EXAMINATION SYNOPSIS
OF BIOCHEMISTRY
FOR DENTAL MEDICAL STUDENTS
Academic year 2012-2013

1. Globular proteins – myoglobin and hemoglobin. Comparative characteristics of structure and functions. Dissociation curves of myoglobin and hemoglobin. R and T-states. Allosteric properties of hemoglobin. The Bohr effect.
2. Fibrillar proteins – collagen and elastin. Structure, biosynthesis, biologic role.
3. Glycoproteins and proteoglycans. Structure, biosynthesis, biologic role.
4. Enzymes as biocatalysts. Nomenclature and classification of enzymes. Mechanism of enzyme action. Enzyme cofactors. Water-soluble vitamins as enzyme cofactors – cofactors for electron and proton transfer. Water-soluble vitamins as enzyme cofactors – cofactors for group transfer.
5. Enzyme kinetics - substrate concentration as a factor affecting enzyme velocity. MIchaelis-Menten plot. Km and Vmax. Linewever-Burk plot. Enzyme concentration as a factor affecting enzyme velocity. Enzyme activity. Effect of pH and temperature on enzyme velocity.
6. Enzyme inhibition. Reversible and non-reversible enzyme inhibition. Kinetics of competitive and non-competitive enzyme inhibition.
7. Allosteric enzymes – structure, kinetics. Regulation of enzyme activity: allosteric regulation, covalent modification, limited proteolysis, induction and repression of enzyme synthesis.
8. Isoenzymes – characteristics, biological role.
9. Exergonic and endergonic processes. Coupling of exergonic and endergonic processes. High and low energy redox-compounds with biological significance. The central role of ATP in cellular bioenergetics.
10. Molecular organization of mitochondrial respiratory chain. Redox-systems of mitochondrial respiratory chain. Vector organization of redox-systems in the mitochondrial respiratory chain. Chemiosmotic hypothesis of oxidative phosphorylation, ATP-synthase. Regulation of oxidative phosphorylation. Inhibitors of oxidative phosphorylation. Uncoupling agents of oxidative phosphorylation.
11. Extramitochondrial oxidation. Oxidation in peroxisomes. Short-chain electron transport systems – cytochrome P_{450} and desaturase system.
12. Free radical oxidation – endogenous sources of free radicals. Biologic role of free radicals. Antioxidant systems. Types antioxidants. Biologic role of antioxidants.
13. Carbohydrate metabolism - digestion and absorption of carbohydrates. Mechanism of anaerobic glycolysis. Phosphorylation of glucose to glucose-6-phosphate. Type hexokinases. Fate of pyruvate in anaerobic conditions. Energy yield. Substrate phosphorylation. Regulation of glycolysis. Mechanism of aerobic glycolysis. Electron shuttles for transfer electrons from NADH in the cytosol to the mitochondria. Glycerol phosphate shuttle. Malate-aspartate shuttle.
14. Oxidative decarboxylation of pyruvate. Pyruvate dehydrogenase complex. Regulation of oxidative decarboxylation of pyruvate. Tricarboxylic acid cycle – biologic role. Reactions of the tricarboxylic acid cycle. Regulation of tricarboxylic acid cycle. Anaplerotic (filling up) reactions for the production of oxaloacetate. Energy yield of glucose oxidation to CO_2 and water in aerobic conditions. Link between glycolysis and respiration. The Pasteur effect.
15. Gluconeogenesis – mechanism, key enzymes, and biologic significance. Reciprocal regulation of glycolysis and gluconeogenesis.
16. Glycogen structure and biologic role. Glycogen synthesis – mechanism, key enzymes. Glycogen breakdown – mechanism, key enzymes. Regulation of glycogen synthesis and glycogen breakdown. Glycogen storage diseases.
17. Pentose phosphate pathway. Biologic significance. Mechanism of the oxidative phase of pentose phosphate pathway.
18. Hormonal regulation of blood glucose. Hyper- and hypoglycemia.

