THE MINISTRY OF HEALTH OF UKRAINE
ZAPORIZHZHIA STATE MEDICAL AND PHARMACEUTICAL UNIVERSITY
Biological Chemistry Department

BIOCHEMISTRY
LABORATORY MANUAL

Section 2
Molecular biology. Biochemistry of intercellular communications, tissues and physiological functions

For students of II international faculty

Speciality: 221 “Dentistry”

ZAPORIZHZHIA
2025

It is confirmed on the Central Methodological Council of ZSMPhU
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This manual is recommended to use for students of II International faculty (the second year of study) for independent work on Biochemistry discipline at home and in class.

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Section 2
Molecular biology. Biochemistry of intercellular communications, tissues and physiological functions

II International faculty second year student`s

_____gr. №_____
name, surname

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ZAPORIZHZHIA
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Introduction

The proposed laboratory manual serves as an essential supplementary methodological guide for second-year students of the International Faculty, specializing in 221 “Dentistry,” in their study of biological chemistry. It includes a thematic plan for practical classes in Section 2, outlining the relevance of each topic, the learning objectives, and a list of theoretical questions for preparation.

Each laboratory session features key components such as a detailed explanation of the methodological principles, step-by-step experimental procedures, and the clinical-diagnostic significance of the methods in practical medicine. Additionally, every practical lesson incorporates an initial knowledge assessment and test questions aligned with the “KROK 1” licensing exam.

The content and scope of the manual align with the allocated study hours for Section 2 and the requirements of the biochemistry curriculum for students specializing in 221 “Dentistry.” It provides all the necessary information for independent study, along with preparatory questions for intermediate and final assessments of Section 2.

This comprehensive approach will enhance students' readiness for practical sessions and various forms of academic evaluation.

A Plan for Lectures of Section 2

	Section 2 ***Molecular Biology. Biochemistry of intercellular communications, tissues and physiological functions***	**Number of hours**
1	Biosynthesis of Nucleic Acids. Protein Biosynthesis. Regulation of Gene Expression. Molecular Mechanisms of Mutations.	**2**
2	Biochemical Functions of the Liver. Metabolism of Chromoproteins. Biochemistry of Jaundice. Biotransformation of Xenobiotics.	**2**
3	Molecular Mechanisms of Hormone Action.	**2**
4	Biochemical Foundations of Vitamins.	**2**
5	Biochemistry of Connective and Bone Tissues. Biochemical Composition and Functions of Dental Tissues.	**2**
6	Biochemical Composition and Functions of Saliva. Changes in the Composition of Saliva in Various Pathological Conditions.	**2**
7	Biochemistry and Pathobiochemistry of Blood. Biochemical Functions of the Kidneys.	**2**
Sum total, hours		**14**

Plan for Practical Classes of Section 2

	Molecular Biology. Biochemistry of intercellular communications, tissues and physiological functions	**Number of hours**
1	Metabolism of purine and pyrimidine nucleotides. Disorders of nucleotide metabolism.	3
2	Biosynthesis of nucleic acids. Protein biosynthesis and its regulation.	3
3	Chromoproteins. Metabolism of hemoglobin and its disorders. Metabolism of porphyrins.	3
4	Classification and properties of hormones. The mechanisms of protein-peptide hormones and biogenic amines action.	3
5	Mechanism action and influence on metabolism of steroid and thyroid hormones. The regulation of calcium and phosphates homeostasis by hormones in the blood.	3
6	The role of hormones in the regulation of metabolic processes. Formation and functions of eicosanoids.	3
7	**Intermediate control on basic themes 6, 7. Control work № 2.**	3
8	The role of water-soluble and fat-soluble vitamins in metabolism. Vitamin-like substances.	3
9	Biochemistry of bone tissue and dental tissues. Mineral and organic components of dental tissues. Mineralization, demineralization, remineralization.	3
10	Biochemical composition and functions of biological fluids of the oral cavity in normal and various pathological conditions.	3
11	Biochemistry of the liver. Microsomal oxidation. Xenobiotic biotransformation.	3
12	Biochemistry of muscular and connective tissues.	3
13	Biochemistry of blood. Plasma proteins, lipoproteins, enzymes. Non-protein components of plasma.	3
14	Biochemistry of nervous tissue.	3
15	The role of kidneys in the regulation of water and mineral metabolism. The normal and pathological components of urine.	3
16	The integration of metabolic pathways. General principles of metabolic regulation.	3
17	**Border control of knowledge acquisition from section 2 "Molecular biology. Biochemistry of intercellular communications, tissues and physiological functions".**	3

Independent work of students in Section 2

№	Name of the topic	Number of hours
1	Clinical and biochemical characteristics of uric acid metabolism disorders.	**0,5**
2	Drawing up diagrams of the sequential stages of replication and transcription. Assessment of congenital metabolic pathologies (molecular diseases) as a consequence of genetic disorders and point mutations. Influence of physiologically active compounds on translation processes.	**0,5**
3	Porphyrias: causes of occurrence and diagnosis.	**0,5**
4	Analysis of biochemical parameters that characterise the metabolism of carbohydrates, proteins and lipids in endocrine gland disorders.	**0,5**
5	Pathologies of the thyroid gland; peculiarities of metabolic disorders in hyper- and hypothyroidism. Mechanisms of endemic goiter and its prevention.	**0,5**
6	Distribution of calcium ions in the body, forms of calcium in human blood plasma. The contribution of bone tissue, small intestine and kidneys to calcium homeostasis.	**0,5**
7	**Preparation for intermediate control of content sections 7, 8**	**0,5**
8	Explanation of the role of fat-soluble vitamins in metabolic processes and cellular functions. Assessment of the body's vitamin status and manifestation of hyper-, hypo-, and avitaminosis based on biochemical indicators.	**0,5**
9	Vitamins of the D group and their role in the metabolism of bone tissue and teeth. Specificities of metabolism and mechanisms of enamel mineralization.	**0,5**
10	Biochemical mechanisms of the development of caries and periodontitis. Principles of prevention and treatment.	**0,5**
11	Bile-forming function of the liver. Bile pigments metabolism. Pathobiochemistry of jaundice. Biochemical basis of detoxification of endogenous toxins. Assessment of liver detoxification function by biochemical parameters.	**0,5**
12	Molecular mechanisms of contraction in skeletal, smooth, and cardiac muscles. Comparative characteristics.	**0,5**
13	Investigation of nitrogen metabolism indicators and changes in the content of nitrogen-containing non-protein components in blood. Genetic and acquired disorders of vascular-platelet and coagulation hemostasis.	**0,5**
14	Influence of neurotransmitters and psychotropic drugs on the metabolism of nervous tissue. Analysis of disruptions in the functioning of the human immune system. Primary and	**0,5**

	secondary immunodeficiencies.	
15	Assessment of the levels of normal and pathological components in urine.	**0,5**
16	**Preparation for border control of knowledge acquisition from section 2**	**1,0**
Total		**9**

Lesson 1

THEME: METABOLISM OF PURINE AND PYRIMIDINE NUCLEOTIDES. DISORDERS OF NUCLEOTIDE METABOLISM.

RELEVANCE OF THE THEME: the structural components of nucleic acids – DNA and RNA – are nucleotides of the purine and pyrimidine series. The biosynthesis of mononucleotides is a vital process as it ensures the formation of components of nucleic acid molecules and nucleotide coenzymes. Free nucleotides that are not used for nucleic acid synthesis undergo breakdown, resulting in end products of metabolism. Determining the quantitative content of such products (such as uric acid) has clinical diagnostic significance in the treatment of certain diseases (such as gout).

THE PURPOSE OF THE LESSON: to study the theoretical material on the metabolism of purine and pyrimidine nucleotides and its disorders. Acquire the ability to perform quantitative determination of uric acid in blood serum and urine.

QUESTIONS FOR PREPARATION

1. Nucleoproteins digestion in the gastro-intestinal tract. Nucleosides absorption in the small intestine.
2. The common representations about biosynthesis of purine nucleotides (phases, energy suppliers, vitamins intake), its regulation.
3. The degradation of purine nucleotides in tissues. The determination of uric acid in the blood serum and urine of patients.
4. The common representations about pyrimidine nucleotides biosynthesis, its regulation.
5. Deoxyribonucleotide synthesis. The formation of dTMP; the inhibitors for this synthesis in cancer treatment.
6. The end-products of pyrimidine nucleotide degradation.
7. Hypo- and hyperuricemia states in patients: the reasons of development and diagnostics. The gout: the diagnostic tests for it and its treatment.

LABORATORY WORKS

1. Determination of uric acid content in the blood serum.
2. Determination of uric acid content in the urine.

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. Identify the final product of nucleic acid digestion that is absorbed in the small intestine:

A. Nucleosides
B. Ribose
C. Polynucleotides
D. Oligonucleotides
E. Trinucleotides

2. Identify the nitrogenous base that, after absorption as part of mononucleosides, is not used for nucleic acid synthesis:
A. Adenine
B. Cytosine
C. Thymine
D. Guanine
E. Uracil

3. Identify the metabolic pathway as a source of ribose:
A. Glycolysis
B. Krebs Cycle
C. Pentose Phosphate Pathway
D. Glycogenolysis
E. Ornithine Cycle

4. Identify the amino acid that serves as a source of carbon and nitrogen during purine biosynthesis:
A. Lysine
B. Histidine
C. Alanine
D. Cysteine
E. Glycine

5. Identify the vitamin, the active form of which serves as a source of carbon and nitrogen in the purine molecule:
A. Pantothenic Acid
B. Folic Acid
C. Ascorbic Acid
D. Tocopherol
E. Retinol

6. Identify the metabolite that is a precursor to the synthesis of purine mononucleotides:
A. Free Purine
B. Adenylate
C. Xanthine
D. Inosinic Acid
E. GMP

7. Identify the nucleotide monophosphate formed from IMP:
A. ATP
B. GTP
C. ADP
D. AMP
E. CMP

8. Identify the metabolite of the ornithine cycle required for the synthesis of pyrimidine nucleotides:
A. Urea
B. Carbamoyl Phosphate
C. Citrulline
D. Ornithine
E. Fumarate

9. Identify the derivative of a vitamin involved in the methylation of dUMP during thymidylate nucleotide biosynthesis:
A. Ascorutin
B. Methylene-THF
C. Carnitine Chloride
D. Haloscorbin
E. Potassium Orotate

10. Identify the amino acid actively involved in the synthesis of purine nucleotides:
A. Cysteine
B. Arginine
C. Proline
D. Lysine
E. Glycine

PREPARATION FOR THE KROK-1 LICENSURE EXAM

1. The doctor prescribed allopurinol to a patient with gout. What pharmacological action of allopurinol provides a therapeutic effect in this case?
A. Slowing down the reutilization of pyrimidine nucleotides
B. Acceleration of nucleic acid synthesis
C. Competitive inhibition of xanthine oxidase
D. Acceleration of catabolism of pyrimidine nucleotides
E. Increasing the rate of elimination of nitrogen-containing compounds

2. A 65-year-old man suffering from gout complains of pain in the kidney area. An ultrasound examination revealed the presence of kidney stones. As a result of which process are kidney stones formed?
A. Heme decay
B. Protein catabolism
C. Restoration of cysteine
D. Ornithine cycle
E. Decay of purine nucleotides

3. A 42-year-old man suffering from gout has an increased concentration of uric acid in his blood. He was prescribed allopurinol to reduce uric acid levels. Allopurinol is a competitive inhibitor of which enzyme?

A. Hypoxanthinesphoribosyltransferases
B. Guanindeaminases
C. Adenine phosphoribosyltransferases
D. Adenosine deaminase
E. Xanthine oxidase

4. The patient has an increased content of uric acid in the blood, which is clinically manifested by a pain syndrome due to the deposition of urates in the joints. As a result of which process is this acid formed?
A. Decay of pyrimidine nucleotides
B. Heme catabolism
C. Cleavage of proteins
D. Decay of purine nucleotides
E. Reutilization of purine bases

5. With hereditary orotaciduria, the excretion of orotic acid is many times higher than the norm. Synthesis of what substances will be disturbed in this pathology?
A. Biogenic amines
B. Purine nucleotides
C. Urea
D. Pyrimidine nucleotides
E. Uric acid

6. Allopurinol, a competitive inhibitor of xanthine oxidase, was prescribed to a patient with urolithiasis after examination. The basis for this was the chemical analysis of kidney stones, which consisted mainly of:
A. Calcium sulfate
B. Sodium urate
C. Calcium oxalate monohydrate
D. Calcium phosphate
E. Calcium oxalate dihydrate

7. An oncological patient was prescribed the drug methotrexate, to which the target cells of the tumor subsequently lost sensitivity. The gene expression of which enzyme changes
A. Dihydrofolate reductase
B. Folate oxidase
C. Thyminase
D. Deaminase
E. Folate decarboxylase

8. A 46-year-old patient turned to the doctor with a complaint of pain in the joints, which worsens on the eve of a change in weather. An increase in the concentration of uric acid was detected in the blood. Increased decay of which substance is the most likely cause of the disease?

