Azerbaijan Medical University
Training program
(syllabus) on the subject
Biological Chemistry-2

"Confirmed" by
Head of Biological Chemistry
Department,
Prof. Azizova G.I.

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SYLLABUS

ACADEMIC DAILY CALENDAR ON MEDİCAL BIOCHEMISTRY-2 LECTURE AND LABORATORY LESSONS. LABORATORY CLASSES, COLLOQUIUMS AND EXAM QUESTIONS

Subject code:	2406.02
Subject teaching semester:	V (Medical faculty – 050904)
Subject credits:	5
Subject type:	Compulsory
Teaching language:	Azerbaijani, Russian, English
Teachers on the subject:	The teaching staff of the Biological Chemistry Department
Department contact number	(012)440 80 77
E.mail:	biochemistry@amu.edu.az

BAKU – 2022

The program developed by assoc. prof. Amirova M.F., senior theacher: Dadashova A.R., Dashdamirova G.S., under edition head of the Biological Chemistry department prof. Azizova G.I.

Evaluation method	Score (points)
Exam (final)	50
Ongoing assessment (1st colloquium)	5
Ongoing assessment (2nd colloquium)	20
Ongoing assessment (3rd colloquium)	5
Assessment for class attendance	10
Free topics (students' project presented in a group)	10
Totally	100

Student knowledge assessment based on the sum of the cumulative grade, midterm grade and a grade received on the exam		
less than 51 points	unsatisfactory grade (failed)	F
51-60 points	marginal grade	E
61-70 points	satisfactory score	D
71-80	good score	C
81-90	Very good score	B
91-100	Excellent score	A

Study-load in semester			
Activity	Amount	Duration (hours)	Total working hours
Ongoing assessment (colloquium)	3	2	6
Semester exam	1	1	1
Lectures	10	2	20
Laboratory (practical exercises)	25	2	50
Self-training			73
Total working hours			150

Thematic plan of laboratory classes on Medical biochemistry-2 for II year students of Medical faculty in the 2021/2022 academic year spring term

№	Lesson's topic	Biochem.lab. manual theory & meth., 2019
1.	***Introduction to the dynamic biochemistry program. General laws of metabolism – 2 h.***	**Teacher, text-book**
2.	***General laws of metabolism.*** General and specific stages of catabolism. I and II general pathways of catabolism ***– 2 h.*** ***Lab. work:*** Determination of pyruvic acid in the blood. Determination of Succinate Dehydrogenase activity.	156-158
3.	***Biological oxidation.*** Electron transport chain. Oxidative phosphorylation ***– 2 h.***	theoretical material
4.	***Biological oxidation.*** Peroxidase, oxygenase reactions. Body antioxidant system ***– 2 h.*** ***Lab. work:*** Qualitative and quantitative analysis of catalase.	121-122
5.	***Carbohydrate metabolism:*** digestion, transport of monosaccharides through membranes. Glycogen metabolism, process regulation ***– 2 h.*** ***Lab. work:*** Determination of glucose in blood by glucose oxidase method.	145
6.	***Carbohydrate metabolism:*** glycolysis, its types, energetic value, regulation. Interaction gluconeogenesis-glycolysis, regulation of these processes***– 2 h.***	theoretical material
7.	***Carbohydrate metabolism:*** pentose phosphate pathway of glucose breakdown, its significance. Carbohydrate metabolism regulation ***– 2 h.*** ***Lab. work:*** The glucose tolerance test.	146
8.	***Carbohydrate metabolism. Synthesis of oligosaccharides in the body. Features of fructose and galactose metabolism.***	theoretical material

	Assessment of the learning mastery based on situational tasks and tests – 2 h.	
9.	***Carbohydrate metabolism disorders:*** hereditary and acquired. Diabetes mellitus. Glycogenoses and glycosidoses ***– 2 h.*** ***Lab. work:*** Significance of glycosylated hemoglobin definition.	148
10.	***Colloquium: Metabolism of the major body constituents and energy. Carbohydrate metabolism. Acceptance of independent works – 2 h.***	**textbook and practice book on questions**
11.	***Protein metabolism:*** digestion, absorption, decay of proteins. İndigestion, malabsorption syndrome – ***2 h.*** ***Lab. work:*** Qualitative and quantitative analysis of gastric juice. Digestion of proteins with pepsin and trypsin.	52-57
12.	***Protein metabolism:*** nitrogen balance. Sources of amino acid pool and the main ways of its usage. General ways of amino acid metabolism – ***2 h.*** ***Lab. work:*** Diagnostic significance of ALT and AST activity definition.	283
13.	***Protein metabolism:*** formation, toxic effects and neutralization of ammonia. Ketogenic and glycogenic amino acids. Biosynthesis of non-essential amino acids – ***2 h.*** ***Lab. work:*** Aminasiduria test. Definition of urea in the blood.	259
14.	***Protein metabolism: specific ways of aliphatic amino acids metabolism (gly, ser, tre, ala, arg, lys, met, cys) – 2 h.***	theoretical material
15.	***Protein metabolism: specific ways of dicarboxylic, aromatic and heterocyclic amino acids metabolism (glu, asp, phe, tyr, tri, his) – 2 h.***	theoretical material
16.	***Nucleoprotein metabolism:*** digestion. ***Purine nucleotide metabolism:*** synthesis and catabolism. Disorders of purine nucleotide metabolism – ***2 h.*** ***Lab. work:*** Definition of uric acid in the blood.	264