19. Metabolism of fructose. Disturbances in fructose metabolism. Metabolism of galactose. Disturbances in galactose metabolism.
20. Digestion and absorption of lipids. Digestive enzymes. Role of bile acids.
21. Lipoproteins – types, biologic role, and general structure. Apoproteins – types, role for lipoprotein metabolism. Transport of dietary lipids. Chylomicrons – structure, metabolism.
22. Lipolysis – mechanism, regulation. Activation and transport of saturated fatty acids into mitochondria. Mechanism of β - oxidation of saturated fatty acids with even carbon atoms. Energy yield.
23. Ketone bodies – biologic role. Mechanism of ketogenesis and ketolysis. Ketoacidosis.
24. Biosynthesis of fatty acids - mechanism. Acetyl-CoA carboxylase and fatty acid synthetase complex. Regulation of fatty acid biosynthesis. Biosynthesis of TAG. Regulation.
25. Lipoproteins involved in the transport of endogenous lipids. Metabolism of VLDL.
26. Phospholipid biosynthesis: de novo and salvage pathway. Phospholipid catabolism. Phospholipases. Release of arachidonic acid from membrane phospholipids: role of phospholipase A_2.
27. Biosynthesis of prostaglandins, tromboxanes, and leucotrienes from arachidonic acid. Biologic role.
28. Cholesterol biosynthesis – mechanism. Regulation. Role of LDL и HDL for cholesterol transport.
29. Biosynthesis of bile acids. Biologic role. Enterohepatic circulation of bile acids.
30. Digestion of dietary proteins. Role of hydrochloric acid. Enzymes in dietary protein digestion. Absorption of aminoacids. Na-dependent transport. Gamma-glutamyl cycle.
31. Transamination of amino acids – mechanism. Transaminases - role of pyridoxal cofactors. Oxidative deamination of glutamate – mechanism. Transdeamination - biologic significance.
32. Routes for release of ammonium ions in the organism. Toxic effects of ammonium ions. Detoxification of ammonium ions in peripheral tissues – role of glutamine and alanine. Detoxification of ammonium ions in the liver – urea biosynthesis. Regulation of urea cycle.
33. *De novo* pathway for purine nucleotides biosynthesis. Role of tetrahydrofolic acid. Regulation. Salvage pathway for purine nucleotides biosynthesis. Inborn defects in salvage pathway. Catabolism of purine nucleotides. Hyperuricemias.
34. *De novo* pathway for pyrimidine nucleotides biosynthesis. Regulation. Biosynthesis of 2′- deoxyribonucleotides. Regulation. Biosynthesis of dTTP – role of tetrahydrofolic acid.
35. Heme biosynthesis – mechanism, regulation. Defects in heme biosynthesis – porphyrias. Heme catabolism – bile pigments. Direct and indirect bilirubin. Disturbances in bile pigments metabolism - jaundices. Iron metabolism. Proteins required for iron absorption, transport and deposition.
36. General principles of cell-cell communication. Signal molecules. Receptors. Authocrine, paracrine, endocrine, and synaptic signaling. Adenylyl cyclase signaling pathway: $G_{\alpha\beta\gamma}$ – protein coupled membrane receptors. Role of adenylyl cyclase and cAMP as a second messenger. Signaling chain. Phosphatidylinositol signaling pathway: $G_{\alpha\beta\gamma}$ – protein coupled membrane receptors. Role of phospholipase C and Ca-ions as a second messenger. Signaling chain.
37. Cytosolic receptors. Receptor for steroidal hormons. Signaling chain.
38. Metabolism of bone tissue: bone formation and bone resorption. Metabolism of calcium and phosphate. Hormones, regulating calcium homeostasis – parathormone, calcitonin. Biosynthesis of calcitriol. Role of calcitriol in regulation of calcium and phosphate metabolism and bone homeostasis. Hypo- and hypervitaminosis D. Role of vitamin K in bone metabolism.
39. Metabolism of xenobiotics.
40. Biochemistry of dental caries: organic and inorganic components of teeth tissues. Saliva as carioprotective factor. Cariogenic factors.
41. Biochemistry of dental caries: biochemical processes in the micro flora of dental plaque.

References

1. Champe, P., R. Harvey, D. Ferrier. Lippincott's Illustrated Reviews: Biochemistry. Lippincott Williams& Wilkins, 2005.
2. Williams R.A.D., J.C. Elliot. Basic and Applied Dental Biochemistry, 2nd edition, Churchill Livingstone, 2001.
3. Baynes J. W. and M. H. Dominiczak: Medical Biochemistry. 2nd edition Mosby, 2004.
4. Meisenberg G. and W. Simmons. Principles of Medical Biochemistry, 2nd edition, Mosby, 1998.

Department council protocol № 77, April, 27-th 2011. **Faculty council protocol №** 9, November, 28-th 2011.

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