A. TMF
B. AMP
C. CMF
D. UMF
E. UTF

9. A 65-year-old man suffering from gout complains of pain in the kidney area. An ultrasound examination revealed the presence of kidney stones. As a result of increasing the concentration of which substance, kidney stones are formed?
A. Uric acid
B. Cholesterol
C. Urea
D. Bilirubin
E. Cystin

10. Pterin derivatives (aminopterin and methotrexate) are competitive inhibitors of dihydrofolate reductase, as a result of which they suppress the regeneration of tetrahydrofolic acid from dihydrofolate. These drugs lead to inhibition of the intermolecular transport of one-carbon groups. The biosynthesis of which polymer is inhibited at the same time?
A. DNA
B. Protein
C. Homopolysaccharides
D. Gangliosides
E. Glycosaminoglycans

11. On the basis of laboratory analysis, the diagnosis of gout was confirmed in the patient. To establish the diagnosis, the content was determined:
A. Uric acid in blood and urine
B. Creatinine in urine
C. Residual nitrogen in the blood
D. Urea in blood and urine
E. Ammonia in urine

12. In the synthesis of purine nucleotides, some amino acids, vitamin derivatives, phosphoric esters of ribose are involved. The coenzyme form of which vitamin is the carrier of one-carbon fragments in this synthesis?
A. Folic acid
B. Pantothenic acid
C. Nicotinic acid
D. Riboflavin
E. Pyridoxine

Protocol N **Date**

1. Determination of uric acid content in the blood serum.

THE PRINCIPLE OF THE METHOD:

The uric acid reduces a phosphate-tungstate reagent; as a result you can see tungsten oxides of a blue coloring. The intensity of coloring is proportional to the quantity of uric acid.

THE COURSE OF THE WORK:

The course of the work is represented in the table:

Measure to a centrifuge test tube, ml	Experimental test	Control test
Distilled water	**4.0**	**4.5**
Blood serum	**0.5**	**-**
Sulfuric acid	**0.25**	**0.25**
Sodium tungstate	**0.25**	**0.25**

Mix and leave on the table for 10 min.

Centrifuge for 10 min (3000g). Take the supernatant:

Supernatant	**2.0**	**2.0**
Sodium carbonate solution	**1.0**	**1.0**
Phosphate tungstate reagent	**0.6**	**0.6**

Make the standard sample as a test sample, taking 0.5 ml of standart solution of uric acid instead of a serum. Exclude centrifugation stage.

Mix and leave on the table for 30 min. Measure the optical density in cuvettes (10 mm) at a wave length 650 nm against the control sample.

The concentration of uric acid in the blood serum is calculated by formula:

$$C = \frac{E_{test} \cdot 300}{E_{st} \cdot 1000}$$, where

C - concentration of uric acid in the blood serum (mmol/L);

E_{test} - extinction of the test sample;

E_{st} - extinction of the standard sample;

300 - concentration of uric acid in the standard solution (μmol/l);

1000 - recalculation coefficient to mmol/L.

Blood serum of healthy people contains 0.20- 0.42 mmol/L (for men) or 0.14-0.34 mmol/L (for women) of uric acid normally.

RESULTS:

CONCLUSIONS:

2. Determination of uric acid content in the urine

THE COURSE OF THE WORK:

Dissolve the urine (1ml of the urine: 9ml of distilled water) before analysis.

Measure into a test tube, ml	Experimental test	Control test
Distilled water	**4.0**	**4.5**
Diluted urine	**0.5**	**-**
Sulfuric acid	**0.25**	**0.25**
Sodium tungstate	**0.25**	**0.25**

Mix and leave on the table for 10 min.

Filtrate out and take necessary quantity of the filtrate

Filtrate	**2.0**	**2.0**
Sodium carbonate solution	**1.0**	**1.0**
Phosphate tungstate reagent	**0.6**	**0.6**

Make the standard sample as a test sample, taking 0.5 ml of standart solution of uric acid instead of a serum.

Mix and leave on the table for 30 min. Measure the optical density in cuvettes (10 mm) at a wave length 650 nm against the control sample.

The concentration of uric acid in the urine is calculated by formula:

$$C = \frac{E_{test} \cdot 300 \cdot 10 \cdot X}{E_{st} \cdot 1000}, \text{ where}$$

C - concentration of uric acid in the urine (mmol/day);

E_{test} - extinction of the test sample;

E_{st} - extinction of the standard sample;

300 - concentration of uric acid in the standard solution (μmol/l);

1000 - re-calculation coefficient to mmol/L;

10 - urine dilution

X - daily average of the urine: men – 1.5 lit, women -1.2 lit;

The uric acid is allocated with urine 1.48 - 4,43 mmol/day (or 270-600 mg/day).

RESULTS:

CONCLUSIONS:

<u>Clinical significance:</u>

The content of uric acid in the blood depends on the content of purine bases in food and also upon intensity of nucleoprotein metabolism.

At gout the uric acid salts are retained in cartilages, muscles and mucous bag of joints. The content of uric acid in the blood can be increased without gout (***hyperuricemia***). It can be typical at greenstone, kidneys insufficiency.

Hyperuricemia and gout develop at patients with genetic infringements of purine nucleotides synthesis enzyme activity (PRPP amidotransferase, hypoxanthine-guanine phosphoribosyl transferase), at patients affected with Lesch-Nyhan syndrome.

Hypouricemia is observed at genetic defect of xanthine oxidase that is accompanied by accumulation of xanthines in blood of the patients and their excretion with urine in big concentration (xanthinuria).

Literature (p. 130)

Lesson 2

THEME: BIOSYNTHESIS OF NUCLEIC ACIDS. PROTEIN BIOSYNTHESIS AND ITS REGULATION.

RELEVANCE OF THE THEME: the most significant achievement in mid-20th-century biological science was the establishment of the role of nucleic acids in information storage and transmission. Nucleic acids facilitate the processes of protein synthesis, which, in turn, determine the character of metabolic exchanges, the patterns of growth and development, as well as the phenomena of heredity and variability. Structural disruptions in nucleic acids lead to pathological changes in the organism.

Protein biosynthesis is a universal form of plastic metabolism for all living organisms. In cells, it occurs continuously because proteins are regularly broken down, and there is a constant need for their renewal. The most intensive protein biosynthesis takes place during periods of organism growth and development.

Protein biosynthesis contributes to the processes of self-renewal in the organism. Disruptions in protein biosynthesis occur due to insufficient provision of nutrients and the presence of various pathological conditions.

THE PURPOSE OF THE LESSON: to study the theoretical material on the biosynthesis of nucleic acids. Be able to interpret the biochemical features of the emergence of molecular pathologies (mutations and the mechanism of action of mutagens). Familiarize yourself with the main directions of genetic engineering and biotechnology.

QUESTIONS FOR PREPARATION

1. Molecular Mechanisms of DNA Replication. Types of Replication. Sequence of Stages and Enzymes Involved in DNA Synthesis in Prokaryotes and Eukaryotes.
2. Mutations and Mechanisms of Action of Mutagens. Concepts of Molecular Diseases.
3. Biological Role and Mechanisms of DNA Repair.

4. Contemporary Insights into the Transcription Mechanism. RNA Polymerases in Prokaryotes and Eukaryotes, Transcription Signals. Post-transcriptional Processing of Primary Transcript (mRNA Maturation in Eukaryotes).
5. Stimulators and Inhibitors of Nucleic Acid Biosynthesis.
6. General Concepts of Genetic Engineering and Its Biomedical Significance.
7. Genetic Code and Its Properties.
8. Ribosomal Protein Synthesis System of the Cell.
9. Structure and Biological Role of RNA (tRNA, mRNA, rRNA) in Protein Biosynthesis (Translation).
10. Mechanism of Translation and Its Stages. Energetic Provision of Protein Synthesis. Post-translational Processing of Polypeptide Chains.
11. Modern Insights into Intracellular Regulation of Gene Expression in Prokaryotes: Regulatory Scheme according to F. Jacob and J. Monod (Operon Hypothesis). Concepts of Gene Induction and Repression Mechanisms.
12. Antibiotics – Inhibitors of Protein Biosynthesis.

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. Identify the amino acid derivative that initiates the translation process in prokaryotes:
A. Methylhistidine
B. Formyl-methionine
C. Oxylisine
D. Oxiproline
E. Homocysteine

2. The "recognition" of aminoacyl-tRNA by the mRNA triplet during protein synthesis is facilitated by:
A. Ribosome
B. Acceptor triplet of tRNA
C. DNA triplet
D. Amino acid
E. tRNA anticodon

3. Identify the enzyme that participates in the activation of amino acids in the process of protein biosynthesis:
A. RNA polymerase
B. Aminoacyl-tRNA synthetase
C. DNA polymerase
D. Transamidase
E. Peptidyl transferase

4. Choose the enzyme involved in the transamination reaction and the formation of a peptide bond during translation:
A. Aminotransferase
B. Peptidyl transferase

C. Aminoacyl-tRNA synthetase
D. Translocase
E. Polymerase

5. Choose codons that serve as termination signals in translation:
A. ACC, GCA, AAG
B. TAA, ACA, GAA
C. UAC, CUA, GAC
D. GAU, CCA, CAG
E. UAG, UAA, UGA

6. Specify the triplet that is part of the acceptor arm of tRNA:
A. CCA
B. CAC
C. UAC
D. CUA
E. UUA

7. According to the operon hypothesis, the function of the operator gene is to control the synthesis of:
A. tRNA
B. Cofactors
C. Amino acids
D. mRNA
E. rRNA

8. Identify the DNA sequence that serves as the initiation point for mRNA synthesis:
A. Corepressor
B. Codon
C. Anticodon
D. Promoter
E. Operator

9. Identify the antibiotic that inhibits protein biosynthesis and simultaneously has antitumor effects:
A. Cycloheximide
B. Penicillin
C. Levomycetin
D. Rifamycin
E. Actinomycin D

10. Choose the antibiotic that is an inhibitor of translocase, an elongation enzyme in translation:
A. Cycloheximide
B. Puromycin

C. Actinomycin D
D. Rifamycin
E. Tetracycline

11. Identify the enzyme that catalyzes the synthesis of a short oligoribonucleotide, which initiates DNA synthesis:
A. Elongase
B. DNA polymerase I
C. Primase
D. Ligase
E. Topoisomerase

12. Identify the main enzyme that catalyzes the elongation stage of DNA replication:
A. DNA polymerase I
B. DNA polymerase III
C. Primase
D. Helicase
E. DNA ligase

13. Specify the direction of the formation of the phosphodiester bond in the DNA molecule during its synthesis:
A. 3'-5'
B. 3'-4'
C. 5'-3'
D. 2'-3'
E. 5'-4'

14. Identify the metabolite that serves as the matrix for the biosynthesis of the primer in DNA replication:
A. mRNA
B. DNA
C. tRNA
D. rRNA
E. mRNA

15. Specify the substrate of the primase enzyme:
A. Ribonucleoside triphosphate
B. DNA
C. Okazaki fragment
D. Nucleotide
E. Protein

16. Identify the enzyme that catalyzes the joining of Okazaki fragments:
A. Primase
B. Helicase

C. Topoisomerase
D. DNA ligase
E. DNA polymerase

17. Identify the synonym for the term "RNA-dependent DNA polymerase":
A. Reverse transcriptase
B. Helicase
C. Topoisomerase
D. DNA ligase
E. DNA-dependent RNA polymerase

18. What are the nucleotide sequences in the pre-mRNA molecule that do not carry information called?
A. Intron
B. Exon
C. Primer
D. Codon
E. Cap

19. Choose the process that does not belong to post-transcriptional modifications:
A. Splicing
B. Capping
C. Methylation
D. Primer synthesis
E. Polyadenylation

20. Identify the structure within the RNA molecule that protects it from nucleases:
A. Primer
B. Intron
C. Exon
D. Operon
E. Cap

PREPARATION FOR THE KROK-1 LICENSURE EXAM

1. To study the localization of protein biosynthesis in mouse cells, the amino acids alanine and tryptophan were introduced. At which organelles will the accumulation of amino acids be observed?
A. Ribosomes
B. Golgi apparatus
C. Cellular center
D. Lysosomes
E. Smooth EPR

2. A low level of albumin and fibrinogen was found in the patient's blood. A decrease in the function of which hepatocyte organelle is most likely to cause this phenomenon?
A. Granular endoplasmic reticulum
B. Golgi complex
C. Smooth endoplasmic reticulum
D. Mitochondria
E. Lysosomes

3. A decrease in the content of magnesium ions, necessary for the attachment of ribosomes to the granular endoplasmic reticulum, was found in the patient. It is known that this leads to a violation of protein biosynthesis. Which stage of protein biosynthesis will be disrupted?
A. Activation of amino acids
B. Broadcasting
C. Termination
D. Replication
E. Transcription

4. The work of the bacterial operon is studied. The operator gene was released from the repressor protein. Immediately after that, the cell will start:
A. Transcription
B. Broadcasting
C. Replication
D. Processing
E. Repression

5. In the cell, a stage of translation takes place in the granular EPS, during which the advancement of i-RNA relative to the ribosome is observed. Amino acids are connected by peptide bonds in a certain sequence - polypeptide biosynthesis takes place. The sequence of amino acids in the polypeptide will correspond to the sequence:
A. Codons of i-RNA
B. Nucleotides of t-RNA
C. Anticodons of t-RNA
D. Nucleotides of p-RNA
E. Anticodons of p-RNA

