Study program: Integrative academic studies in Medicine

Course title: Medical Biochemistry

Teacher: Ljiljana N. Andrijević, Karmen M. Stankov, Tatjana N. Ćebović**,** Jasmina N. Katanić

Course status: compulsory

ECTS Credits: 13

Condition: Biology and Human Genetics; Chemistry in Medicine

Course aim:
To gain knowledge about the structure and function of basic biomolecules, the metabolic pathways, the specificities of the metabolism of organs and tissues, as well as mechanisms of the regulation of metabolism. Acquiring the necessary knowledge for better understanding of biochemical-physiological and pathological processes in the organism. In addition, to provide an overview of the basic biochemical methods used in clinical biochemistry as diagnostic tools and thus to prepare future physicians to properly use and interpret these methods and the results obtained.

Expected outcome of the course:
Knowledge of basic constituents of the body. Knowledge of common biochemical pathways, bioenergetics, regulatory mechanisms and its importance for the normal metabolism. Knowledge of biological processes on the molecular level and understanding the basics of the diseases. Knowledge of the specific biochemical processes in various tissue-types and organs. Proper sampling of biologic material for biochemical tests. Evaluation of the reliability of biochemical methods and their use in the diagnostic procedure Use of results of biochemical analyses in diagnostic procedure. Functional examination of metabolisms based on the analysis of the biological specimens.

Course description
Theoretical education
1. Introduction. Bioelements and biomolecules. Energy. Chemical reactions within cells. 2. Water as biological solvent and biomolecule. 3. Amino acids. Peptides. 4. Proteins – structure, physical and chemical properties, classification. 5. Fibrillary proteins – keratin and collagen, structure and function. 6. Haemoproteins – structure and function of haemoglobin and myoglobin, cytochromes, non-porphyrin metalloproteins. 7. Nucleic acids – general structure. Structure and properties of DNA. Structures, types and functions of RNA. 8. Carbohydrates – mono-, di- and oligosaccharides, polysaccharides, glycosaminoglycans. 9. Lipids – fatty acids, alcohols, simple and complex lipids, properties. Phospho-, glycero-, and sphingolipids; biological membranes. 10. Glyco-, lipo-, and phosphoproteins. 11. Enzymes – structure, properties, mechanism of catalysis, classification. Enzymatic reaction kinetics. Factors influencing enzymatic kinetics, activation and inhibition. Isoenzymes, diagnostic importance of enzymes in practical medicine. Coenzymes and vitamins. 12. Bioenergetics – thermodynamics, exergonic and endergonic reactions. Energy rich chemical bonds. Biological oxidation. Electron transport system of mitochondria, ATP synthesis. 13. Biochemistry of oxidative stress. Antioxidative mechanisms. 14. Metabolic pathways. Catabolism, anabolism. Regulation of metabolism. 15. Digestion and absorption of carbohydrates. Catabolism of carbohydrates – glycogen catabolism, glycogenolysis. Glycolysis: process, energy balance, regulation. Oxidative decarboxylation of pyruvate. The Krebs cycle of citric acid: process, energy balance, regulation. Pentose phosphate pathway – process and importance. Catabolism of other hexoses. Anabolism of carbohydrates – gluconeogenesis: process, energy balance, regulation. 16. Digestion and absorption of lipids. Lipoprotein metabolism. Catabolism of lipids – beta-oxidation of fatty acids, regulation. Catabolism of triglycerides, phospho-, and sphingolipids, cholesterol. Ketogenesis. Anabolism of lipids – biosynthesis of fatty acids: process and regulation. Biosynthesis of triglycerides, phospho-, and sphingolipids. Biosynthesis of cholesterol. 17. Digestion of proteins and absorption of amino acids. Metabolism of amino acids. Deamination, transamination. Ureagenesis. 18. Biosynthesis of nucleotides. Breakdown of nucleic acids. Biosynthesis of heme. 19. Molecular basis of heredity – DNA. Synthesis of DNA – replication. Synthesis of RNA – transcription. Synthesis of proteins – translation and processing. 20. Restrictive endonucleases. Vectors and cloning. Identification and isolation of genes (Blot). cDNA library. Polymerase chain reaction – PCR. 21. Cell cycle, oncogenes, growth factors, carcinogenesis. 22. Signaling molecules, mechanism of signal transduction. 23. Biochemistry of the eye. Biochemistry of nervous tissue – general metabolism, transduction of nerve impulses. 24. Water and electrolytes – distribution and metabolism of water, transport of electrolytes via the cell membrane, acid-base balance, mineral metabolism. 25. Biochemistry of the blood – blood plasma, blood clotting, biochemistry of red blood cell. 26. Biochemistry of connective tissue. 27. Biochemistry of bones. 28. Central position of the liver, metabolism of glycogen, gluconeogenesis, ureagenesis. Metabolism of bilirubin, mechanisms of detoxification. 29. Hormones - classification, mechanism of action. Hormones of thyroid gland. Parathyroid hormone and D-hormone. Hormones of the adrenal medulla: adrenalin, noradrenalin, dopamine. Hormones of the pancreas. Hormones of the

