BIOCHEMISTRY COURSE

Requirements for the Exam – 2006/2007

1. **Proteins - structure and function**: primary, secondary, tertiary and quaternary protein structure; physico-chemical properties; denaturation; separation; homo- and heteroproteins; immunoglobulins; glycoproteins; glycated proteins; proteoglycans; myoglobin and hemoglobin - allostery, cooperative binding, mechanism and a role of oxygen, CO_2 and 2,3-BPG binding; mechanism of CO and CN-poisoning.

   ***F**: all amino acids, components of proteoglycans (amino sugars, uronic acids), O- and N-glycosidic bonds; heme; 2,3-BPG*

2. **Enzymes**: structure, properties, classification; specificity; cofactors, coenzymes, prostetic groups - function and relation to vitamins; mechanism of enzymic catalysis; enzyme activity; enzyme kinetics; inhibition; factors affecting enzyme activity; regulation of the enzyme activity in organism; isoenzymes; clinically important enzymes.

   ***F**: NAD, NADH, pyridoxal phosphate, ATP, reactions catalyzed by LDH, AST, ALT*

3. **Bioenergetics**: exergonic and endergonic reactions; free energy; coupled reactions; coupled reactions in clinical diagnostics; high-energy compounds; ATP - role in metabolism, membrane transport, and metabolic regulations. Importance of redox potencial.
   Mitochondrial electron transport (respiratory) chain - organization, components, function - chemiosmotic theory; oxidative phosphorylation; energy yield of respiratory chain; uncoupling; cytochromes; CN-poisoning; shuttles, mitochondrial membrane carriers; oxidases, oxygenases - mono- and dioxygenases - examples.

   ***F**: NAD, NADH, heme, ATP, 1,3-bisphosphoglycerate, phosphoenol pyruvate, creatine phosphate , reactions of glycerol phosphate shuttle.*

4. **Citric acid cycle**: catabolic and anabolic role of the cycle; energy yield; regulation; oxidative decarboxylation; acetyl CoA - central role in metabolism. Metabolic pathways in mitochondria and cytosol - overview.

   ***F**: all intermediates of the cycle, reactions of cycle, pyruvate, acetyl CoA, lipoic acid.*

5. **Carbohydrate metabolism:** oligo- and polysaccharide structure; glycosidic bonds; digestion of carbohydrates; glycolysis - aerobic and anaerobic, energy yields; gluconeogenesis, substrates of gluconeogenesis; regulation of glycolysis and gluconeogenesis - allosteric, hormonal; pentose phosphate pathway; formation and utilization of NADPH; biosynthesis and degradation of glycogen; regulation of glycogenolysis and glycogenogenesis. Cori cycle.
   Carbohydrate metabolism in liver, muscle, brain, adipose tissue, erythrocyte. Metabolism of fructose and galactose. G-6-P defficiency, lactose intolerance, fructose intolerance, glycogen storage diseases. UDPG - metabolic role; Glucuronic acid - biosynthesis, role in the organism. Glycoprotein metabolism.
   ***F**: glucose, fructose, galactose, sucrose, maltose, lactose, all intermediates and reactions of glycolysis and gluconeogenesis, oxidative phase of pentose phosphate pathway, UDPG, G-1-P, glucuronic acid.*

6. **Lipid metabolism**: Triacylglycerol, phospholipid and glycolipid structure; digestion and transport of lipids; lipoproteins - composition and metabolism; lipases; biosynthesis and degradation of fatty acids, energy yield of beta-oxidation; carnitine function; regulation of fatty acid biosynthesis and degradation; biosynthesis and degradation of triacylglycerols; biosynthesis and degradation of phospholipids; ketone bodies metabolism; prostaglandins and leukotriens - overview of metabolism, function.

   F: *triacylglycerol, glycerol-3-P, phosphatidic acid, phospholipid, sphingosine, ceramide, glycolipid; palmitic, stearic, oleic, linoleic, linolenic, arachidonic acids; malonyl-CoA, all intermediates and reactions of beta-oxidation, acetoacetate, HMGA, aceton, beta-hydroxybutyrate.*

7. **Steroid metabolism**: Cholesterol biosynthesis and utilization; cholesterol transport; HDL, LDL-metabolism, LDL-receptors; hypercholesterolemia; role of LDL in atherosclerosis; bile acids formation and function; cholelithiasis; steroid hormones classification; steroid hormones biosynthesis and degradation - overview; hydroxylation in metabolism of steroids; hydroxylases deficiences.

   F: *cholesterol, cholesterol ester, cholic acid, progesterone, all intermediates and reactions of cholesterol biosynthesis up to isopentenyl pyrophosphate.*

8. **Protein and amino acid metabolism**: Protein digestion and utilization; extracellular and intracellular proteases; signals of protein degradation; proteases specificity; amino acids catabolism - overview; role of pyridoxal phosphate; decarboxylation - biogenic amines, polyamines; transamination, diagnostic importance of ALT, AST; oxidative deamination; metabolism of amonia in liver, brain, muscle, kidney; urea cycle; hyperammonemia;
   Gluco- and ketogenic acids; glucose-alanine cycle; metabolism of phenylalanine and tyrosine; catecholamines biosynthesis and inactivation, MAO, COMT; inherited disorders in aromatic amino acid and catecholamine metabolism; phenylketonuria; precursors of amino acid biosynthesis; essential amino acids.