6. Infectious disease doctors widely use antibiotics that inhibit the synthesis of nucleic acids. What stage of biosynthesis does rifampicin inhibit?
A. Initiation of transcription in prokaryotes
B. Transcription in prokaryotes and eukaryotes
C. Replication in prokaryotes
D. Termination of transcription in prokaryotes and eukaryotes
E. Splicing in prokaryotes and eukaryotes

7. For the formation of a transport form of amino acids for protein synthesis, it is necessary:
A. Aminoacyl-tRNA synthetase
B. GTF
C. mRNA
D. Ribosome
E. Revertase

8. Nitrous acid is formed from nitrates and nitrites in the body, which causes oxidative deamination of nitrogenous bases of nucleotides. This can lead to a mutation - replacing cytosine with:
A. Adenine
B. Uracil
C. Guanine
D. Inosine
E. Timin

9. In the experiment, it was shown that ultraviolet-irradiated skin cells of patients with xeroderma pigmentosum restore the native structure of DNA more slowly than cells of healthy people, due to a defect in the repair enzyme. With the help of which enzyme does this process take place?
A. RNA ligase
B. Endonuclease
C. DNA gyrase
D. DNA polymerase
E. Primaza

10. The RNA containing the human immunodeficiency virus penetrated the inside of the leukocyte and, with the help of the revertase enzyme, forced the cell to synthesize viral DNA. This process is based on:
A. Convariant replication
B. Operon depression
C. Reverse transcription
D. Backcasting
E. Repression of the operon

11. Certain compounds, such as fungal toxins and some antibiotics, have been found to be depressing RNA polymerase activity. Violation of which process occurs in the cell in case of suppression of the activity of this enzyme?
A. Transcription
B. Broadcasting
C. Processing
D. Replication
E. Reparation

12. It was proved that the molecule of immature i-RNA (pro-i-RNA) contains more triplets than the number of amino acids found in the synthesized protein. This is explained by the fact that the broadcast is normally preceded by:
A. Mutation
B. Replication
C. Initiation
D. Processing
E. Reparation

13. HIV T-lymphocyte infection was established. At the same time, the viral enzyme reverse transcriptase (RNA-dependent DNA polymerase) catalyzes the synthesis of:
A. DNA on the matrix of viral i-PHK
B. i-RNA on a viral protein matrix
C. Viral DNA on a DNA matrix
D. Viral i-RNA on a DNA matrix
E. DNA on viral r-RNA

14. A worker of a chemical enterprise suffered a toxic effect as a result of violating the rules of safe work of nitric acid and nitrites, which
cause deamination of cytosine in the DNA molecule. What enzyme initiates a chain of repair processes?
A. Uridine-DNA-glycosidase
B. Cytidine triphosphate synthetase
C. Orotidyl monophosphate decarboxylase
D. DNA-dependent RNA polymerase
E. Thymidylate synthase

15. The synthesis of i-RNA takes place on the DNA matrix, taking into account the principle of complementarity. If the triplets in DNA are as follows - ATG-CHT, then the corresponding codons of i-RNA will be:
A. UAC-HCA
B. AUG-CSU
C. ATG-CHT
D. UAG-CSU
E. TAG-UGU

Literature (p. 130)

Lesson 3

THEME: CHROMOPROTEINS. METABOLISM OF HEMOGLOBIN AND ITS DISORDERS. METABOLISM OF PORPHYRINS.

RELEVANCE OF THE THEME: the determination of blood hemoglobin and its derivatives, particularly bilirubin, holds significant importance in clinical research.

Bilirubin, a bile pigment derived from hemoglobin, is formed in the liver and spleen. The assessment of direct and indirect bilirubin serves as a diagnostic marker for various types of jaundice. Inherited disorders affecting the synthesis of porphyrins are the cause of severe pathological conditions known as porphyrias.

THE PURPOSE OF THE LESSON: to study the theoretical principles of the metabolism of hemoglobin and its derivatives. Acquire the ability to determine total bilirubin and its fractions and apply the obtained indicators in clinical diagnostic practice.

QUESTIONS FOR PREPARATION

1. Chromoproteins: a classification, and biological role.
2. Hemoglobin: types in adults, their structure, properties and biological role.
3. Normal hemoglobin derivatives. Derivatives of hemoglobin formed under carbon monooxide poisoining and influence the strong oxidation agents.
4. Abnormal types of hemoglobin (at sickle-cell anemia and talassemia states).
5. Stages of hemoglobin synthesis, and its regulation.
6. Porphyrins: a scheme of protoprohyrin IX and heme synthesis. Inherited disorders of enzymes for this synthesis. Types of Porphyries.
7. Hemoglobin catabolism in humans: the location of stages, formation of bile pigments. Terminal bile pigments found in feces and urine. The role of the liver in the hemoglobin catabolism.
8. The infringements in the hemoglobin catabolism. Jaundices: types, the reasons of occurance, and diagnostic.

LABORATORY WORKS

1. Determination of total, direct and indirect bilirubins in the blood serum.
2. The test for bile pigments in the urine (Gmelin`s test).
3. Urobilinogen determination in the urine (Bogomolov`s reaction)

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. The breakdown product of hemoglobin in the liver is:

A. Biliverdin
B. Bilirubin
C. Verdohemoglobin
D. Porphobilinogen
E. Stercobilin

2. Identify the pyridoxal-dependent enzyme that catalyzes the first stage of heme synthesis:

A. Peroxidase
B. Catalase
C. Decarboxylase
D. Aminotransferase
E. δ-Aminolevulinic acid synthase

3. During a blood examination, sickle-shaped erythrocytes are detected in a child. Indicate the type of disease for which this anomaly is characteristic:
A. Oncological
B. Infectious
C. Traumatic
D. Neurological
E. Hereditary

4. Identify the amino acid that serves as a substrate for the first stage of hemoglobin synthesis:
A. Methionine
B. Glycine
C. Valine
D. Lysine
E. Proline

5. Select the inhibitor of the enzyme that catalyzes the first stage of heme synthesis:
A. Heme
B. Glycine
C. Porphobilinogen
D. Uroporphobilinogen
E. Bilirubin

6. In a healthy individual, the conversion of indirect bilirubin to direct bilirubin occurs in the liver. Specify the mechanism of this process:
A. Oxidation via FAD
B. Hydroxylation
C. Methylation
D. Interaction with UDP-Glucuronic acid
E. Conjugation with glycine

7. Identify the plasma protein that binds with hemoglobin during erythrocyte hemolysis:
A. Transferrin
B. Haptoglobin
C. Trypsin inhibitor
D. Interferon
E. Albumins

8. Choose the type of hemoglobin that predominantly constitutes the erythrocytes of a healthy adult:
A. Hb F
B. Hb A1
C. Hb S

D. Hb A2
E. Hb A3

9. A 42-year-old patient developed yellowing of the skin, sclera, and mucous membranes. The plasma shows an elevated level of total bilirubin, and the feces contain stercobilin, while the urine contains urobilin. What type of jaundice does the patient likely have?
A. Obstructive
B. Cholestatic
C. Gilbert's disease
D. Hemolytic
E. Parenchymal

10. A mother brought her 5-year-old child to the doctor because, under the influence of sunlight, the child develops erythema, vesicular rash, and pruritus on the skin. Laboratory studies revealed a decrease in iron content in the serum and increased excretion of uroporphyrinogen I in the urine. The most likely inherited pathology in the child is:
A. Coproporphyria
B. Erythropoietic porphyria
C. Hepatic porphyria
D. Methemoglobinemia
E. Intermittent porphyria

PREPARATION FOR THE KROK-1 LICENSURE EXAM

1. In a group of children who ate a sweet juicy watermelon, two of them showed signs of poisoning: severe weakness, dizziness, headache, vomiting, shortness of breath, tachycardia, blueness of the lips, ears, and fingertips. Laboratory analysis of the watermelon revealed a high content of nitrates. What is the main mechanism in the pathogenesis of the poisoning of the two children?
A. Blockade of cytochrome oxidase
B. Lack of superoxide dismutase
C. Lack of met-Hb reductase
D. Lack of glutathione peroxidase
E. Lack of catalase

2. A 1.5-year-old child with signs of nitrate poisoning was delivered to the emergency department: persistent cyanosis, dyspnea, convulsions. What pathogenetic mechanism underlies these symptoms?
A. Formation of methemoglobin
B. Formation of oxyhemoglobin
C. Formation of carbhemoglobin
D. Formation of carboxyhemoglobin
E. Formation of reduced hemoglobin

3. A 52-year-old patient for the past few days has been experiencing attacks of pain in the right hypochondrium after eating fatty foods. Visually, there is yellowing of the sclerae and skin, acholic feces, and "beer-colored" urine. The presence of what substance in the urine caused the dark color of the urine in case of obstructive jaundice?
A. Ketone bodies
B. Glucose
C. Stercobilin
D. Urobilin
E. Bilirubin glucuronide

4. The patient has hypersensitivity of the skin to sunlight. His urine turns dark red after standing for a long time. What is the most likely cause of this condition?
A. Porphyria
B. Alkaptonuria
C. Albinism
D. Pelagra
E. Hemolytic jaundice

5. After repairing a car in a garage, the driver was admitted to the hospital with symptoms of exhaust poisoning. The content of which substance in the blood will be increased?
A. Carboxyhemoglobin
B. Carbhemoglobin
C. Glycosylated hemoglobin
D. Oxyhemoglobin
E. Methemoglobin

6. The patient's consumption of contaminated vegetables and fruits for a long time led to nitrate poisoning. What hemoglobin derivative was formed in the patient's blood?
A. HbCN
B. Hb-OH
C. HbO2
D. HbCO
E. Hb NHCOOH

7. A patient suffering from congenital erythropoietic porphyria has photosensitivity of the skin. The accumulation of which compound in the skin cells was the cause of this condition?
A. Hem
B. Uroporphyrinogen I
C. Uroporphyrinogen II
D. Protoporphyrin
E. Coproporphyrinogen III

8. In the study of the primary structure of the hemoglobin molecule, the replacement of glutamic acid with valine was found. For which hereditary pathology is this characteristic?
A. Thalassemia
B. Minkowski-Shoffar disease
C. Sickle cell anemia
D. Hemoglobinosis
E. Favism

9. A 20-year-old patient complains of generalized weakness, dizziness, and fatigue. In the blood: Hb - 80 g/l. Microscopically: red blood cells of altered shape. The cause of this condition may be:
A. Sickle cell anemia
B. Acute intermittent porphyria
C. Addison-Birmer disease
D. Parenchymal jaundice
E. Obstructive jaundice

10. A patient who came to the doctor has yellow skin color, dark urine, dark yellow feces. An increase in the concentration of which substance will be observed in the blood serum?
A. Mesobilirubin
B. Conjugated bilirubin
C. Biliverdin
D. Free bilirubin
E. Verdoglobin

11. A person suffers from diabetes mellitus, accompanied by hyperglycemia of more than 7.2 mmol/l fasting. The level of which plasma protein allows to estimate the level of glycemia retrospectively (for the previous 4-8 weeks before the examination)?
A. Glycosylated hemoglobin
B. Ceruloplasmin
C. C-reactive protein
D. Fibrinogen
E. Albumin

12. A 48-year-old patient was admitted to the clinic with complaints of weakness, irritability, sleep disturbance. Objectively: yellow skin and sclerae. In the blood: increased content of total bilirubin with a predominance of direct bilirubin. The feces are acholic. Urine is dark in color (bile pigments). What kind of jaundice is observed in the patient:
A. Gilbert's syndrome
B. Kriegler-Nayyar syndrome
C. Hemolytic

D. Parenchymal
E. Mechanical

13. A mother consulted a doctor about a 5-year-old child with erythema, vesicular rash, and itching on the skin after exposure to sunlight. Laboratory tests revealed a decrease in serum iron content, an increase in urinary excretion of uroporphyrinogen I in the urine. The most likely cause of hereditary pathology in a child is:
A. Coproporphyria
B. Erythropoietic porphyria
C. Hepatic porphyria
D. Methemoglobinemia
E. Intermittent porphyria

14. A 42-year-old patient developed jaundice of the skin, sclerae and mucous membranes. The level of total bilirubin is increased in the blood plasma, the amount of ster-cobilin in the feces, and urobilin in the urine. What type of jaundice does the patient have?
A. Obstructive
B. Cholestatic
C. Gilbert's disease
D. Hemolytic
E. Parenchymal

15. For the treatment of jaundice, the appointment of barbiturates that induce the synthesis of UDP-glucuronyltransferase is indicated. The therapeutic effect is due to the formation of:
A. Direct (conjugated) bilirubin
B. Indirect (unconjugated) bilirubin
C. Biliverdin
D. Protoporphyrin
E. Heme

16. A patient with jaundice has elevated levels of direct bilirubin and bile acids in the blood; there is no stercobilinogen in the urine. What kind of jaundice can have these signs?
A. Mechanical
B. Hepatic
C. Parenchymal
D. Hemolytic
E. Suprahepatic

17. The patient came to the clinic with complaints of general weakness, sleep disturbance. The skin is yellow in color. In the blood: increased amount of direct bilirubin, bile acids. The feces are acholic. What condition is characterized by these changes?