17.	***Catabolism and biosynthesis of pyrimidine nucleotides. Disorders of pyrimidine nucleotide metabolism. Carbohydrate metabolism– 2 h.***	
18.	***Metabolism of hemoproteins: biosynthesis of hemoglobin and its regulation. Porphyria types. Iron metabolism – 2 h.*** ***Lab. work:*** Definition of hemoglobin in the blood.	67
19.	***Decomposition of hemoglobin. Jaundice – 2 h.*** ***Lab. work:*** Definition of bilirubin in the blood.	280
20.	***Mid-term assessment. Main compounds and energy metabolism.*** ***Metabolism of carbohydrates and proteins – 2 h.***	**textbook and practice book on questions**
21.	***Lipid metabolism:*** digestion, absorption, resynthesis and transport to tissues. Metabolism of bile acids. Disorders of lipid digestion, intestinal absorption and transport ***– 2 h.*** ***Lab. work:*** Definition of bile acids.	87
22.	***Lipid metabolism: intracellular lipolysis. Types of fatty acid catabolism: α-, β- and ω-oxidation. β-oxidation of fatty acids (saturated, unsaturated and odd-chain). Energetic value of process. Glycerin metabolism – 2 h.***	nəzəri material
23.	***Lipid metabolism:*** biosynthesis of fatty acids. Biosynthesis of unsaturated fatty acids. Biosynthesis of triacylglycerols and phospholipids. Lipotropic factors ***– 2 h.*** ***Lab. work:*** Definition of triacylglycerols in the blood.	96
24.	***Lipid metabolism:*** cholesterol biosynthesis. Types of blood lipoproteins, metabolic features ***– 2 h.*** ***Lab. work:*** Definition of cholesterol.	106
25.	***Colloquium: Lipid metabolism - 2 h.*** ***Acceptance of independent works***	***textbook and practice book on questions***
26.	***Functional biochemistry of blood and liver – 2 h.*** ***Lab. work:*** Definition of total protein in the blood.	64
27.	***Functional biochemistry of kidneys, muscles and nerve tissue – 2 h.*** ***Lab. work:*** Analysis of normal and pathological urine.	230-244

28.	***The final lesson. Assessment of the learning mastery on the basis of situational tasks and tests. Acceptance of independent works – 2 h.***	**suallar üzrə dərslik və prakt.**

Totally: 56 hours

Thematic plan of lectures on* Medical biochemistry-2 *for II year students of Medical facultiy in the spring semester of 2021/2022 academic year

№	Lecture's topic	Hours
1.	The general principles of main body compounds and energy metabolism. General pathways of catabolism, their energetic significance. The biological oxidation types. ETC. ATP synthesis ways: oxidative phosphorylation, ATP synthase and substrate-level phosphorylation.	2
2.	Carbohydrate metabolism: digestion, absorption. Diagnostic value of the sugar load test. Glycolysis and gluconeogenesis, the relationship and biochemical features of these processes. Cori cycle. Fructose and galactose metabolic pathways.	2
3.	Glycogen metabolism. Pentose phosphate pathway of glucose breakdown. The other possible fates of glucose in the body. Mechanisms for blood sugar control; hypo- and hyperglycemia. Diabetes mellitus. Glycosylated hemoglobin**.** Inherited and acquired disorders of carbohydrate metabolism.	2
4.	Significance of dietary proteins: their biological value, digestion, absorption. Malabsorption syndrome. General pathways of amino acid metabolism in tissues. Hyperammonemia.	2
5.	Formation of ammonia, its impact on the body and ways of neutralization. Biosynthesis of non-essential amino acids.	2
6.	Metabolic features of some amino acids (glycine, serine, sulfur-containing, dicarboxylic, aromatic amino acids). Inherited and acquired disorders of amino acid metabolism. Nucleic acids digestion and metabolism. Digestion and metabo-	2