adrenal cortex: gluco-, and mineralocorticoids. Hormones of adeno- and neurohypophysis. Hormones of the gonads: oestrogens, progesterone, testosterone. Hormones of gastro-intestinal system. Hormones of the fatty tissue. 30. Prostaglandins, thromboxane and leukotrienes. 31. Biochemical basis of the immunological defence. 32. Molecular mechanisms of muscular contraction. 33. Biochemistry of the kidneys.

Practical education

1. Measurements in medical biochemistry – review. Calculation of the reference values, precision and accuracy of measurement. 2. Photometry – principles of the Lambert-Beer law. Absorbance (extinction) and molar extinction coefficient. Blank and the standard solution. Colorimeter and spectrophotometer. The absorption spectrum. Application of photometry. Colorimetric determination concentration via molar extinction coefficient, standard solution and calibration curve. Determination of the proportionality factor. 3. Quantitative determination of blood plasma protein concentration – methodology review. Quantitative determination of total blood plasma protein concentration. Determination of serum albumin concentration. 4. Serum protein fractions. Albumin/Globulin index. Plasma fibrinogen isolation. 5. SEMINAR: Enzymology. Qualitative assessment of enzymatic activity of α-amylase from saliva. 6. Principles of quantitative determination of enzymatic activity. Determination of the initial velocity of the enzymatic reaction. Determination of the Michaelis constant 7. Determination of the molar extinction coefficient of NADH coenzyme. UV test. Measurement of the enzymatic activity in serum. 8. Isoenzymes – definition, characteristics, diagnostic importance of isoenzyme profile. 9. SEMINAR: Vitamins and coenzymes. Quantitative determination of vitamin C in urine. 10. Metabolism of carbohydrates. Metabolism of glucose. Quantitative determination of blood glucose concentration – methodology review. Quantitative determination of serum glucose concentration. 11. Polarimetry – the principle of Biot law. The specific rotation. Determination of specific rotation of glucose. Quantitative determination of glucose in urine by polarimetry. 12. Metabolism of lipoproteins. Quantitative determination of serum cholesterol and triglyceride concentration. 13. Metabolism of proteins. Amino acid metabolism. Ureogenesis. Quantitative determination of serum urea concentration. 14. Metabolism of nucleic acid. The metabolism of purine and pyrimidine nucleotides. Quantitative determination of uric acid in serum. 15. Quantitative determination of DNA and RNA. 16. SEMINAR: Molecular biology. Recombinant DNA technology. 17. Metabolism of minerals. Metabolism of calcium. Quantitative determination of total calcium in blood plasma. 18. Metabolism of magnesium and inorganic phosphate. Quantitative determination of magnesium and inorganic phosphate in plasma. 19. Metabolism of minerals. Metabolism of iron. Quantitative determination of iron and iron binding capacity in serum. Quantitative determination of haemoglobin. 20. Biochemistry of liver. Metabolism of bilirubin. Qualitative determination of direct and indirect bilirubin in serum. Quantitative determination of serum bilirubin concentration. Qualitative analysis of bilirubin, urobilinogen and urobilin in urine. 21. Biochemistry of kidneys. Quantitative determination of creatinine. 22. Ion-exchange chromatography of amino acids..

Literature

Compulsory

1. Lieberman M, Marx A. Marks' Basic Medical Biochemistry – A Clinical Approach, 4th Edition. Wolters Kluwer Health, 2013.
2. Harvey R, Ferrier D. Lippincott's Illustrated Reviews: Biochemistry, 5th Edition. Wolters Kluwer Health, 2011.
3. Rodwell A, et al. Harper's Illustrated Biochemistry, 30th Edition. The McGraw-Hill Education, 2015.
4. Kovačević Z, Milošević Tošić M. Practical Biochemistry And Molecular Biology, Novi Sad, 2001..

Number of active classes	**Theoretical classes:** 90	**Practical classes:** 90

Teaching methods Oral presentations for small group of students using multi-medial didactic tools. Control of knowledge by the use of tests with multiple choice questions. Practical work in independent execution of biochemical tests and interpretation of the obtained results.

Student activity assessment (maximally 100 points)

Pre-exam activities	**points**	**Final exam**	**points**
Lectures	8	Written	-
Practices	12	Practical	15
Colloquium	25	Oral	40
Essay	-		