A. Mechanical jaundice
B. Hemolytic jaundice
C. Suprahepatic jaundice
D. Gilbert's syndrome
E. Chronic cholecystitis

18. In a patient with jaundice, it was found that the content of total bilirubin in the blood plasma increased due to indirect (free) bilirubin, high content of stercobilin in the feces and urine, the level of direct (bound) bilirubin in the blood plasma is within normal limits. What type of jaundice can we think of?
A. Hemolytic
B. Parenchymal (hepatic)
C. Mechanical
D. Jaundice of infants
E. Gilbert's disease

19. The patient is 33 years old. He has been ill for 10 years. He periodically visits the doctor with complaints of acute abdominal pain, cramps, and visual impairment. His relatives have similar symptoms. The urine is red in color. He is hospitalized with a diagnosis of acute intermittent porphyria. The cause of the disease may be a violation of the biosynthesis of the following substance:
A. Hem
B. Insulin
C. Bile acids
D. Prostaglandins
E. Collagen

20. In the 70s, scientists found that the cause of severe jaundice in newborns is a violation of bilirubin binding in hepatocytes. Which substance is used to form a conjugate?
A. Glucuronic acid
B. Uric acid
C. Sulfuric acid
D. Lactic acid
E. Peracetic acid

21. A premature infant has jaundice. This is due to a lack of which enzyme?
A. UDP transglucuronidase
B. Alkaline phosphatase
C. Acid phosphatase
D. Catalase
E. NAD^+-dehydrogenase

22. In a 20-year-old patient with jaundice, it was found that the content of total bilirubin in the blood plasma increased due to indirect (free), in the feces and urine - a

high content of stercobilin, the level of direct (bound) bilirubin in the blood plasma is within normal limits. What type of jaundice can we think of?
A. Hemolytic
B. Parenchymal (hepatic)
C. Mechanical
D. Jaundice of infants
E. Gilbert's disease

23. A 53-year-old man complained of acute pain in the right hypochondrium. On examination, the doctor noticed yellowed sclerae of the patient. Laboratory tests showed increased ALT activity and a negative reaction to stercobilin in the feces. Which disease is characterized by such symptoms?
A. Cholelithiasis
B. Hemolytic jaundice
C. Hepatitis
D. Chronic colitis
E. Chronic gastritis

Protocol N **Date**

1. Determination of total, direct and indirect bilirubins in the blood serum

THE PRINCIPLE OF THE METHOD:

Diazo-reagent produces a pink colouring with conjugated bilirubin. The intensity of the colouring is proportional to the concentration of conjugated bilirubin and can be determined. Non-conjugated bilirubin can be converted into a soluble form by addition of caffeine reagent to the blood serum and can be determined by diazo-reaction.

THE COURSE OF THE WORK:

Pour 0.5 ml of blood serum (dilute with 0, 9% sodium chloride solution 1:1), in every of 2 test-tubes. Add 1.75 ml of 0.9% NaCl solution and 0.25 ml of Erlich's reagent into one test-tube (determination of conjugated bilirubin). Add 1,75 ml of caffeine reagent and 0.25 ml of Erlich's reagent to the 2-nd one (determination of total bilirubin). Shake up both test tubes and let them stay on the table for 5 min (conjugated bilirubin) and 20 min (total bilirubin).

Measure the optical density of every test tube against water at a green colour filter in cuvettes (5 mm). If colouring in the test tube is slight, add 3 drops of 30% NaOH solution into each test-tube. The content of total and conjugated bilirubin is determined according to the graph. The difference between total and conjugated bilirubin is non-conjugated bilirubin of the blood serum.

Blood serum of healthy people contain: total bilirubin 3.5-20.5 μmol/l; non-conjugated bilirubin – < 12 μmol/l; conjugated bilirubin – < 7μmol/l.

RESULTS:

CONCLUSIONS:

Clinical significance:

The determination of total bilirubin and its fractions has a big clinical significance. It is noticed, that jaundice appears when the total bilirubin level in blood exceeds 27-34 μmol/L (hyperbilirubinemia state).

The increase of non-conjugated bilirubin content in the blood is observed at hemolytic jaundice. The excretion of conjugated bilirubin in the bile capillaries is disturbed at hepatocellular jaundice, so this form is increased in plasma. Conjugated bilirubin appears in the urine. The non-conjugated bilirubin does not appear in the urine. Hyperbilirubinemia is determined at jaundice of newborns (physiological), Crigler-Najjar syndrome, Gilbert's disease etc.

Two main reasons for hyperbilirubinemia are known:

1) The increase of indirect (unconjugated) bilirubin content in the blood plasma;

2) The increase of direct (conjugated) bilirubin content in the blood plasma;

Gilbert's disease is the most common hereditary cause of increased bilirubin and is found in up to 5% of the population. The cause of this hyperbilirubinemia is either defect in the uptake of bilirubin by hepatocytes or the reduced activity of the UDP-glucuronyltransferase, that enzyme which conjugates bilirubin and a few other lipophilic molecules. A major characteristic is jaundice, caused by elevated levels of **unconjugated** bilirubin in the bloodstream. These diseases proceed without increased hemolysis, with decreased contents of sterkobilin and urobilin.

There are actually two types of Crigler-Najjar (CN) syndrome. Type I is a disorder in which patients have no UDP-glucuronyl-transferase activity. The bile is colorless, with only trace amounts of unconjugated bilirubin. So the unconjugated bilirubin backs up into the blood, producing severe jaundice and icterus. The liver, by the way, looks totally normal under the microscope. Type 1 CN is fatal in the neonatal period unless the baby gets a liver transplant.

Type II CN is a disorder in which patients have some UDP-glucuronyltransferase activity, but it is decreased (the enzyme is only capable of forming monoglucuronidated bilirubin). The disorder is not fatal; in fact, the major consequence is simply really yellow skin.

Dubin-Johnson and Rotor syndromes are disorder in which patients have an increase in **conjugated bilirubin** in the blood. It's caused by a defect in secretion of bilirubin glucuronides (already conjugated!) across the canalicular membrane (patients are missing a canalicular protein that transports bilirubin glucuronides into bile). The liver looks normal, and most patients are asymptomatic (other than some jaundice).

Viral hepatitis, obstruction of the bile capillaries are connected with conjugated bilirubin increasing in plasma.

2. The test for bile pigments in the urine (Gmelin`s test).

THE PRINCIPLE OF THE METHOD:

The reaction is based on ability of the bile pigments to be oxidized by concentrated nitric acid. As the result the various colouring products are obtained: for biliverdine (green colour), bilicyanin (blue colour), cholelethine (yellow colour).

Gmelin's test can be carried out in a test tube or on filter paper. It can estimate the bilirubin at dilution 1:80 000.

THE COURSE OF THE WORK:

Pour 1-2 ml of concentrated nitric acid into a test-tube. Stratify cautiously an equal volume of urine over the wall of the test tube. Don't mix! The colour rings will appear in the presence of the bile pigments. The green, blue, violet, red and yellow rings indicate the various pathology states. The brown ring is typical for healthy people.

RESULTS:

CONCLUSIONS:

3. Urobilinogen determination in the urine (Bogomolov`s reaction)

THE PRINCIPLE OF THE METHOD:

Urobilin with copper sulfate gives pink-red compound.

THE COURSE OF THE WORK:

Before carrying out of test add 1-2 drops of iodine solution to urine for oxidation of the urobilinogen bodies in urobilin ones.

Add 2 ml of the saturated copper sulfate solution to 10 ml of urine. If there is the turbidity of solution, add some drops of hydrochloric acid. This gives the transparent solution. Add 2-3 ml of chloroform by drops and shake up. The layer of chloroform is coloured in rose-red color.

RESULTS:

CONCLUSIONS:

Clinical significance:

Urobilinogen, stercobilinogen (urobilinogen bodies) and their oxidized forms: urobilin, stercobilin (urobilin bodies) are pigments that are formed from bilirubin in intestines.

The increased allocation of urobilinogen bodies (urobilin bodies) with urine is called urobilinuria.

Urobilinuria (with determination of urobilinogen) more often occur at hepatocellular diseases of a liver (a hepatites, a cirrhosis, poisonings, etc.), the cardiovascular pathology accompanying with stagnant damage of a liver.

Urobilinogen come back from intestines on a portal vein does not undergo usual transformations for it because of functional failure of liver and it is takes out with urine.

Literature (p. 130)

Lesson 4

THEME: CLASSIFICATION AND PROPERTIES OF HORMONES. THE MECHANISMS OF PROTEIN-PEPTIDE HORMONES AND BIOGENIC AMINES ACTION.

RELEVANCE OF THE THEME: hormones are biologically active substances secreted into the blood by endocrine glands through humoral pathways (via blood, lymph, saliva, cerebrospinal fluid). They regulate all types of metabolic processes and physiological functions. Hormones serve as universal regulators of the organism's vitality, playing a crucial role in maintaining homeostasis and influencing essential life processes such as growth, metabolism, development, immune defense, reproduction, behavior, and adaptation to environmental conditions.

Hormones exert their effects by controlling metabolic processes in target cells through complex interactions with specific receptors. Depending on the cellular localization of these receptors, various mechanisms of hormone action exist. For peptide and protein hormones, membrane and membrane-cytosol mechanisms are characteristic.

THE PURPOSE OF THE LESSON: to study the theoretical material on the classification, biochemical properties, and mechanism of action of protein-peptide hormones. Acquire the ability to perform qualitative determination of insulin and adrenaline.

QUESTIONS FOR PREPARATION

1. General notions about hormones and their properties. The modern methods for their content determination in biological fluids.
2. A Classification of hormones according their chemical nature and the mechanism of action.
3. The determination of target tissue for hormone. Types of receptors; their structure and location in a target cell.
4. Membrane-intracellular mechanism of hormones action: G-proteins, adenylate- and guanylate cyclases, phosphodiesterase, phospholipase C, all the secondary messengers, protein kinases in transmission of hormone action.
5. Hormones of adrenal medulla (epinephrine and nor-epinephrine): structure, synthesis, mechanism of their action, and biological role.
6. Molecular mechanism of insulin action. Receptor tyrosine kinases.

LABORATORY WORKS

Qualitative tests for insulin

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. Identify the amino acid from which catecholamines are synthesized:
A. Lysine
B. Threonine
C. Tyrosine
D. Tryptophan
E. Glutamic acid

2. Identify the hormone that belongs to the class of steroid hormones:
A. Adrenaline
B. Insulin
C. Cortisol
D. Melatonin
E. Adrenocorticotropic hormone

3. Identify the compound that is not a secondary messenger:
A. cAMP
B. cGMP
C. Inositol triphosphate
D. Adenylate cyclase
E. Diacylglycerol

4. Identify the class of complex proteins that perform the function of receptors in the body:
A. Lipoproteins
B. Phosphoproteins
C. Nucleoproteins
D. Glycoproteins
E. Chromoproteins

5. Identify the metal ion that serves as a secondary messenger in the cell:
A. Fe^{3+}
B. Ca^{2+}
C. Na^{+}
D. Mg^{2+}
E. Mn^{2+}

6. Identify the G-protein index that activates adenylate cyclase:
A. I
B. A
C. K
D. S

E. Q

7. Identify the secondary messenger formed as a result of phospholipase C activity:
A. cAMP
B. cGMP
C. Choline
D. Diacylglycerol
E. Na^+

8. According to their molecular organization, insulin receptors are:
A. Heterodimers
B. Heterotetramers
C. Homodimers
D. Homotetramers
E. Hexamers

9. One of the enzymes phosphorylated by receptor tyrosine kinases is:
A. Hexokinase
B. Phospholipase D
C. Protein kinase A
D. Protein kinase C
E. Phospholipase C

10. Identify the enzyme that catalyzes the breakdown of the secondary messenger cAMP to the inactive AMP:
A. Adenylate cyclase
B. Adenylate kinase
C. Guanylate cyclase
D. Protein kinase A
E. Phosphodiesterase

PREPARATION FOR THE KROK-1 LICENSURE EXAM

1. A 42-year-old man was admitted to the cardiology department with a diagnosis of angina pectoris. The complex of drugs prescribed to the patient includes an inhibitor of the enzyme phosphodiesterase. The concentration of which substance in the heart muscle will increase?
A. cyclo-AMP
B. HMF
C. AMP
D. ADP
E. ATP

2.Inositol triphosphates in body tissues are formed as a result of hydrolysis of phosphatidylinositol diphosphates and play the role of secondary mediators (messengers) in the mechanism of hormone action. Their effect in the cell is aimed at:

A. Release of calcium ions from cellular depots
B. Activation of adenylate cyclase
C. Activation of protein kinase A
D. Inhibition of phosphodiesterase
E. Inhibition of protein kinase C

3. A person has been eating foods poor in methionine for a long time, resulting in disorders of the nervous and endocrine systems. This may be a result of a synthesis disorder:
A. Adrenaline
B. Pyruvate
C. Tyronine
D. Fatty acids
E. Glucagon

Protocol N **Date**

1. Color reactions for insulin:

1.1. Biuretic reaction.

THE COURSE OF THE WORK:

To 5 drops of insulin solution 5 drops of 10 % NaOH solution are added, 2 drops of 1 % copper sulfate solution, and all is mixed. The test tube contents get violet color. A copper sulfate shouldn't be added surplusly, as the dark blue residue of the copper hydroxide masks the characteristic violet coloring of the biuretic protein complex.

RESULTS:

CONCLUSIONS:

1.2. Fole's test.

The reaction allows to find the amino acid residues containing sulfur in insulin.