	lism of purine and pyrimidine nucleotides. Hyperuricemia, causes, manifestations.	
7.	Lipid metabolism: digestion, absorption, re-synthesis in the intestine. Metabolism of fatty acids; fatty acid oxidation types, their significance.	2
8.	Ways of acetyl-CoA usage: metabolism of ketone bodies, biosynthesis of fatty acids. Features of cholesterol metabolism, its stages; derivatives of cholesterol. Atherosclerosis, gallstone disease.	2
9.	Biosynthesis of lipids (triacylglycerols, phospho- and sphingolipids) in the tissues. Transport of lipids in the blood: lipoproteins, the role of apoproteıns ın their metabolısm. Mechanisms of lipid metabolism regulation. Obesity. Liver fatty distrophy. Hereditary lipidoses.	2
10.	Blood biochemistry: biosynthesis of hemoglobin. Stages of toxins detoxification in the liver. Breakdown of hemoglobin. Jaundice. the role of the kidneys in maintaining acid-base balance.	2

Totally: 20 hours

COLLOQUİUM QUESTIONS ON MEDİCAL BIOCHEMISTRY-2

Metabolism of the major body constituents and energy. Biological oxidation. The general stages of catabolism. Carbohydrate metabolism

1. General laws of metabolism. Specific and general pathways of catabolism of main nutrients. The first general pathway of catabolism and its energetic value.
2. Second general pathway of catabolism: sequential reactions, main substrates and energetic value.
3. Biological oxidation and tissue respiration. Oxidase reactions (for energy production), enzymes involved in process. Function of electron transfer chain, its structure, sequential localization of its com-

ponents according to their redox potential. Transfer of electrons and protons to oxygen (scheme).

4. Oxidative phosphorylation. P/O coefficient. Modern theory of oxidative phosphorylation mechanism (Mitchell's theory). Mechanism of proton potential formation in the mitochondrial inner membrane, H^+-ATP-synthase and ADP-ATP-translocase, their structure, localization and functions.
5. Tissue respiration and regulation of oxidative phosphorylation: respiratory control. Regulation of heat generation in the body (muscle shivering, free oxidation, brown adipose tissue). Uncouplers of oxidative phosphorylation. Hypoenergetic conditions.
6. Oxygenase reactions. Mono- and dioxygenases. Microsomal oxidation, microsomal chain, its components, significance. Cytochrome P_{450}, its role in the oxidation of exogenous and endogenous substrates.
7. Peroxidase reactions, their significance. Free radical oxidation. Active oxygen species (superoxide anion, hydroxyl radical, singlet oxygen). Lipid peroxidation. Formation of malondialdehyde, epoxides, ketones, lipoperoxides. Prooxidants.
8. Antioxidants. Protection of the organism from the oxygen active species toxic effects. Enzymes, vitamins and vitamin-like substances with antioxidant properties.
9. Carbohydrates digestion: dietary carbohydrates, and saliva, pancreas and intestinal juice amylolytic enzymes that digest them. Transport of monosaccharides across the membranes, their absorption and transformation in the tissues.
10. Glycogen metabolism. Regulation of glycogenesis and glycogenolysis.
11. Sequential reactions of the glycolysis and its biological significance. Glycolysis oxidation-reduction reaction. Entry of fructose and galactose into glycolysis.
12. Aerobic breakdown of carbohydrates, bioenergetic value.
13. Gluconeogenesis (scheme). Substrates of the process. Cori cycle.
14. Sequential reactions of pentose phosphate pathway (apotomic oxidation) of carbohydrates and biological significance of this process.

15. Glycoconjugates, types: biosynthesis of oligosaccharides in the body.
16. Regulation of carbohydrate metabolism. Hyper- and hypoglycemia, glucosuria. Diabetes mellitus: causes, manifestations, biochemical mechanism in the development of complications.
17. Inherited and acquired disorders of intermediary carbohydrate metabolism: fructosuria, fructose intolerance, galactosemia, glycogen storage diseases, mucopolysaccharidoses.
18. Metabolism of ethyl alcohol in the human body.

Metabolism of proteins and nucleic acids

1. Biological value of dietary proteins. Nitrogen balance. Sources and fate of amino acid pool. Proteinases that break down tissue proteins.
2. Digestion of proteins in the stomach. Gastric juice composition: hydrochloric acid, pepsin, gastrixin.
3. Digestion of proteins in the small intestine. Pancreatic juice composition, its proteolytic enzymes - trypsin, chymotrypsin, elastase, carboxypeptidase. Proteases of intestinal juice.
4. Decay of proteins in the large intestine and neutralization of products of putrefaction. PAPS and UDPGA.
5. Intestinal absorption of proteins digestive products. Disorders of protein digestion and intestinal absorption of amino acids. Malabsorption syndrome.
6. Deamination of amino acids. Oxidative deamination.
7. Transamination of amino acids, diagnostic value of serum-transaminase activity determination. Transdeamination.
8. Decarboxylation of amino acids and neutralization of the obtained products.
9. Ways of ammonia formation, its toxic effect and neutralization. Synthesis of urea and other ways of neutralizing ammonia.
10. The fate of nitrogen-free hydrocarbon residues of amino acids. Glucogenic and ketogenic amino acids. Biosynthesis of non-essential amino acids.
11. Aliphatic amino acids (gly, ala, ser, met, cys, arg) specific pathways