   F: *pyridoxal phosphate, all amino acids, alfa-ketoglutarate, histamine, cysteamine, ethanolamine, putrescine; reactions catalyzed by ALT, AST, glutamate dehydrogenase; all intermediates and reactions of urea cycle; all intermediates and reactions of phenylalanine catabolism; all intermediates and reactions of catecholamine biosynthesis.*

9. **Tetrapyrroles:** Cyclic and lineary tetrapyrroles - representatives, biological role; porphyrin classification; biosynthesis of hemoglobin; porphyrias; lead poisoning; regulation of heme biosynthesis; degradation of hemoglobin; bilirubin metabolism; bile pigments; causes of jaundince and their diagnostics.

   F: *porphyrin, methylene and methine bridges in tetrapyrrole stucture, heme, intermediates and reactions up to porphobilinogen, glucuronic acid, conjugation reaction (formation of bilirubin glucuronides).*

10. **Nucleotide metabolism**: structure and function of nucleotides; degradation of nucleic acids; de novo synthesis of pyrimidine and purine nucleotides - overview; synthesis of deoxyribonucleotides; salvage pathways, Lesch-Nyhan syndrom; role of tetrahydrofolate in metabolism of nucleotides; metabolism of one-carbon units; degradation of pyrimidine and purine nucleotides; uric acid, hyperuricemia, gout treatment; antimetabolites of nucleotides and tetrahydofolate in cancer treatment; mechanism of sulphonamide function.

***F**: adenosine, guanosine, cytidine, uridine, thymidine, carbamoyl phosphate, orotic acid, orotidine, inosine, hypoxanthine, xanthine, uric acid, phosphoribosylpyrophosphate, tetrahydrofolate.*

11. **Mechanism of hormonal regulation**: hormone receptors; hormone classification acording to their structure and mechanism of action; second messengers; G-proteins, protein kinases; adenylate cyclase system; phosphatidylinositol system; calmodulin; tyrosine kinase system; examples of metabolic pathways regulated through the above mentioned transduction systems; mechanism of steroid hormone action; pathways regulated by steroid hormones.
    Insulin and glucagon: structure, biosynthesis and degradation, mechanism of action; insulin receptor; regulation of carbohydrate, lipid and amino acid metabolism; metabolism in starvation; Diabetes mellitus - comparison of metabolic events in IDDM and NIDDM.

    ***F**: cAMP, inositol-1,4,5-triphosphate, diacylglycerol, glycolysis, gluconeogenesis, lipolysis, beta-oxidation, ketogenesis.*

12. **Radicals, antioxidants**: oxygen radicals - classification, formation in biological systems, role of xanthine oxidase, cytochrome P-450, leukocytes; biological effect; lipid peroxidation; antioxidants - uric acid; GSH, vitamin C, vitamin E - their synergistic function; ezymatic antioxidants - superoxide dismutase, catalase, glutathione peroxidase.
    NO radical - synthesis in organism, cytotoxic function; biological action in brain.

    ***F:** uric acid, glutathione, ascorbic and dehydroascorbic acid; tocopherol, tocoquinone (only chromane skeleton), arginine.*

13. Biochemistry of liver: metabolic function of liver, liver-specific metabolic pathway; detoxification role of liver; I. phase reactions; mixed-function oxidase (=monoxygenase) system; cytochrome P-450 - structure, function, mechanism of action; II.phase reactions - conjugation with glucuronic and sulphuric acids, conjugation with amino acids and glutathione; detoxification of ethanol.

***F**: glucuronic acid, hippuric acid, mercapturic acid, benzpyrene, reactions of ethanol detoxication.*

14. **Biochemistry of muscle**: myosin, actin, tropomyosin, troponine - structure and function; sources of energy for contraction in muscle and myocard; creatine phosphate - structure, metabolism and its role in muscle; biochemical markers of myocardial infarction.

    ***F**: creatine phosphate, creatinine, glycine, arginine*

15. **Biochemistry of connective tissues**: composition of connective tissues; collagen - structure, biosynthesis, degradation; importance of postranslation modification for collagen function; role of ascorbic acid in collagen metabolism; cross-links in collagen structure; elastin - structure, function.
    Bones: organic and inorganic components of bones and their function; bone formation, and resorption; osteoporosis; regulation of bone metabolism; Vitamin D metabolism.

    ***F**: hydroxyproline, hydroxylysine, hydroxylation reactions in collagen metabolism.*
    hydroxyapatite, fluoroapatite

16. **Overview of metabolism** in cells and tissues: metabolic pathways localized in mitochondria and cytosol; metabolic pathways characteristic for liver, muscle, brain, adipose tissue, blood cells.