THE COURSE OF THE WORK:

Add 10 drops of 10 % NaOH solution to 10 drops of insulin and boil. After cooling pour some drops of acetic lead solution into the test tube. Brown or black sediment of lead sulfide has to appear there.

RESULTS:

CONCLUSIONS:

Literature (p. 130)

Lesson 5

THEME: MECHANISM ACTION AND INFLUENCE ON METABOLISM OF STEROID AND THYROID HORMONES. THE REGULATION OF CALCIUM AND PHOSPHATES HOMEOSTASIS BY HORMONES IN THE BLOOD.

RELEVANCE OF THE THEME: steroid and thyroid hormones exhibit a cytosolic-nuclear mechanism of action. Representative examples of steroid hormones include adrenal cortex hormones and sex gland hormones. Thyroid hormones encompass those produced by the thyroid gland. The study of these hormones is crucial for understanding mineral and energy metabolism, as well as sexual development, with applications in the development of corresponding hormonal pharmaceuticals.

Calcium (Ca^{2+}) is a ubiquitous macronutrient in the human body. This chemical element plays a crucial role in key physiological and biochemical cellular processes. Calcium ions participate in blood clotting processes and serve as universal secondary messengers within cells, regulating various intracellular processes such as muscle contraction, exocytosis, including the secretion of hormones and neurotransmitters.

THE PURPOSE OF THE LESSON: to study the theoretical material on the mechanism of action, synthesis features, secretion, blood transport, and the impact on metabolism of steroid and thyroid hormones. Be able to conduct qualitative determination of estrone and testosterone.

QUESTIONS FOR PREPARATION

1. Common notions about cytosolic mechanism of lipophilic hormones action: steroidal and thyroid hormones.
2. Hormones of adrenal cortex (glucocorticoids, mineral corticoids): structure, the control of their secretion, the feature of their transport in the blood stream, the influence on the metabolism, the infringements of their secretion. Addison`s disease, Cushing's syndrome.
3. Female sex hormones (estrogens, progesterone): structure, the control of their secretion in each phase of menstrual cycle, the feature of their transport in the blood stream, the influence on the metabolism.
4. Male sex hormones (androgens): structure, the control of their secretion, the feature of their transport in the blood stream, the influence on the metabolism. The infringements of sex hormones` synthesis and secretion.
5. Thyroid hormones (triidothyronine, thyroxin): the features of their synthesis and secretion, their transport in the blood stream, and the influence on the metabolism. The disorders of metabolism at hypo- and hyperthyroidism in patients.
6. Distribution of calcium ions in the body, forms of calcium in human blood plasma
7. Hormonal regulation of calcium and phosphate homeostasis.

LABORATORY WORKS

Determination of total calcium levels in the blood serum

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. Point out the location of the receptor for steroid hormone in a target cell:
A. Membrane
B. Mitochondria
C. Ribosome
D. Cytoplasm
E. Lysosome

2. Point out the hormone that is intermediate metabolite for testosterone and estradiol synthesis:
A. Aldosterone
B. Cortisol
C. Progesterone
D. 25-hydrooxy cholecalciferol
E. 17-ketosteroid

3. Point out the major hormone of luteal phase in females:
A. Progesterone
B. Cortisol
C. Aldosterone
D. Androstenedione
E. 17-ketosteroid

4. Find out the substance whose content will be increased in the blood after the influence of glucocorticoids on the liver metabolic pathways:
A. Glucose
B. Alanine
C. Palmitic acid
D. Oxygen
E. Carbon monooxide

5. What function in the target cell may be found for thyroxin at its levels which are higher then physiological?:
A. Catalytic function
B. Secondary messenger function
C. Uncoupler for oxidative phosphorylation
D. Allosteric inhibitor for ATP synthetase
E. Suppresser of calcium transport across cellular membrane

6. What amino acid residue is considered as precursor for thyroid gland hormone formation:
A. Glycine

B. Alanine
C. Proline
D. Tyrosine
E. Valine

7. Find out the main target tissues for parathyroid hormone (PTH):
A. Liver tissue, only
B. Bone, kidney tissues
C. Nervous tissue
D. Spleen tissue
E. Skeletal muscular tissue

8. Name the index of blood plasma whose content will be increased after parathyroid hormone secretion:
A. Calcium ions
B. Ammonia
C. Urea
D. Uric acid
E. Zinc ions content

9. Name the enzyme whose activity is controlled by PTH in kidney tissue:
A. Alpha-1-hydroxylase
B. 25-hydroxylase
C. Pyruvate dehydrogenase
D. Prostaglandin synthetase
E. Prostacyclin hydratase

10. What influence of calcitriol on kidney tissue is observed at its excess levels in the blood?
A. Protein degradation induction
B. The feed-back inhibition of alpha-1-hydroxylase
C. The allosteric activation of alpha-1-hydroxylase
D. Activation of calcidiol formation
E. Inhibition of calcidiol formation

PREPARATION FOR THE KROK-1 LICENSURE EXAM

1. A patient living in a specific geochemical area was diagnosed with endemic goiter. What type of post-translational modification of thyroglobulin is disturbed in his body?
A. Methylation
B. Phosphorylation
C. Acetylation
D. Glycosylation
E. Iodination

2. A person has decreased diuresis, hypernatremia, hypokalemia. Hypersecretion of which hormone can cause such changes?
A. Adrenaline
B. Aldosterone
C. Vasopressin
D. Parathormone
E. Atrial natriuretic factor

3. By the method of indirect calorimetry it was found that the basic metabolism of the subject is 40% lower than normal. Violation of the activity of which endocrine gland is the cause?
A. Pancreas
B. Adrenal gland
C. Thymus
D. Epiphysis
E. Thyroid gland

4. A patient complained of constant thirst. Hyperglycemia, polyuria and increased content of 17-keto-steroids in the urine were found. Which disease is most likely?
A. Addison's disease
B. Myxedema
C. Glycogenosis type I
D. Steroid diabetes mellitus
E. Insulin-dependent diabetes mellitus

5. A patient complained of weight loss by 10 kg in 2 months, palpitations, and staring. For the hyperfunction of which endocrine gland (glands) these complaints are most characteristic?
A. Thyroid
B. Adrenal gland
C. Pancreas
D. Parathyroid glands
E. Ovaries

6. Testosterone and its analogs increase the mass of skeletal muscles, which allows them to be used for the treatment of dystrophies. Interaction with which cellular substrate is responsible for this effect?
A. Membrane receptors
B. Ribosomes
C. Chromatin
D. Nuclear receptors
E. Transcriptional activator proteins

7. During the examination of the patient, the doctor suspected Itzenko-Cushing's syndrome. Determination of which substance in the patient's blood will confirm the doctor's assumption?
A. Adrenaline
B. Tocopherol
C. Cholesterol
D. Retinol
E. Cortisol

8. In case of thyrotoxicosis, the production of thyroid hormones T3 and T4 increases, tachycardia, weight loss, mental agitation, etc. develops. How exactly do thyroid hormones affect energy metabolism in mitochondria?
A. Block substrate phosphorylation
B. Separate oxidation and non-oxidative phosphorylation
C. Activate oxidative phosphorylation
D. Block the respiratory chain
E. Activate substrate phosphorylation

9. A 38-year-old woman complains of excessive sweating, palpitations, and fever in the evening. Basal metabolism increased by 60%. The doctor diagnosed thyrotoxicosis. What properties of thyroxine lead to increased heat production?
A. Reduces the deamination of amino acids
B. Increases oxidation and phosphorylation coupling
C. Uncouples oxidative phosphorylation
D. Promotes the accumulation of acetyl-CoA
E. Reduces β-oxidation of fatty acids

10. A patient diagnosed with Itzenko-Cushing's disease (adrenal cortex hyperproduction) has an increased concentration of glucose, ketone bodies, and sodium in the blood. What biochemical mechanism is the leading one in the occurrence of hyperglycemia?
A. Gluconeogenesis
B. Glycogenesis
C. Glycogenolysis
D. Glycolysis
E. Aerobic glycolysis

11. A 44-year-old woman complains of generalized weakness, pain in the heart, significant weight gain. Objectively: hirsutism, blood pressure – 165/100 mm Hg, height – 164 cm, weight – 103 kg; mainly accumulation of fat on the neck, upper shoulder girdle, abdomen. What is the main pathogenetic mechanism of obesity in a woman?
A. Decrease in glucagon production
B. Increased production of insulin
C. Decreased production of thyroid hormones

D. Increased production of glucocorticoids
E. Increased production of mineralocorticoids

12. A patient with neurodermatitis has been taking prednisolone for a long time. During the examination, he was found to have an increase in blood sugar. The effect of drugs on which link of carbohydrate metabolism leads to this complication?
A. Activation of glycogenolysis
B. Increased intestinal glucose absorption
C. Activation of insulin breakdown
D. Activation of gluconeogenesis
E. Inhibition of glycogen synthesis

13. The patient is registered in an endocrinology clinic for hyperthyroidism. Weight loss, tachycardia, tremors of fingers and toes have been accompanied by symptoms of hypoxia – headache, fatigue, flashing of "flies" before the eyes. What is the mechanism of action of thyroid hormones underlying the development of hypoxia?
A. Specific binding of active centers of respiratory enzymes
B. Competitive inhibition of respiratory enzymes
A. Decoupling of oxidation and phosphorylation
B. Enhancing the synthesis of respiratory enzymes
C. Inhibition of synthesis of respiratory enzymes

14. The parents of a 10-year-old boy with increased body hair, beard and mustache growth, and a low voice came to the doctor. Increased secretion of which hormone can be assumed?
A. Estrogen
B. Progesterone
C. Cortisol
D. Somatotropin
E. Testosterone
15. The patient was diagnosed with hyperkalemia and hyponatremia. Reduced secretion of which hormone can cause such changes?
A. Aldosterone
B. Vasopressin
C. Cortisol
D. Parathormone
E. Natriuretic

16. Residents of the territory with a cold climate have an increased content of a hormone in the blood that has an adaptive thermoregulatory value. What hormone is it?
A. Thyroxine
B. Glucagon
C. Insulin
D. Cortisol

E. Somatotropin

17. In case of chronic overdose of glucocorticoids, hyperglycemia develops. Name the process of carbohydrate metabolism, which increases the concentration of glucose in the blood plasma:
A. Gluconeogenesis
B. Glycogenolysis
C. Aerobic glycolysis
D. Pentose phosphate cycle
E. Schogenesis

18. The patient's endocrine function of ovarian follicular cells is impaired due to inflammation. The synthesis of which hormones will be suppressed?
A. Estrogens
B. Progesterone
C. Lutropin
D. Follicle stimulating hormone
E. Follistatin

Protocol N **Date**

Determination of total calcium levels in the blood serum

THE PRINCIPLE OF THE METHOD:

Free murexide has a blue-violet colour in alkaline environment and it can obtain a complex with calcium (pinky-orange colour). During titration with trilon B solution this complex is destructed and free murexide is released. The sample gets violet colour.

THE COURSE OF THE WORK:

Pour 20 ml of distilled water, 0.2 ml of 9N NaOH solution into a flask for titration and add 0,5 ml murexide solution (30-40 mg murexide in 1 ml of distilled water). The solution will have the violet colour. Add precisely 1 ml of the blood serum, mix the content, the pink colour will appear soon. The titration with trilon B continues till the violet coloring will appear (the volume A). The volume B is determined by the same way for standard calcium solution (2 mmol/L).

Calculation is carried out by the formula.

$$X = \frac{A}{B} \cdot C, \text{ where}$$

X - concentration of total calcium in the blood serum (mmol/L);

À - volume of trilon B solution, used for titration of test sample (ml);

B - volume of trilon B solution, used for titration of standard sample (ml);

C - concentration of calcium in a standard solution (2 mmol/L)

The normal content of the total calcium in the blood serum is 2,25-2,75 mmol/L (9,0-11 mg%).

RESULTS:

CONCLUSIONS:

Clinical significance.

Hypercalcemia can be physiological and pathological. Physiological one takes place at newborns after 4-th day of life and also after acceptance of food (alimentary). Pathological hypercalciemia is observed at hypersecretion of parathormone, hypervitaminose D, Addison disease, acromegaly, leucosis, gangrene, peritonitis (owing to disintegration of cells, containing calcium), at jaundice, intimate insufficiency.

Hypocalcemia is marked at infringement of absorption in the intestines (as the result of steatorrhea) or at hypovitaminose D, during chronic nephritis, diarrhea, sharp pancreatitis and at children's convulsive state (tetany) - the insufficiency of parathyroid glands.

Literature (p. 130)

Lesson 6

THEME: THE ROLE OF HORMONES IN THE REGULATION OF METABOLIC PROCESSES. FORMATION AND FUNCTIONS OF EICOSANOIDS.

RELEVANCE OF THE THEME: the pituitary gland serves as the central endocrine organ in the human body and higher animals. It controls the endocrine activity of most subordinate (peripheral) glands of internal secretion. In turn, the functional activity of the pituitary is regulated by neuroendocrine cells of specific nuclei in the hypothalamus. Hormones and/or neuromediators (or modulatory neuropeptides) from the hypothalamic and other subcortical nuclei of the brain control the secretion (and in some cases, biosynthesis, production) of pituitary hormones.