of metabolism.
12. Specific pathways of metabolism glutamic and aspartic acids and their amides.
13. Specific pathways of aromatic and heterocyclic (phe, tyr, tri, his, pro) amino acids.
14. Inherited and acquired disorders of amino acid metabolism.
15. Digestion and absorption of nucleoproteins. Breakdown of nucleic acids in tissues.
16. Catabolism of purine nucleotides in the tissues.
17. Catabolism of pyrimidine nucleotides.
18. Biosynthesis of purine nucleotides.
19. Biosynthesis of pyrimidine nucleotides. Biosynthesis of deoxyribonucleotides.
20. Disorders of purine and pyrimidine nucleotide metabolism (gout, xanthinuria, Les-Nyhan syndrome, orotasiduria).

Lipid metabolism

1. Digestion of lipids: the breakdown of fats (triacylglycerols) and phospholipids in the gastrointestinal tract (GIT). Lipases and phospholipases. Bile acids, their types and significance in digestion.
2. Absorption of lipid hydrolysis products. Lipids re-synthesis in the enterocytes and transport to tissues.
3. Intracellular lipolysis. Fatty acids catabolism types. Catabolism of glycerol/
4. Fatty acids β-oxidation, reactions and energetic value. Catabolism of fatty acids with a odd number of carbon atoms.
5. Biosynthesis of fatty acids, regulation of process and its energy sources.
6. The main features of unsaturated fatty acids metabolism.
7. Synthesis of ketone bodies (ketogenesis). Breakdown of ketone bodies (ketolysis). Ketonemia and ketonuria, causes.
8. Biosynthesis of triacylglycerols and phospholipids. Lipotropic factors.
9. Synthesis of cholesterol. Diagnostic significance of blood choleste-

rol levels. Functions of blood lipoproteins, their metabolic features.
10. Neuro-endocrine regulation of lipid metabolism.
11. Disorders of lipid digestion, absorption, transport to tissues. Hyperlipidemia types. Pathology of cholesterol metabolism. Gallstone disease.
12. Liver fatty infiltration and fatty liver dystrophy. Pathology of fat depots. Inherited lipidoses.

FUNCTIONAL BIOCHEMISTRY

Functional biochemistry of blood

1. Blood functions. Metabolic features of blood cells (red blood cells, leukocytes, platelets). Synthesis of hemoglobin. Porphyria types.
2. Blood biochemical composition. Plasma and serum proteins. Blood serum enzymes.
3. Non-protein nitrogenous compounds of blood: residual nitrogen. Definition azotemia, its types.
4. Nitrogen-free organic and inorganic compounds in blood plasma. Trace elements.
5. Acid-base balance of blood. Blood buffer systems. Acidosis, alkalosis.
6. Respiratory function of blood, effect of external (environmental) and internal factors.
7. Blood clotting. Coagulation factors. Clot formation mechanism.
8. Anticoagulant system of blood. Inhibitors of blood clotting enzymes and anticoagulant system. Fibrinolysis.

Functional biochemistry of the liver

1. Morphofunctional characteristics of structure and blood supply in the liver
2. Liver role in carbohydrate metabolism.
3. The role of liver in lipid metabolism. Bile composition, general characteristics and significance.

4. Liver role in protein metabolism.
5. Stages of detoxification in the liver. Breakdown of hemoglobin: bile pigments. Formation, neutralization and excretion. Jaundice, its types.
6. Syndromes of liver damage.

Functional biochemistry of the kidney

1. Morphofunctional characteristics of the kidneys, and urine formation mechanism.
2. Features of metabolism in the kidneys.
3. The role of the kidneys in the body acid-base balance regulation.
4. General properties of urine (in norm and pathology).
5. Normal chemical compounds of urine. Diagnostic significance of creatinine definition in urine.
6. Pathological compounds of urine. Kidney stone disease.

Functional biochemistry of the nervous system

1. Lipids of nerve tissue and their metabolism.
2. The chemical composition of nerve tissue carbohydrates and their role in energy supply.
3. Chemical composition and metabolism of proteins, neuropeptides and nucleic acids in nerve tissue.
4. Biochemical mechanisms of generation and transmission of nerve impulses.
5. The role of mediators in the transmission of nerve impulses. Cholinergic and adrenergic receptors.
6. Biochemical mechanisms of memory.

