphibolic nature, progression, regulation.

8. General mechanisms of amino acid conversion, deamination, transamination, decarboxylation. Nitrogen balance.

9. Metabolism of one-carbon residues- sources and utilization of one-carbon residues, cofactors.

10. Formation of ammonia, its detoxification, ureosynthetic cycle and its regulation, hyperammonemia.

11. Metabolism of amino acids of pyruvate and oxaloacetate group, involvement of these amino acids in metabolic processes.

12. Metabolism of the carbon skeleton of amino acids of the 2-oxoglutarate group, amino acids

branched-chain amino acids, involvement of these amino acids in metabolic processes.

13. Catabolism of aromatic amino acids, disorders.

14. Metabolism of sulphur amino acids.

15. Biosynthesis, biodegradation and function of the most important biogenic amines.

16. Conversion of amino acids into specialized products: creatine, S-adenosylmethionine, carnitine, taurine and their significance.

17. Glycolysis, energy balance, utilization of glycolysis by different organs of the body under different physiological situations, regulation, oxidation of pyruvate, pyruvate dehydrogenase complex.

18. Gluconeogenesis, importance, regulation.

19. Glycogen synthesis and degradation, significance, regulation, disorders.

20. Pentose cycle, significance, regulation.

21. Galactose and fructose metabolism, disorders.

22. Metabolism of glucuronic acid and its importance in the body.

23. Biosynthesis of fatty acids.

24. Formation of ketone bodies from acetyl-CoA, metabolic causes, significance.

25. Oxidation of fatty acids, energy yield, carnitine system.

26. Triacylglycerols, biosynthesis, degradation.

27. Biosynthesis and degradation of phospholipids (glycerophospholipids and sphingolipids).

28. Biosynthesis of prostaglandins, thromboxanes and leukotrienes.

29. Cholesterol biosynthesis and its regulation, role of HMG-CoA reductase and SREBP protein .

30. Cholesterol metabolism and excretion, bile acid biosynthesis and its regulation .

31. Biosynthesis and degradation of steroid hormones.

32. Lipid transport, roles of lipoproteins, structure of lipoprotein particle. Lipoprotein electrophoresis.

33. Transport of endogenous and exogenous cholesterol (formation, transformation and role of chylomers, VLDL, LDL and HDL lipoproteins).

34. Tetrapyrrole-heme biosynthesis and its disorders. Heme incorporation into apoproteins and its function.

35. Intravascular and extravascular degradation of erythrocytes.

36. Metabolism of purine nucleotides, regulation, inhibitors, disorders.

37. Metabolism of pyrimidine nucleotides, regulation, inhibitors, disorders.

38. Reactive oxygen species, formation and significance, antioxidants.

III. Basic biochemistry of organs and functions

1. Biochemical interrelationships of carbohydrate and other nutrient metabolism.

2. Glycaemia, regulation, diagnosis (oGTT, glycated haemoglobin).

3. Metabolism of adipose tissue.

4. Regulation of heme biosynthesis, differences between hepatocyte and erythroid cell, iron metabolism.

5. Mechanism of action of hormones regulating water and mineral metabolism.

6. Hormonal regulation of energy metabolism.

7. Biochemical processes in the digestion of carbohydrates, lipids and proteins.

8. Biochemical functions of the hepatocyte and liver, possibilities of biochemical diagnosis of damage

hepatocyte and liver function.

9. Biotransformation of endogenous and exogenous substances, types of biotransformation processes, toxic and carcinogenic substances in the environment.

10. Buffer systems of the organism, function and importance for acid-base balance.

11. Erythrocyte metabolism.

12. Important proteins of blood plasma, importance in the organism (albumin, Ig, proteins

acute phase, transport proteins).

13. Haemocoagulation, cascade of coagulation factors, initiation, amplification and propagation, tenas and prothrombinase complex. Role of platelets and protein C.

14. Fibrin, fibrinolysis. Mechanism of action of anticoagulants.

15. Urine - physiological and pathological components.

16. Extracellular matrix, extracellular polysaccharides and proteins (collagen, elastin) - structure, properties, function. Metabolism of collagen.