Pancreatic hormones play a crucial role in regulating the homeostasis of glucose (the primary energy metabolite of the body). Insulin, the only hormone in the human body responsible for maintaining blood sugar levels and facilitating glucose transport into cells, is of paramount importance. Disruptions in its metabolism play a central role in the pathogenesis of diabetes mellitus.

Eicosanoids are lipid compounds that function as regulators of cellular functions and, in many cases, act as mediators in the implementation of specific effects of other hormones and mediators on the cell. These properties allow considering disturbances in their metabolism as important factors in the pathogenesis of hypertension, bronchial asthma, weak uterine contractions during labor, etc., and applying eicosanoid drugs in pharmacotherapy.

THE PURPOSE OF THE LESSON: to consolidate the theoretical material on the role of hormones in the regulation of metabolic processes. Study the theoretical aspects of the chemical nature, biosynthesis, mechanism of action, and impact on metabolism of hormones from the hypothalamus, anterior pituitary, and pancreas.

QUESTIONS FOR PREPARATION

1. Feed-back mechanism in the maintenance of hormone levels in the blood. Short and long back communications in the block of hormones secretion.
2. Hypothalamic hormones (liberins and statins): structure, mechanism of their action, and the influence on pituitary gland.
3. Hormones of anterior lobe of pituitary gland (STH, TTH, FSH, LH, prolactin): the features of structure, the regulation of secretion, the influence on target tissues, the disorder associated with their secretion disturbance.
4. Hormones – the products of post-translational modification of pro-opiomelanocortin (ACTH, MSH, lipotropins, endorphins): the features of structure and function in humans.
5. Hormones of posterior pituitary (oxytocin and vasopressin), their structure and biological role. The disorder vasopressin secretion (diabetes insipidus).
6. Pancreatic hormones (insulin, glucagon): synthesis from precursors, structure and mechanism of action, the influence on the metabolism in target tissues. The disorder of the secretion (diabetes mellitus).
7. Insulin-like growth factors: the location of synthesis, factors for control of their secretion, the characteristic of their influence on the metabolism in comparison with insulin.
8. Eicosanoids (prostaglandins, thromboxans, prostacyclins and leucotrienes): their formation and function in tissues.
9. The regulation of eicosanoids metabolism by some drugs.
10. Mediators and hormones of the immune system (cytokines, interferons): chemical nature, synthesis, biochemical effects.

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. Identify the target organs for corticotropin hormone:

A. Adenohypophysis
B. Thyroid gland
C. β-Cells of the Islets of Langerhans
D. Cortex of the adrenal glands
E. Medulla of the adrenal glands

2. Identify the hormones that do not enter the general bloodstream after synthesis:

A. Thyroid hormones
B. Steroid hormones
C. Releasing factors
D. Tropic hormones
E. Insulin

3. Identify the hormone synthesized in the hypothalamus and stored in the neurohypophysis:
A. Thyrotropin
B. Vasopressin
C. Parathyroid hormone
D. Thyroxine
E. Progesterone

4. Identify the hormone that shares identical α-subunits but different β-subunits with thyrotropin:
A. Somatotropin
B. Luteotropin
C. Corticotropin
D. Prolactin
E. Somatomedin

5. Identify the hormone for which adrenocorticotropic hormone (ACTH) is a precursor:
A. TSH (thyroid-stimulating hormone)
B. STH (somatotropic hormone)
C. LH (luteinizing hormone)
D. FSH (follicle-stimulating hormone)
E. α-MSH (melanocyte-stimulating hormone)

6. Identify the hormone that inhibits the release of ACTH from the pituitary gland:
A. Thyroxine
B. Cortisol
C. Insulin
D. Glucagon
E. Prolactin

7. Identify the protein that transports oxytocin and vasopressin from the hypothalamus to the pituitary gland:
A. Ferritin
B. Albumin
C. Transcortin
D. Neurophysin
E. Erythropoietin

8. Identify the mechanism of converting proinsulin into its active form:
A. Cleavage of the C-peptide
B. Oxidation of C-terminal amino acids
C. Cleavage of the nonapeptide inhibitor
D. Binding of a cofactor
E. Formation of a complex with metal ions

9. Identify the name of the hypothalamic hormones that promote the release of hormones from the adenohypophysis:
A. Tropic hormones
B. Statins
C. Liberins
D. Promoters
E. Kinins

10. Identify the neuropeptides that have analgesic effects:
A. Catecholamines
B. Prostaglandins
C. Endorphins
D. Progestins
E. Thyroids

11. Identify the hormone, the impaired synthesis of which in the hypothalamus leads to diabetes insipidus:
A. Insulin
B. Vasopressin
C. Glucagon
D. Cortisol
E. Oxytocin

12. Identify the hormone of the pancreas that possesses counterregulatory activity:
A. Vasopressin
B. Sinestrol
C. Thyroxine
D. Adrenaline
E. Glucagon

13. Identify the substance that is a precursor to all prostaglandins:
A. Cholesterol
B. Vitamin D
C. Arachidonic acid
D. Tyrosine
E. Sphingomyelin

14. Identify which phospholipase catalyzes the release of arachidonic acid from membrane phospholipids:
A. Phospholipase A_1
B. Phospholipase A_2
C. Phospholipase C
D. Phospholipase D
E. Phospholipase E

15. Choose the enzyme that acts at the initial stage of prostaglandin synthesis:
A. Dehydrogenase
B. Peroxidase
C. Prostaglandin synthetase
D. Cytochrome oxidase
E. Catalase

16. Choose the compound that does not belong to prostanoids:
A. Prostaglandin D_2
B. Prostacyclin I_2
C. Thromboxane A_2
D. Leukotriene A_4
E. Prostaglandin E_2

17. Identify the end products of the lipoxygenase pathway of arachidonic acid metabolism:
A. Thromboxanes
B. Prostaglandins
C. Prostacyclins
D. Leukotrienes
E. Prostane acid

18. Choose a drug that irreversibly inhibits the cyclooxygenase of arachidonic acid:
A. Norfloxazol
B. Diclofenac
C. Sulfadimethoxine
D. Vitamin E
E. Aspirin

19. Identify the mechanism of action of prostaglandins on the cell:
A. Membrane-intracellular
B. Membrane
C. Extracellular
D. Intracellular
E. Cytosolic

20. Identify the main biological action of thromboxane A_2 (TXA_2):
A. Promotes excretion of Na^+ from the body
B. Constricts blood vessels
C. Facilitates K^+ retention in the body
D. Increases diuresis
E. Dilates blood vessels

1. For analgesia, substances that mimic the effects of morphine but are produced in the CNS can be used. Specify them.
A. Vasopressin
B. β-Endorphin
C. Oxytocin
D. Calcitonin
E. Somatoliberin

2. In a patient with chronic inflammatory process of the skin and subcutaneous tissue, the predominance of proliferation processes was determined. The lack of which hormone in the body can lead to this?
A. Cortisone
B. Insulin
C. Thyroxine
D. GH
E. Aldosterone

3. The patient has been taking glucocorticoids for a long time. After abrupt drug discontinuation, he complains of myalgia, fatigue, emotional instability, headache, insomnia, loss of appetite, nausea. Glucocorticoid withdrawal syndrome has developed. Which drugs are indicated for the correction of this condition?
A. Mineralocorticoids
B. Glucocorticoids
C. ACTH
D. Adrenaline
E. Corticosteroids

4. An elderly patient was observed to have enlarged and thickened fingers, hands, feet, nose and lower jaw. These disorders are associated with an increase in the secretion of which hormone?
A. Parathyroid hormone
B. Insulin
C. Adrenocorticotropin
D. Thyrotropin
E. Somatotropin

5. A 55-year-old patient is being examined by an endocrinologist for endocrine disorders of the pancreas, which is manifested by a decrease in the amount of the hormone glucagon in the blood. What cells of this gland are impaired in this case?
A. δ_1-Cells of the islets of Langerhans
B. δ-Cells of the islets of Langerhans
C. α-Cells of the islets of Langerhans
D. PP cells of the islets of Langerhans
E. β-Cells of the islets of Langerhans

6. A very tall patient with long, thick fingers, a large lower jaw and a drooping lower lip came to the doctor's office. Increased secretion of which hormone of which gland can be suspected?
A. Thyroid hormones
B. Antidiuretic hormone of the posterior pituitary gland
C. Somatotropic hormone of the anterior pituitary gland
D. Gonadotropic hormones of the anterior pituitary gland
E. Adrenal hormones from the group of glucocorticoids

7. The secretion of which pituitary hormones is inhibited after taking oral contraceptives containing sex hormones?
A. Gonadotropic
B. Vasopressin
C. Thyrotropic
D. Somatotropic
E. Oxytocin

8. A patient who has been taking glucocorticoids for a long time, as a result of drug withdrawal, has an exacerbation of the disease, lowering of blood pressure, weakness. What can be associated with these phenomena?
A. The occurrence of adrenal insufficiency
B. Addiction to the drug
C. Sensitization
D. Hyperproduction of corticotropic hormone
E. Cumulation

9. A 50-year-old patient complains of of thirst, drinks a lot of water; severe polyuria. Blood glucose is 4.8 mmol/L. In the urine there is no glucose and acetone bodies, the urine is colorless, specific gravity – 1.002-1.004. What is the cause of polyuria?
A. Lack of vasopressin
B. Hypothyroidism
C. Insulin insufficiency
D. Aldosteronism
E. Thyrotoxicosis

10. A mother consulted a doctor whose son grew by 18 cm over the summer. On examination the boy is 12 years old: height – 180 cm, weight 68 kg. With the hyperfunction of which endocrine gland can this be associated?
A. Pituitary gland
B. Thyroid
C. Adrenal gland
D. Pancreas
E. Epiphysis

11. A person has been taking a drug from the group of glucocorticoid hormones for a long time as prescribed by a doctor. The secretion of which (which) of the following hormones will be suppressed as a result?
A. Corticotropic
B. Somatotropic
C. Thyrotropic
D. Sexual
E. Mineralocorticoids

12. A person has a sharp decrease in diuresis due to the loss of 1.5 liters of blood. Increased secretion of which hormone primarily caused changes in diuresis?
A. Parathyroid hormone
B. Cortisone
C. Oxytocin
D. Natriuretic
E. Vasopressin

13. A pregnant woman with weak labor activity was admitted to the maternity ward. Prescribe a hormonal agent to enhance labor activity:
A. Oxytocin
B. Progesterone
C. Methandrostenolone
D. Hydrocortisone
E. ACTH

14. The patient has reduced synthesis of vasopressin, which leads to polyuria and, as a result, to severe dehydration. What is the mechanism of polyuria development?
A. Decreased tubular reabsorption of water
B. Decreased tubular reabsorption of Na ions
C. Decreased tubular reabsorption of protein
D. Decreased glucose reabsorption
E. Increased glomerular filtration rate

15. A 32-year-old woman complained of lack of lactation after the birth of a child. Deficiency of which hormone can explain this disorder?
A. Prolactin
B. Somatotropin
C. Vasopressin
D. Thyrocalcitonin
E. Glucagon

16. The products of hydrolysis and modification of some proteins are biologically active substances – hormones. Lipotropin, corticotropin, melanotropin and endorphins are formed in the pituitary gland from which of the following proteins?
A. Proopiomelanocortin (POMC)

B. Neuroalbumin
C. Neurostromin
D. Neuroglobulin
E. Thyroglobulin

17. A 42-year-old patient complains of palpitations, sweating, nausea, visual disturbances, hand tremors, and high blood pressure. From the anamnesis: 2 years ago, he was diagnosed with pheochromocytoma. Hyperproduction of which hormones causes this pathology?
A. Catecholamines
B. Aldosterone
C. Glucocorticoids
D. ACTH
E. Thyroid hormones

18. After parenteral administration of a hormone, a patient woman experienced an increase in blood pressure and also increased blood glucose and lipid levels. What hormone was injected?
A. Adrenaline
B. Glucagon
C. Insulin
D. Progesterone
E. Folliculin

19. Aspirin has an anti-inflammatory effect because it inhibits the activity of cyclooxygenase. The level of which biologically active substances will decrease?
A. Iodothyronine
B. Biogenic amines
C. Leukotrienes
D. Prostaglandins
E. Catecholamines

20. The utilization of arachidonic acid by the cyclooxygenase pathway produces biologically active substances. Specify them:
A. Prostaglandins
B. Thyroxine
C. Biogenic amines
D. Somatomedins
E. Insulin-like growth factors

21. The secretion of which pituitary hormones is inhibited after taking oral contraceptives containing sex hormones?
A. Gonadotropin-releasing hormones
B. Vasopressin
C. Thyrotropic

D. Somatotropic
E. Oxytocin

22. The animal was intravenously injected with a concentrated solution of sodium chloride, which caused a decrease in the reabsorption of sodium ions in the renal tubules. As a result of of what changes in hormone secretion?
A. Reduction of aldosterone
B. Increase in aldosterone
C. Decrease in vasopressin
D. Increase in vasopressin
E. Decrease in natriuretic factor

23. The lack of linoleic and linolenic acids in the body leads to skin damage, hair loss, slow wound healing, thrombocytopenia, and reduced resistance to infectious diseases. Disruption of the synthesis of which substances is most likely to cause these symptoms?
A. Eicosanoids
B. Interleukins
C. Interferons
D. Catecholamines
E. Corticosteroids

24. After suffering from sepsis, a 27-year-old patient developed a bronze skin color characteristic of Addison's disease. The mechanism of hyperpigmentation is an increase in the secretion of the following hormone:
A. Melanocyte stimulating hormone
B. Somatotropic
C. Gonadotropic
D. B-lipotropic
E. Thyrotropic

25. Bioregulators of cellular functions of lipid nature include thromboxanes. The source for the synthesis of these compounds is:
A. Arachidonic acid
B. Stearic acid
C. Palmitic acid
D. Phosphatidic acid
E. Palmitoleic acid

26. In a 28-year-old patient, prolonged vomiting led to dehydration. Increased secretion of which hormone will primarily contribute to the preservation of water in the body?
A. Vasopressin
B. Calcitonin
C. Thyroxine

D. Somatostatin
E. Aldosterone

27. As a result of a domestic injury, the patient had significant blood loss, which was accompanied by a decrease in of blood pressure. The action of which hormones ensures rapid recovery of blood pressure caused by blood loss?
A. Adrenaline, vasopressin
B. Cortisol
C. Sexual
D. Oxytocin
E. Aldosterone

28. A 26-year-old woman was admitted to the maternity ward at 40 weeks' gestation. The cervix is dilated, but there are no uterine contractions. The doctor gave a hormonal agent to increase labor activity. Name the drug:
A. Oxytocin
B. Hydrocortisone
C. Estrone
D. Testosterone
E. ACTH

Literature (p. 130)

Lesson 7

THEME: INTERMEDIATE CONTROL ON BASIC THEMES 6, 7.
CONTROL WORK № 2.