Functional biochemistry of muscle tissue

1. Chemical composition of muscle tissue; muscle proteins.
2. Nitrogenous extractive compounds of muscle tissue, their biological significance. Nitrogen-free organic compounds.

3. Chemical composition of the heart and smooth muscle.
4. The main sources of energy for muscle contraction
5. Biochemical events in muscle contraction.
6. Biochemical changes in muscles in the case of disease and injury.

Functional biochemistry of connective tissue

1. An overview of connective tissue, its functions, main cells.
2. Proteins of the intercellular matrix of connective tissue: collagen, elastin.
3. Non-collagenous proteins of connective tissue.
4. Glycosaminoglycans (GAGs) and proteoglycans of connective tissue.

LABORATORY TRAINING QUESTIONS ON MEDİCAL BIOCHEMISTRY-2

LESSON II – General laws of metabolism. Specific and general pathways of catabolism. I and II general pathways of catabolism

1. Metabolism: definition, types according to living organisms, the difference and relationship between catabolism and anabolism.
2. Metabolic pathway types, their regulation.
3. Main stages of catabolism and energy formation (scheme explanation): specific and general pathways.
4. The first general pathway of catabolism. Pyruvate dehydrogenase complex, energetic value of process. Determination of pyruvic acid in the blood (lab. work).
5. Second general pathway of catabolism: write and explain scheme.
6. Reactions that provide energy in the citric acid cycle, the enzymes involved. Principle of succinate dehydrogenase determination in muscle (lab. work).

LESSON III – Electron transport chain. Oxidative phosphorylation

1. Biological oxidation. The theories of tissue respiration (modern concept).
2. Oxidase reactions: significance and enzymes involved.
3. NAD, NADP-dependent dehydrogenases, their role in metabolism and active site function.
4. Flavin dehydrogenases, their role in metabolism and active site function.
5. Ubiquinone, Iron-sulfur proteins, cytochromes, their role in oxidase reactions.
6. Structure, localization, function and main substrates of tissue respiratory chain.
7. Oxidative phosphorylation and ATP-synthase, ATP/ADP-translocase.
8. Respiratory control. Regulation of heat generation in the body.
9. Uncouplers (substances that inhibit the coupling between the electron transport and phosphorylation reactions).

LESSON IV – Peroxidase, oxygenase reactions. Antioxidant system of the body

1. Oxygen use in the body, its significance.
2. Oxygenase reactions. Microsomal oxidation. Microsomal chain and its significance.
3. Different types of biological oxidation: peroxidase reactions. Free radical radical oxidation.
4. Active oxygen species, their toxic effects. Prooxidants.
5. Antioxidant system of the body.
6. Qualitative and quantitative determination of catalase (lab. work).

LESSON V – Carbohydrate metabolism: digestion, transport of monosaccharides across cell membranes. Glycogen metabolism, its regulation

1. Carbohydrate metabolism significance for the body.

2. Digestion of carbohydrates in the oral cavity and intestine. Amylolytic enzymes of the pancreas and intestinal juice. Amylase types.
3. Different ways of monosaccharide transport across membranes. GLUT types.
4. Normoglycemia, glucose levels change. Estimation of blood glucose by glucose oxidase method.
5. Glycogen synthesis (scheme), enzymes involved.
6. Glycogen breakdown (scheme). Phosphorylase activation.
7. Regulation of glycogen metabolism.

LESSON VI – Carbohydrate metabolism: glycolysis, its types, regulation and energetic value (ATPs produced). Glycolysis- gluconeogenesis interaction

1. Glycolysis. Preparatory stage reactions, enzymes involved. Isoenzymes of hexokinase, their role in metabolism. Significance of the process.
2. Redox (oxidation-reduction) reaction in glycolysis (scheme), enzymes involved, energetic value (ATP produced).
3. Aerobic glycolysis (scheme), its steps, energetic value (ATP produced).
4. Entry of fructose and galactose into glycolysis.
5. Shunt mechanisms: malate-aspartate, lactate shuttle, glycerol phosphate shunt mechanisms.
6. Gluconeogenesis scheme, its substrates and 3 by-pass (irreversible) stages.
7. Gluconeogenesis-glycolysis interaction: Cori cycle.
8. Regulation of glycolysis and gluconeogenesis.

LESSON VII – Carbohydrate metabolism: glucose breakdown via pentose phosphate pathway, its significance. Carbohydrate metabolism regulation

1. Pentose phosphate pathway of glucose breakdown: oxidative stage (scheme) and its significance.

2. Pentose phosphate pathway of glucose breakdown: non-oxidative stage (scheme), the enzymes involved and its significance.
3. Significance of pentose phosphate pathway for red blood cells, the cause of hemolytic anemia.
4. Regulation of carbohydrate metabolism. Insulin action mechanism.
5. Glucose tolerance test. Sugar curves in diagnostics.
6. Hypo-, hyperglycemia, types, causes, glucosuria.

