Study program: Pharmacy

Type and level of the study program: Integrative academic studies

Course title: Medical Biochemistry (PhIII-MBCH)

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Course status: Compulsory

ECTS Credits: 8

Condition: General biochemistry

Course aim The aim of this course is to fit the students with biochemical knowledge necessary for better understanding of pathologic processes and the mechanisms of action of drugs in the body. Also, to offer to the students an overview of basic biochemical tests used in clinical biochemistry as diagnostic tools and appropriate interpretation of obtained results.

Expected outcome of the course: Knowledge about specific biochemical processes occurring in several tissues and organs, and their importance for the function of the organism as a whole. Knowledge about biochemical basis of functional exploration of several organs. Proper sampling of biologic material for biochemical tests. The proper use of analytical methods and devices in biochemical laboratory, as so as their results in the diagnostic algorithm. Measuring units, normal and reference ranges of the results. Functional examination of metabolisms of several body components on the basis of their estimation in the biological samples.

Course description

Theoretical education

1. Introduction to medical biochemistry. 2. Digestion and absorption of carbohydrates. General metabolic pathways in carbohydrate metabolism. Liver and muscles in glucose metabolism. 3. The regulation of blood glucose level. Hormones in carbohydrates metabolism. Insulin, IGF1 and IGF2. Glucagon, corticosteroids, somatostatin, adrenalin, T-3, T-4, somatotropin. 4. Diabetes mellitus, classification, glucose intolerance, metabolic consequences of reduced action of insulin. Acute and chronic complications of diabetes mellitus. 5. Digestion and absorption of proteins. General metabolic pathways of proteins, nitrogen balance, role of hormones in the metabolism of proteins. 6. Total plasma proteins, hypo-, and hyperproteinaemia, immunoglobulins – the structure and disturbances. Proteinuria, types of proteinuria. Primary and secondary disorders of protein metabolism. 7. Digestion and absorption of lipids, fatty acids, transportation, breakdown and ketogenesis. Metabolism of triacylglycerols and phospholipids. 8. Metabolism of cholesterol. Apolipoproteins, classification and composition of lipoproteins. Transport of lipids. 9. A role of liver and adipose tissue in lipid metabolism. Disturbances in lipoprotein metabolism. 10. A role of water in human organism, volume and distribution between body compartments. Isovolemia, isotonia, isoionia and isohydria. Metabolism and distribution of water, control of renal excretion of water, osmo- and volume- receptors, ADH, renal response and aldosterone. Mechanism of action of ADH, aquaporins. 11. Disturbances in water metabolism, dehydration, deficiency of water and sodium, dehydration. Hyperhydration, excess of water and sodium, biochemical aspects of hyperhydration. 12. Sodium ingestion and excretion, distribution of sodium between body fluids. Regulation of sodium in extracellular fluid. Renal control of sodium excretion. System renin-angiotensin-aldosterone. Natriuretic hormones. Disturbances of sodium metabolism. Sodium depletion in the body. Excess of sodium in the body with and without oedema and hypernatremia. 13 Potassium, ingestion and excretion, distribution of potassium in the body fluids. Renal and extrarenal control of potassium excretion. Disturbances in potassium metabolism, excess and deficiency of potassium. 14. Chlorides, ingestion and excretion, regulation. Disturbances in chloride metabolism – hypochloraemia and hypochloraemia. 15. General characteristics of body fluids, electrolyte contents in the body fluids, buffer systems and their role in the regulation of pH. Henderson-Hasselbalch equation. 16. Gasses in blood, bicarbonate and phosphate buffer, plasma proteins and haemoglobin buffer systems. The role of respiratory system in the regulation of pH, elimination of CO_2 from tissues and lung. Isohydric and chloride shift. The role of kidneys in the regulation of pH, elimination of acids, exchange of hydrogen and sodium ions, ammonia excretion, reabsorption of bicarbonates. 17. Disturbances in acid-base balance. Acid-base balance parameters – definitions. Metabolic and respiratory acidosis, compensatory mechanisms. 18. Factors which influence the plasma enzyme level. Release of enzymes from the cells, the entrance of enzymes into the bloodstream. Decrease in enzyme level as a consequence of reduced synthesis. 19. The profile of enzyme concentration in serum in various diseases, choice of test. Isoenzymes, enzymopathies. 20. The profile of enzymes in serum following myocardial infarction, liver diseases and pathological conditions of bones, muscles, pancreas and prostate. 21. Role of calcium in the body. Intracellular and extracellular calcium. Ingestion and excretion of calcium. Absorption of calcium in the intestines. Reabsorption and excretion of calcium in the kidneys. Role of bones in the maintenance of calcium equilibrium. Regulation of calcium metabolism. Parathyroid hormone, calcitonin and D – hormone. Their roles in the regulation of the calcium concentration and inorganic phosphate in the plasma. Hyper and hypocalcaemia, causes and consequences, ionised calcium. 22. Inorganic phosphate, hyper-, and hypophosphatemia. Magnesium and regulation of magnesium metabolism, hyper-, and hypomagnesaemia. 23. Physiologic role of iron. Ingestion and excretion of iron. Transportation and deposition of iron, ferritin, hemosiderin. Serum level of iron, TIBC and UIBC, disturbances in iron metabolism. 24. Structure of normal haemoglobin. Function of haemoglobin. Changes of haemoglobin structure at oxygenation and deoxygenation. Structure of haemoglobin variants. Thalassemia. Classification of the structural variants of haemoglobin. 25. The examination of the liver function. The examination of excretory function of liver for exogenous and endogenous molecules. Examination of metabolic function of liver metabolism of proteins, carbohydrates and lipids. Examination of function of reticuloendothelial system. Biochemical aspects of liver disease. Icterus and biochemical aspects of alcoholism. 26. The examination of kidney function, examination of glomerular function, renal and extrarenal azotaemia. Urea, uric acid, creatine. Primary and secondary hyperuricemia. Clearence – the principle, clearence of creatinine. The examination of tubular function, tubular reabsorption, tests for tubular reabsorption. Exploration of urine (urinary syndrome). Physical examination of urine, chemical examination, microscopic examination of urine.