QUESTIONS FOR PREPARATION

1. Nucleoproteins digestion in the gastro-intestinal tract. Nucleosides absorption in the small intestine.
2. The common representations about biosynthesis of purine nucleotides (phases, energy suppliers, vitamins intake), its regulation.
3. The degradation of purine nucleotides in tissues. The determination of uric acid in the blood serum and urine of patients.
4. The common representations about pyrimidine nucleotides biosynthesis, its regulation.
5. Deoxyribonucleotide synthesis. The formation of dTMP; the inhibitors for this synthesis in cancer treatment.
6. The end-products of pyrimidine nucleotide degradation.
7. Hypo- and hyperuricemia states in patients: the reasons of development and diagnostics. The gout: the diagnostic tests for it and its treatment.
8. Molecular Mechanisms of DNA Replication. Types of Replication. Sequence of Stages and Enzymes Involved in DNA Synthesis in Prokaryotes and Eukaryotes.

9. Mutations and Mechanisms of Action of Mutagens. Concepts of Molecular Diseases.
10. Biological Role and Mechanisms of DNA Repair.
11. Contemporary Insights into the Transcription Mechanism. RNA Polymerases in Prokaryotes and Eukaryotes, Transcription Signals. Post-transcriptional Processing of Primary Transcript (mRNA Maturation in Eukaryotes).
12. Stimulators and Inhibitors of Nucleic Acid Biosynthesis.
13. General Concepts of Genetic Engineering and Its Biomedical Significance.
14. Genetic Code and Its Properties.
15. Ribosomal Protein Synthesis System of the Cell.
16. Structure and Biological Role of RNA (tRNA, mRNA, rRNA) in Protein Biosynthesis (Translation).
17. Mechanism of Translation and Its Stages. Energetic Provision of Protein Synthesis. Post-translational Processing of Polypeptide Chains.
18. Modern Insights into Intracellular Regulation of Gene Expression in Prokaryotes: Regulatory Scheme according to F. Jacob and J. Monod (Operon Hypothesis). Concepts of Gene Induction and Repression Mechanisms.
19. Antibiotics – Inhibitors of Protein Biosynthesis.
20. Chromoproteins: a classification, and biological role.
21. Hemoglobin: types in adults, their structure, properties and biological role.
22. Normal hemoglobin derivatives. Derivatives of hemoglobin formed under carbon monooxide poisoining and influence the strong oxidation agents.
23. Abnormal types of hemoglobin (at sickle-cell anemia and talassemia states).
24. Stages of hemoglobin synthesis, and its regulation.
25. Porphyrins: a scheme of protoprohyrin IX and heme synthesis. Inherited disorders of enzymes for this synthesis. Types of Porphyries.
26. Hemoglobin catabolism in humans: the location of stages, formation of bile pigments. Terminal bile pigments found in feces and urine. The role of the liver in the hemoglobin catabolism.
27. The infringements in the hemoglobin catabolism. Jaundices: types, the reasons of occurance, and diagnostic.
28. General notions about hormones and their properties. The modern methods for their content determination in biological fluids.
29. A Classification of hormones according their chemical nature and the mechanism of action.
30. The determination of target tissue for hormone. Types of receptors; their structure and location in a target cell.
31. Membrane-intracellular mechanism of hormones action: G-proteins, adenylate- and guanylate cyclases, phosphodiesterase, phospholipase C, all the secondary messengers, protein kinases in transmission of hormone action.
32. Hormones of adrenal medulla (epinephrine and nor-epinephrine): structure, synthesis, mechanism of their action, and biological role.
33. Molecular mechanism of insulin action. Receptor tyrosine kinases.
34. Common notions about cytosolic mechanism of lipophilic hormones action: steroidal and thyroid hormones.

35. Hormones of adrenal cortex (glucocorticoids, mineral corticoids): structure, the control of their secretion, the feature of their transport in the blood stream, the influence on the metabolism, the infringements of their secretion. Addison`s disease, Cushing's syndrome.
36. Female sex hormones (estrogens, progesterone): structure, the control of their secretion in each phase of menstrual cycle, the feature of their transport in the blood stream, the influence on the metabolism.
37. Male sex hormones (androgens): structure, the control of their secretion, the feature of their transport in the blood stream, the influence on the metabolism. The infringements of sex hormones` synthesis and secretion.
38. Thyroid hormones (triidothyronine, thyroxin): the features of their synthesis and secretion, their transport in the blood stream, and the influence on the metabolism. The disorders of metabolism at hypo- and hyperthyroidism in patients.
39. Distribution of calcium ions in the body, forms of calcium in human blood plasma
40. Hormonal regulation of calcium and phosphate homeostasis.
41. Feed-back mechanism in the maintenance of hormone levels in the blood. Short and long back communications in the block of hormones secretion.
42. Hypothalamic hormones (liberins and statins): structure, mechanism of their action, and the influence on pituitary gland.
43. Hormones of anterior lobe of pituitary gland (STH, TTH, FSH, LH, prolactin): the features of structure, the regulation of secretion, the influence on target tissues, the disorder associated with their secretion disturbance.
44. Hormones – the products of post-translational modification of proopiomelano-cortin (ACTH, MSH, lipotropins, endorphins): the features of structure and function in humans.
45. Hormones of posterior pituitary (oxytocin and vasopressin), their structure and biological role. The disorder vasopressin secretion (diabetes insipidus).
46. Pancreatic hormones (insulin, glucagon): synthesis from precursors, structure and mechanism of action, the influence on the metabolism in target tissues. The disorder of the secretion (diabetes mellitus).
47. Insulin-like growth factors: the location of synthesis, factors for control of their secretion, the characteristic of their influence on the metabolism in comparison with insulin.
48. Eicosanoids (prostaglandins, thromboxans, prostacyclins and leucotrienes): their formation and function in tissues.
49. The regulation of eicosanoids metabolism by some drugs.
50. Mediators and hormones of the immune system (cytokines, interferons): chemical nature, synthesis, biochemical effects.

THE QUESTIONS FOR LABORATORY WORKS

1. The determination of uric acid content in the blood serum and in the urine (the principle of the method). Clinical significance of uric acid determination in biological fluids.

2. Determination of total, direct and indirect bilirubins in the blood serum. The principle & clinical significance of the method.
3. The test for bile pigments in the urine (Gmelin`s test). The principle of the method
4. Urobilinogen determination in the urine (Bogomolov`s reaction). The principle of the method
5. The allocation of deoxynucleoproteins from the spleen (the principle of the method).
6. Biuretic reaction and Fol`s test for hormones-polypeptides and proteins (the example: insulin). What structural fragments are proved in insulin molecule by these reactions?
7. Determination of total calcium levels in the blood serum. The principle & clinical significance of the method.

Literature (p. 130)

Lesson 8

THEME: THE ROLE OF WATER-SOLUBLE AND FAT-SOLUBLE VITAMINS IN METABOLISM. VITAMIN-LIKE SUBSTANCES.

RELEVANCE OF THE THEME: vitamins are essential for the normal vital activity, being low-molecular-weight organic compounds of chemical nature that are not synthesized within the organism. Therefore, they are indispensable nutritional factors. The majority of water-soluble vitamins, either obtained from food or synthesized by intestinal bacteria, manifest their function subsequent to the formation of respective cofactors (coenzymes) during metabolism. The consequence of insufficient intake of these vitamins is a disruption in the function of regenerative complex enzymes, disturbing the metabolism of substances in the organism.

THE PURPOSE OF THE LESSON: to study the materials regarding the section "Water-Soluble Vitamins": their chemical structures, properties, and biological roles; to master qualitative and quantitative methods for determining vitamins B_1 and C in food products and urine. To study the material regarding the section "Fat-Soluble Vitamins," especially their absorption characteristics. To acquire proficiency in qualitative determination methods for vitamins A, D, and K_1 in medicinal preparations.

QUESTIONS FOR PREPARATION

1. Common notions about Vitamins and their role in metabolism. Provitamins. Classification of vitamins. The features of absorption for water-soluble and fat-soluble vitamins in the gastro-intestinal tract.
2. Hypovitaminosises (vitamins deficiency): exogenous and endogenous reasons of their development. Avitaminosis (examples). Hypervitaminosis state for fat-soluble vitamins.

3. Water-soluble vitamins (H, B_1, B_2, PP (B_3), B_5, B_6, B_9, B_{12}): structure, sources of reception, daily requirement, biological role.
4. Vitamins C and P: structure, mechanisms of function in humans, daily requirement, and clinical symptoms of their deficiency.
5. Vitamin-similar substances (CoQ, carnitine, lipoic acid): structure and function in humans.
6. A group of vitamin A (retinol, retinal, retinoic acid) and β-carotines: structure, sources of reception, daily requirement, biological role; clinical symptoms of deficiency
7. A group of vitamin E (tocopherols): structure, sources of reception, daily requirement, biological role; clinical symptoms of deficiency.
8. A group of vitamin D (D_2, D_3, calcitriols): structure, sources of reception, daily requirement, biological role; clinical symptoms of deficiency in children (1-3 years of age) and in adults. Symptoms of hypervitaminosis.
9. A group of vitamin K (naphtoquinones): structure, sources of reception, daily requirement; the use in blood coagulation system and in the metabolism of bone tissue. Clinical symptoms of deficiency. Analogs and antagonists of vitamin K as preparations.
10. Vitamin F (a complex of unsaturated high fatty acids): structure, sources of reception, daily requirement, biological role; clinical symptoms of deficiency.
11. Interaction of vitamins. Combined vitamin drugs (multi-vitamins) in the prophylactic and treatment of some diseases.
12. Antivitamins: the examples of their mechanism of action.

LABORATORY WORKS

The determination of ascorbic acid content in food products and in the urine.

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. The active form of vitamin B_1 is:
A. Nicotinamideadeninedinucleotide
B. Flavin mononucleotide
C. Thiamine pyrophosphate
D. Oxythiamine
E. Neopyrithiamine

2. The characteristic biochemical disturbance in vitamin B1 deficiency is:
A. Positive nitrogen balance
B. Increased levels of pyruvate and lactate in the blood
C. Decreased amino acid content in the urine
D. Decreased creatine levels in the urine
E. Decreased levels of α-ketoglutarate and pentoses in the blood and tissues

3. Select the vitamin based on the molecule of isoalloxazine linked to ribitol:
A. Vitamin B_2
B. Vitamin B_1

C. Vitamin D
D. Vitamin K
E. Vitamin B_3

4. Coenzyme forms of vitamin B_2 are:
A. NAD^+ and $NADP^+$
B. FAD and FMN
C. TPP
D. Pyridoxal phosphate
E. THFA

5. Pellagra develops due to the deficiency of which of the following vitamins:
A. Vitamin B_1
B. Vitamin B_3
C. Vitamin B_5
D. Vitamin PP (niacin)
E. Vitamin C

6. The chemical name of vitamin H is:
A. Para-aminobenzoic acid
B. Pantothenic acid
C. Pangamic acid
D. Biotin
E. Ubiquinone

7. A characteristic manifestation of vitamin B_{12} deficiency is:
A. Megaloblastic anemia
B. Symmetrical dermatitis
C. Degenerative changes in reproductive organs
D. Recent memory loss
E. Specific lesions of mucous membranes and vision organs

8. Coenzyme form of vitamin B_3 is:
A. CoA
B. CoQ
C. NADH
D. TGF-K
E. Deoxyadenosylcobalamin

9. Choose the type of reactions in which vitamin C participates:
A. Oxidation-reduction
B. Carboxylation
C. Decarboxylation
D. Hydrolytic
E. Deamination

10. Among the listed substances, select the one that does not belong to the group of vitamin-like compounds:
A. Inositol
B. Pangamic acid
C. Choline
D. Lipoic acid
E. Asparaginic acid