LESSON VIII – Synthesis of oligosaccharides in the body. Metabolic properties of fructose and galactose

1. Synthesis of lactose in the human body.
2. Features of fructose metabolism.
3. Features of galactose metabolism.
4. Glucose role in the antitoxic function of the liver.

LESSON IX – Carbohydrate metabolism disorders: inherited and acquired. Diabetes mellitus. Glycogenoses and mucopolysaccharidoses

1. Hereditary disorders of carbohydrate metabolism: inherited disorders of fructose and galactose metabolism.
2. Acquired disorders of carbohydrate metabolism.
3. Diabetes mellitus: types, manifestations and biochemical mechanism in the complications development.
4. Significance of blood glycosylated hemoglobin determining (lab. work).
5. Glycogenoses, types, manifestations.
6. Mucopolysaccharidoses.

LESSON XI – Protein metabolism: digestion, absorption of proteins, decay. Indigestion, malabsorption syndrome

1. Significance of protein metabolism in the body.
2. Digestion of proteins in the stomach: gastric juice enzymes, their

activation and specificity. Digestion of proteins by pepsin (lab. work).
3. Normal gastric juice composition. HCI formation mechanism, its role in digestion. Determination and characterization of HCI (lab. work).
4. Total acidity of gastric juice and its changes in various diseases.
5. Analysis of gastric juice (by Michaelis method): determining of total acidity and free HCI (lab. work).
6. Diagnostic value of gastric juice pathological components (such as blood and lactic acid) assay (lab. work).
7. Pancreatic juice proteolytic enzymes: activation and action mechanism of trypsinogen and other endopeptidases. Digestion of proteins by trypsin (lab. work).
8. Exopeptidases of the pancreas and intestinal juice, their action.
9. Amino acids absorption in intestine.
10. Significance of protein decay of in the large intestine.
11. Formation and neutralization of toxic substances (poisons: cresol, phenol, skatol, indole, etc.). PAPS and UDPGA.
12. Disorders of protein digestion and intestinal absorption of amino acids. Malabsorption syndrome.

LESSON XII – Protein metabolism: nitrogen balance. The main sources and ways of amino acids using. General ways of amino acid metabolism

1. Indicator that determine the protein metabolism status: nitrogen balance, its types.
2. The main sources and ways of amino acid using in the cell.
3. General ways of amino acid metabolism. Deamination types, biochemical mechanism of process.
4. Transamination. Enzymes and coenzymes involved in the process. Transdeamination.
5. Clinical significance of determining the transaminases activity in the blood. The principle of determining the activity of AlT and AsT in the blood (lab. work).

6. Decarboxylation. Formation and neutralization of biogenic amines.

LESSON XIII – Protein metabolism: formation of ammonia, ammonia toxic effect and neutralization. Ketogenic and glucogenic amino acids. Biosynthesis of non-essential amino acids

1. Ways of ammonia formation in tissues. Ammonia toxicity.
2. Rapid temporary neutralization of ammonia: synthesis of glutamine, asparagine and alanine. Reductive amination
3. Ultimate neutralization of ammonia: formation of urea in the ornithic cycle; intermediate stages and enzymes involved in this process. Ammonium salts formation.
4. Urea level in the blood, its variations in norm and pathological conditions. The principle of urea estimation in the blood by diacetylmonoxime assay (lab. work).
5. The fate of nitrogen-free amino acid carbon skeletons: glycogenic and ketogenic amino acids. Biosynthesis of non-essential amino acids.

LESSON XIV – Protein metabolism: specific ways of aliphatic amino acids (gly, ser, thr, ala, arg, lys, met, cys)

1. Feature of glycine and alanine metabolism
2. Feature of serine and threonine metabolism.
3. Feature of arginine and lysine metabolism.
4. Feature of sulfur-containing amino acids metabolism.
5. Acquired disorders of amino acid metabolism. Causes of hyperaminoacidemia and aminoasiduria. Aminoasiduria urine test.

LESSON XV – Protein metabolism: specific ways of dicarboxylic, aromatic and heterocyclic (glu, asp, phe, tyr, tri, his) amino acids metabolism

1. Feature of monoamino dicarboxylic acids and their amides metabolism.

2. Feature of tryptophan metabolism.
3. Inherited disorder of tryptophan metabolism.
4. Feature of phenylalanine and tyrosine metabolism.
5. Hereditary disorders of amino acid metabolism: pathology of phenylalanine and tyrosine metabolism. Phenylketonuria, alkaptonuria, tyrosinemia, albinism.
6. Feature of histidine metabolism.