17. Biochemistry of connective tissue (cartilage, bone).

18. Biochemistry of skin (barrier function, vitamin D, cytokeratins, intercellular junctions, melanin biosynthesis).

19. Contractile apparatus, control of smooth and skeletal muscle contraction.

20. Markers of muscle tissue damage, significance, determination.

21. Biochemistry of vision, Wald cycle, transducin cycle.

22. Biochemistry of the senses (taste, smell).

23. Biochemistry of nerve synapses, neurotransmitters.

24. Catecholamines - biosynthesis, biodegradation.

25. Steroid hormones - structure of steroid hormone receptors, mechanism of action, function.

26. Peptide hormones - mechanisms of action, function.

27. Local mediators (cytokines, growth factors, chemokines) - function, mechanism of action.

28. Thyroid hormones and their function in regulatory processes.

29. Structure and function of individual parts of immunoglobulins. Classes of immunoglobulins, properties and functions. Monoclonal antibodies - preparation, use.

30. Molecular basis of immunoglobulin diversity of primary and secondary antibody response, somatic recombination, isotype skipping.

31. Molecular basis of cellular immunity - pathogen recognition by cells of specific and non-specific immunity, effector mechanisms. MHC molecules - structure, function, mechanisms of antigen presentation to Tc and Th lymphocytes.

32. Basic immunochemical methods. Immunoturbidimetry, ELISA, RIA.

33. Biochemical significance of fat-soluble vitamins.

34. Biochemical significance of water soluble vitamins, cofactors derived from these vitamins.

35. Structure, composition and properties of cell membranes.

36. Transport of substances across membranes.

37. Cytoskeleton.

38. Compartmentation of biochemical processes at the subcellular level.

IV. Fundamentals of cellular and molecular biology

1. Principles, mechanisms and importance of intercellular communication and intracellular signal transduction cascades.

2. Types of membrane receptors, their ligands, biological significance, examples.

3. Intracellular receptors, heat-shock proteins, interaction of receptors with DNA

4. Amplification, integration and cross-talk of signaling pathways .

5. G-proteins - structure, activation, function.

6. Types and role of second messengers in signal transduction.

7. Mechanism and significance of reversible phosphorylation in signal transduction.

8. Signaling stimulated by growth factors (MAPK, PKB/AKT) and cytokines (JAK- STAT).

9. Proteolysis-dependent signaling pathways, examples. HIF signaling role in response to hypoxia.

10. Signaling using NO, medical relevance.

11. Structure and function of DNA.

12. Structure and function of RNA.

13. Organization of the prokaryotic, eukaryotic and mitochondrial genome.

14. DNA sequencing techniques (Sanger, NGS, human genome sequencing).

15. Classification of human genomic DNA according to repetitiveness and function, pseudogenes, transposons.

16. Replication of eukaryotic DNA, replication apparatus and its regulation.

17. DNA repair - BER, NER, MMR, direct repair of modified bases.

18. DNA repair - HR, NHEJ.

19. Transcription of prokaryotic and eukaryotic genomic DNA. Transcription factors, DNA-protein binding.

20. mRNA structure, post-transcriptional modifications (cap, poly A, splicing).

21. RNA interference, types and functions of non-coding RNAs .

22. Regulation of gene expression at the level of transcription.

23. Genetic code and its properties.

24. Eukaryotic, prokaryotic translation. Regulation of translation.

25. Sorting , transport and post-translational modifications of proteins .

26. Biosynthesis of glycoproteins and their importance .

27. Vesicular transport . Endocytosis and exocytosis .

28. Restriction enzymes and other genetic engineering tools, construction of recombinant DNA and protein molecules . DNA cloning.

29. Methods of cell fractionation, electrophoresis of nucleic acids and proteins.

30. Polymerase chain reaction, application of PCR in clinical diagnostics, RT-PCR and use of this technique.

31. Nature of gene mutations, inherited and acquired mutations, polymorphisms, mini- and microsatellite sequences and their applications.

32. DNA and RNA viruses - structure and replication.

33. Proto-oncogenes.

34. Tumour suppressor genes.

35. Cell cycle, role of cyclin complex and cdks (cyclin dependent kinases).

36. Lysosomal and proteasomal protein degradation in the cell. Ubiquitination of proteins

37. Biochemistry of apoptosis, examples of pro- and anti-apoptotic genes/proteins. Caspases. Role of mitochondria in cell death.

38. Epigenetics, histone modification, DNA methylation, significance.