Practical education: exercises, other forms of education, research related activities

1. Measurements in medical biochemistry – review. Calculation of the reference values, precision and accuracy of measurement.

Photometry – principles of the Lambert-Beer law. Absorbance (extinction) and molar extinction coefficient. Blank and the standard solution. Standard and construction of the calibration curve. Application of photometry. Colorimetric determination of bromothymol blue concentration by the molar extinction coefficient, by the standard solution and by the construction of the calibration curve. 2. Quantitative determination of blood glucose concentration – methodology review. Quantitative determination of blood glucose concentration using o-toluidine and GOD-PAP method. 3. Quantitative determination of blood plasma protein concentration – methodology review. Quantitative determination of blood plasma protein concentration using biuret test. Determination of serum protein concentration and of A/G index – methodology review.
4. Metabolism of proteins. Amino acid metabolism. Ureogenesis. Quantitative determination of urea in plasma using Berthelot method. 5. Metabolism of lipids. Metabolism of cholesterol and lipoproteins. Quantitative determination of plasma cholesterol and triglyceride levels by CHOD – PAP and GPO-PAP method, respectively. 6. Qualitative assessment of enzymatic activity – methodology review. Determination of activity of alkaline phosphatase in serum. 7. Determination of enzymatic activity of LDH, ALT, AST and CK in serum. 8. Metabolism of minerals. Metabolism of sodium, potassium and chloride. Quantitative determination of chloride concentration in plasma. 9. Metabolism of minerals. Metabolism of calcium. Quantitative determination of total and ionic calcium in plasma. 10. Metabolism of minerals. Metabolism of phosphates and magnesium. Quantitative determination of inorganic phosphates and magnesium in plasma. 11. Metabolism of iron and haemoglobin. Quantitative determination of iron and iron binding capacity in serum. Quantitative determination of haemoglobin. 12. Quantitative analyses of bile pigments. The significance of bile pigment metabolism. Qualitative determination of direct and indirect bilirubin in serum. Determination of bilirubin, urobilinogen and urobilin in urine. Quantitative determination of bilirubin in serum. 13. Quantitative determination of uric acid in plasma using alkaline phosphowolframate. Quantitative determination of creatinine using Jaffe's reaction. 14. Physico-chemical examination of urine, microscopic examination of urine sediment.

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.

Number of active classes				Other:
Lectures:	Practice:	Other types of teaching:	Research related activities:	-
45	45	-	-	

Teaching methods: oral presentations for small group of students using multimedial 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	5
Colloquium	50	Oral	25
Essay	-		