LESSON XVI – Nucleoprotein metabolism: digestion. Metabolism of purine nucleotides: their synthesis and catabolism. Disorders of purine nucleotide metabolism

1. Digestion of nucleic acids in the gastrointestinal tract, the fate of digestion products.
2. Decomposition of purine nucleotides (scheme).
3. Determnation and diagnostic value of uric acid level estimation in blood serum (principle of lab. work). Gout.
4. Synthesis of purine nucleotides (de novo): stages and regulation of process (scheme).
5. Disorders of purine nucleotide metabolism: Lesch-Nyhan syndrome, xanthinuria

LESSON XVII – Catabolism and biosynthesis of pyrimidine nucleotides. Disorders of pyrimidine nucleotide metabolism

1. Catabolism of pyrimidine nucleotides (scheme).
2. Synthesis of pyrimidine nucleotides (scheme).
3. Orotic asiduria.
4. Synthesis of deoxyribonucleotides.

LESSON XVIII – Hemoproteins metabolism: biosynthesis of hemoglobin, regulation of this process. Porphyria types. Iron metabolism

1. Digestion of chromoproteins in the gastrointestinal tract.

2. Iron metabolism in the body.
3. Hemoglobin biosynthesis (scheme).
4. Estimation of hemoglobin level in the blood (lab).
5. Hereditary disorders of hemoglobin synthesis. Porphyries.

LESSON XIX – Hemoglobin degradation. Jaundice

1. Degradation of hemoglobin in tissues: formation of bile pigments (bilirubin and biliverdin). Properties of free (indirect) bilirubin and its determination (lab. work).
2. Formation of conjugated (direct) bilirubin in the liver, its properties and the principle of determination (lab. work).
3. The fate of bile pigments in the intestine. Diagnostic significance of urobilibilogen and stercobilinogen determination in urine and feces.
4. Jaundice types and importance of bilirubin fractions determination for jaundice diagnosis. Total bilirubin level in the blood serum, and its determination by Jendrassik and Cleghorn assay (principle of Van Den Bergh reaction, lab. work).

LESSON XXI – Lipid metabolism: digestion, absorption, resynthesis.and transport to tissues. Metabolism of bile acids. Disorders of lipid digestion, intestinal absorption and transport

1. The importance of lipid metabolism for the body.
2. Enzymes involved in the digestion of lipids in the gastrointestinal tract, their specificity.
3. Synthesis, of bile acids, regulation of process. The role of bile acids in the digestion of lipids. Qualitative determination of bile acids (lab. work).
4. Absorption of lipid breakdown products in the intestine and re-synthesis of lipids in enterocytes.
5. Biosynthesis (re-synthesis) of triacyllycerols: activation of substrates, enzymes involved in the process (scheme).
6. Transport of dietary lipids to tissues. Chylomicrons. Lipoprotein lipase. Hyperlipemia.

7. Disorders of lipid digestion, intestinal absorption and transport to tissues.

LESSON XXII – Lipid metabolism: intracellular lipolysis. Types of fatty acids catabolism: α-,β- and ω-oxidation. β-oxidation of saturated, unsaturated and monounsaturated fatty acids, energetic value of process (ATPs produced). Glycerin metabolism

1. Intracellular lipolysis. Regulation of lipid mobilization in adipose tissue.
2. Catabolism of glycerin, energetic value of process (ATPs produced).
3. Types of fatty acids catabolism: β-oxidation of fatty acids (scheme), its energetic significance, and regulation.
4. Types of fatty acids catabolism: α- and ω-oxidation.
5. β-oxidation of fatty acids with an odd carbon chain, importance of process.

LESSON XXIII – Lipid metabolism: biosynthesis of fatty acids. Biosynthesis of unsaturated fatty acids. Biosynthesis of triacylglycerols and phospholipids. Lipotropic factors

1. Biosynthesis of fatty acids, enzymes involved in the process (scheme).
2. Sources of acetyl-CoA and $NADPH_2$ for fatty acid biosynthesis.
3. Regulation of fatty acid biosynthesis.
4. Feature of unsaturated fatty acid biosynthesis.
5. Biosynthesis of triacylglycerols. Diagnostic significance of estimation triacylglycerol levels in the blood.
6. Biosynthesis of phospholipids. Lipotropic factors.

LESSON XXIV – Lipid metabolism: cholesterol biosynthesis. **Blood lipoprotein types, specificity of their metabolism.** *Lipid metabolism disorders: Pathology of fat depots. Obesity. Pathology of cholesterol metabolism. Hereditary lipidoses*

1. Feature of cholesterol and cholesteride metabolism.
2. The stage of mevalonic acid formation during biosynthesis of cholesterol (scheme).
3. Stage of squalene formation during cholesterol biosynthesis (scheme).
4. Final stage in cholesterol biosynthesis: stage of squalene conversion to cholesterol (scheme).
5. Regulation of cholesterol synthesis. Blood cholesterol levels test, its diagnostic significance (lab. work).
6. Transport of lipids to tissues: blood lipoprotein types, their metabolic properties.
7. Pathology of cholesterol metabolism. Atherosclerosis, gallstones.
8. Liver fatty infiltration and fatty dystrophy. Lipotropic factors.
9. Pathology of fat depots. Obesity, types, causes.
10. Hereditary lipidoses.

LESSON XXVI – Functional biochemistry of blood and liver

1. Plasma proteins: albumins, globulins, fibrinogen, their characteristics; pathological conditions associated with their levels variation. The principle of biuret method (lab work).
2. Some clinically important blood plasma proteins: enzymes, transferrin, ceruloplasmin, haptoglobin, properdin, interferon, C-reactive protein.
3. Small-weight nitrogenous and nitrogen-free compounds of blood serum. Azotemia types.
4. Blood clotting factors.
5. Liver role in carbohydrate metabolism.
6. Liver role in lipid metabolism.
7. Liver role in protein and amino acid metabolism.
8. Detoxification function of the liver

LESSON XXVII – Functional biochemistry of kidneys, muscle and nerve tissue

1. Normal diuresis. The color of urine. Compounds that color normal urine. Turbidity of urine. Identification the causes of turbidity.
2. Urine pH, its determination (lab. work). Specific gravity of urine, its determination and change in pathological conditions (lab. work).
3. Organic and inorganic compounds of urine. Determination of vitamin C in urine (lab. work).
4. Pathological compounds of urine. Ketonuria, causes. Determination of ketone bodies in urine (lab. work).
5. Hematuria, causes. Determination of blood pigments in urine (lab. work).
6. Glucosuria, causes. Qualitative and quantitative determination of sugar in the urine. Quantitative analysis of sugar in urine by titration (lab. work).
7. Proteinuria, causes. Analysis of protein in urine. Determination of urinary protein by Roberts-Stolnikov method (lab. work).
8. Metabolism of carbohydrates, lipids, proteins and amino acids in nerve tissue.
9. Biochemical mechanisms of generation and transmission of nerve impulses.
10. Muscle proteins: types, nitrogenous extractive compounds, their biological significance. Nitrogen-free organic compounds of muscle.
11. Specificity of energy supply of muscle tissue.

COLLOQUIUMS PROCEDURES

RULES FOR CONDUCTING COLLOQUIUMS

The purpose of the training is to reveal the degree of students ' assessment by individual survey.

The teacher calls the 4 student to answer. The sheet contains the date of the month, the surname of the student and 2 questions.

If the question has a structure, scheme, and the student cannot write them, but answers anchak Shi-fahi, then the answer maximum is estimated at 1 point. You do not need to write the text of the answer.

The answer to each question is estimated at 2.5 points.

When students answer questions, it is la-sand to pay attention, first of all, to what extent they master the important questions of their section.

PRESENTATİON TOPICS ON MEDİCAL BIOCHEMISTRY-2

1. Chemical composition of muscle tissue: muscle proteins, nitrogenous extractives. Nitrogen-free compounds.
2. Heart and smooth muscle main characteristics and chemical composition. Energy supply of muscle tissue. Biochemical mechanism of muscle contraction.
3. Functions of connective tissue, main cells and proteins of the intercellular matrix, non-collagen proteins. Adhesive and anti-adhesive proteins. Glucosaminoglycans and proteoglycans.
4. Chemical composition of blood plasma. Plasma proteins, their fractions and biological role. Blood serum enzymes and their clinical significance.
5. Small-weight nitrogenous and nitrogen-free compounds of blood serum. Macro- and microelements of blood. Acid-base balance of blood. Blood buffer systems.
6. Liver role in metabolism as a key metabolic organ.
7. Metabolic features of ethyl alcohol in the human body.
8. Metabolic syndrome as the leading modern pathology.
9. Anemia, its types, biochemical base of development.
10. Metabolism of drugs.
11. Kidneys role in water-salt metabolism.
12. Kidneys role in regulation of acid-base balance.
13. Urine formation mechanism. Regulation of renal function.
14. Biochemistry of bone tissue.
15. Factors affecting bone and connective metabolism tissue.
16. Characteristics of the biochemistry of nerve tissue.
17. Neurotransmitters: types and mechanism of action.
18. Antitoxic function of the liver.
19. Blood coagulation factors and anticoagulation system.

20. Covid-19 virus impact on biochemical processes.
21. Impact of environmental factors on biochemical processes (global warming). Oxidative stress and antioxidant system.

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