11. Among the listed vitamins, select the fat-soluble one:
A. Vitamin C
B. Vitamin D
C. Vitamin H
D. Vitamin B_{12}
E. Vitamin B_1

12. Select the property that is not characteristic of antivitamins:
A. Structural analogs of vitamins
B. Block active centers of enzymes
C. Cause competitive inhibition of enzymes
D. Can induce a picture of hypovitaminosis
E. Precursors of vitamins

13. The main physiological effect of vitamin A is:
A. Antixerophthalmic
B. Antirachitic
C. Antineuritic
D. Antisterile
E. Antidermatitic

14. The breakdown of β-carotene results in the formation of:
A. 1 molecule of vitamin A
B. 2 molecules of vitamin A
C. 3 molecules of vitamin A
D. 4 molecules of vitamin A
E. 5 molecules of vitamin A

15. Identify the provitamin D_3:
A. Ergosterol
B. 7-Hydroxycholesterol
C. $1,25(OH)_2D_3$
D. $24,25(OH)_2D_3$
E. $23,25(OH)_2D_3$

16. Identify the vitamin that is a derivative of cyclopentanoperhydrophenanthrene:
A. Vitamin A

B. Vitamin D
C. Vitamin B_{12}
D. Vitamin B_6
E. Vitamin E

17. Water-soluble structural analog of vitamin K_3 is:
A. Vikasol
B. Dicumarol
C. Salicylic acid
D. Menadione
E. Acetylsalicylic acid

18. Identify the antivitamin of vitamin K:
A. Dicumarol
B. Vikasol
C. Oxythiamine
D. Isoniazid
E. 3-Acetylpyridine

19. The main physiological effect of vitamin E is:
A. Antisterile
B. Antidermatitic
C. Vitamin of growth
D. Antianemic
E. Antineuritic

20. Identify the main metabolic function of vitamin E in the body:
A. Coenzyme of aminotransferases
B. Carboxylase coenzyme
C. Antioxidant
D. Activation of synthesis of Ca-binding proteins
E. Activation of synthesis of blood clotting proteins

PREPARATION FOR THE KROK-1 LICENSURE EXAM

1. The patient has pain along the major nerve trunks and increased pyruvate content in the blood. The lack of which vitamin leads to such changes?
A. B_1
B. PP
C. Pantothenic acid
D. B_2
E. Biotin

2. Most of the members of Magellan's expedition to America died of vitamin deficiency disease, which was manifested by general weakness, subcutaneous

hemorrhages, tooth loss, and bleeding gums. Write the name of this vitamin deficiency.
A. Scorbutus (scurvy)
B. Birmer's anemia
C. Polyneuritis (Berry-Berry)
D. Pelagra
E. Rickets

3. Patients with alcoholism often have hypovitaminosis B_1, which is a consequence of malnutrition. Its symptoms are nervous system disorders, psychosis, and memory loss. Why are nerve cells especially sensitive to vitamin B_1 deficiency?
A. The oxidation of fatty acids is impaired
B. Lipolysis in adipose tissue is enhanced
C. The intensity of glycolysis increases
D. The intensity of glycolysis decreases
E. Aerobic breakdown of glucose is impaired

4. Sulfonamide drugs are similar in structure to para-aminobenzoic acid. What is the molecular basis of their pharmacological effect?
A. Disruption of vitamin synthesis
B. In the destruction of the cell membrane
C. In activation of lipolysis
D. In the inhibition of glycolysis
E. In binding to DNA

5. The patient was diagnosed with megaloblastic anemia. Insufficient amount of which substance can lead to the development of this disease?
A. Cholecalciferol
B. Magnesium
C. Cyanocobalamin
D. Copper
E. Glycine

6. A 10-year-old girl often suffers from acute respiratory infections, after which there are numerous hemorrhages in places of friction of clothing. Hypovitaminosis of which vitamin occurs in the girl?
A. B_2
B. C
C. A
D. B_1
E. B_6

7. During the patronage of the child, the doctor found a symmetrical roughness of the cheeks, diarrhea, and nervous activity. The lack of which nutritional factors is the cause of this condition?

A. Lysine, ascorbic acid
B. Methionine, lipoic acid
C. Threonine, pantothenic acid
D. Phenylalanine, pangamic acid
E. Nicotinic acid, tryptophan

8. In a patient with frequent bleeding from internal organs and mucous membranes, a lack of hydroxyproline and hydroxylizine in collagen fibers was detected. Due to the lack of which vitamin, the processes of hydroxylation of these amino acids are disturbed?
A. Vitamin A
B. Vitamin H
C. Vitamin C
D. Vitamin K
E. Vitamin PP

9. A woman who had been on a diet of refined rice for a long time was diagnosed with polyneuritis (Berry-Berry disease). The lack of which vitamin is caused by this?
A. Thiamine
B. Pyridoxal
C. Ascorbic acid
D. Riboflavin
E. Folic acid

10. A patient with symmetrical dermatitis of the open skin came to the doctor. It was found that he eats mainly cereals, eats little meat, milk and eggs. Which vitamin is deficient in the patient?
A. Calciferol
B. Nicotinamide
C. Folic acid
D. Tocopherol
E. Biotin

11. In case of enterobiosis, acrychine is prescribed – a structural analog of vitamin B_2. Violation of the synthesis of which enzymes in microorganisms causes this drug?
A. Cytochrome oxidase
B. Aminotransferase
C. Peptidases
D. FAD-dependent dehydrogenases
E. NAD-dependent dehydrogenases

12. Pyridoxal phosphate is used to correct which processes?
A. Deamination of purine nucleotides
B. Transamination and decarboxylation of amino acids
C. Synthesis of purine and pyrimidine bases

D. Oxidative decarboxylation of keto acids
E. Protein synthesis

13. After surgical removal of a part of the stomach, the patient's absorption of vitamin B_{12} was impaired. Anemia developed. What factor is necessary for the absorption of this vitamin?
A. Hydrochloric acid
B. Gastrin
C. Pepsin
D. Gastromucoprotein
E. Folic acid

14. Due to vitamin B_1 deficiency, oxidative decarboxylation of α-ketoglutaric acid is impaired. The synthesis of which coenzyme is impaired?
A. Flavinadenine dinucleotide
B. Coenzyme A
C. Thiamine pyrophosphate
D. Lipoic acid
E. Nicotinamide adenine dinucleotide

15. A 9-month-old child is on artificial feeding. Formula feeding is performed with unbalanced vitamin B_6 content. The child has pelagic dermatitis, seizures, and anemia. The development of seizures may be associated with a formation disorder:
A. Serotonin
B. Histamine
C. GABA
D. Dopamine
E. DOPA

16. The patient has an increased concentration of pyruvate in the blood. A significant amount of it is excreted in the urine. What vitamin deficiency does the patient have?
A. B_1
B. E
C. B_3
D. B_6
E. B_2

17. After a course of therapy, a patient with duodenal ulcer is prescribed to drink juices from cabbage and potatoes. What substances in these foods help prevent and heal ulcers?
A. Vitamin U
B. Pantothenic acid
C. Vitamin C
D. Vitamin B_1
E. Vitamin K

18. After removal of 2/3 of the patient's stomach, the hemoglobin content in the blood decreased, the number of red blood cells increased, and the size of these blood cells increased. Deficiency of which vitamin leads to such changes in the blood?
A. B_{12}
B. C
C. P
D. B_6
E. PP

19. Sulfonamide drugs that block the synthesis of bacterial growth factor are used to treat some infectious diseases caused by bacteria. Name the mechanism of their action:
A. They are antivitamins of para-aminobenzoic acid
B. Inhibit the absorption of folic acid
C. Are allosteric enzyme inhibitors
D. Participate in redox processes
E. Are allosteric enzymes

20. A 36-year-old woman has hypovitaminosis B_2. The cause of specific symptoms (lesions of the epithelium, mucous membranes, skin, cornea) is probably a deficiency:
A. Flavin coenzymes
B. Cytochrome A_1
C. Cytochrome oxidase
D. Cytochrome B
E. Cytochrome c

21. A 37-year-old patient after prolonged use of antibiotics has increased bleeding with minor injuries. In the blood – prolongation of blood coagulation time, decreased activity of II, VII, X coagulation factors. What vitamin deficiency is responsible for these changes?
A. Vitamin E
B. Vitamin C
C. Vitamin A
D. Vitamin D
E. Vitamin K

22. A pregnant woman with a history of several miscarriages is prescribed therapy containing vitamin preparations. Specify the vitamin that promotes pregnancy:
A. α-Tocopherol
B. Rutin
C. Folic acid
D. Pyridoxal phosphate
E. Cyanobalamin

23. In a child of the first year of life during a preventive examination revealed a violation of bone mineralization. Lack of which vitamin can be the cause of this?
A. Folic acid
B. Tocopherol
C. Calciferol
D. Cobalamin
E. Riboflavin

24. A six-month-old child has frequent and intense subcutaneous hemorrhages. The appointment of a synthetic analog of vitamin K (vicasol) had a positive effect. In the γ-carboxylation of glutamic acid, which protein of the of the blood coagulation system is this vitamin involved in?
A. Rosenthal factor
B. Antihemophilic globulin A
C. Fibrinogen
D. Prothrombin
E. Hagemann factor

25. The patient has nyctalopia (night blindness). Which of the following substances will have a therapeutic effect?
A. Carnitine
B. Keratin
C. Creatine
D. Carotene
E. Carnosine

26. A patient after removal of the gallbladder has weakened the processes of Ca^{2+} absorption through the intestinal wall. The appointment of which vitamin will stimulate this process?
A. C
B. PP
C. K
D. B_{12}
E. D_3

27. The treatment of a child with rickets with vitamin D_3 did not give a positive result. What is the most likely reason for the ineffectiveness of treatment?
A. Lack of lipids in the food
B. Impaired transport of vitamin D_3 by blood proteins
C. Violation of vitamin D_3 hydroxylation
D. Impaired incorporation of vitamin D_3 into the enzyme
E. Violation of vitamin D_3 absorption in intestine

28. A 39-year-old man has an increased risk of developing infectious processes, hyperkeratosis, and impaired twilight vision. What vitamin preparation should be prescribed?
A. Retinol acetate
B. Pyridoxine hydrochloride
C. Tocopherol acetate
D. Riboflavin
E. Ergocalciferol

29. A patient who underwent mastectomy for breast cancer was prescribed a course of radiation therapy. Which of the following vitamin preparations has a pronounced radioprotective effect due to antioxidant activity?
A. Ergocalciferol
B. Riboflavin
C. Folic acid
D. Tocopherol acetate
E. Thiamine chloride

30.To prevent postoperative bleeding, the patient is recommended vicasol, which is a synthetic analog of vitamin K. What post-translational changes in coagulation factors are activated under the influence of vicasol?
A. Carboxylation of glutamate
B. Polymerization
C. Partial proteolysis
D. Glycosylation
E. Serine phosphorylation

31.A man who has not eaten fat for a long time, but has received a sufficient amount of carbohydrates and proteins, has dermatitis, poor wound healing, and impaired vision. Deficiency of which food components is the cause of this disorder?
A. Palmitic acid
B. Vitamins PP, H
C. Linoleic acid, vitamins A, D, E, K
D. Mineral salts
E. Oleic acid

32. A patient with hypochromic anemia has split and falling hair, increased nail fragility, and impaired taste. What is the mechanism of development of these symptoms?
A. Decreased production of thyroid hormones
B. Iron deficiency
C. Vitamin A deficiency
D. Vitamin B_{12} deficiency
E. Decreased production of parathyrin

33. In patients with biliary obstruction, blood clotting is slowed down and frequent hemorrhages are observed. This should be considered a consequence of insufficient absorption of the vitamin:
A. D
B. A
C. Carotene
D. K
E. E

34. Plasma coagulation factors undergo post-translational modification with the participation of vitamin K. It is used as a cofactor in the enzymatic system of γ-carboxylation of protein coagulation factors. What amino acid is carboxylated in these proteins?
A. Serine
B. Valine
C. Arginine
D. Glutamic
E. Phenylalanine

35.During the examination of a child, the doctor found signs of rickets. An insufficient amount of which compound contributes to the development of this disease:
A. Biotin
B. Retinol
C. 1,25-Dihydroxycholecalciferol
D. Naphthoquinone
E. Tocopherol

36. As a result of post-translational changes in some proteins involved in blood coagulation, in particular prothrombin, they acquire the ability to bind calcium. Vitamin A is involved in this process:
A. B_1
B. A
C. B_2
D. C
E. K

37. In clinical practice, the drug isoniazid is used for the treatment of tuberculosis – an antivitamin that can penetrate the tubercle bacillus. The tuberculostatic effect is due to the disruption of replication processes, redox reactions due to the formation of a false coenzyme from:
A. NAD
B. FAD
C. FMN
D. TDF

E. CoQ

38. A vitamin preparation has been prescribed to accelerate the healing of a radiation ulcer. Specify it:
A. Retinol acetate
B. Retabolil
C. Prednisolone
D. Levamisole
E. Methyluracil

39. A 47-year-old patient with a diagnosis of focal tuberculosis of the upper lobe of the right lung is receiving isoniazid in the discharge of combination therapy. After some time, the patient began to complain of muscle weakness, decreased skin sensitivity, visual impairment, and coordination of movements. Which vitamin preparation should be used to eliminate these phenomena?
A. Vitamin B_6
B. Vitamin A
C. Vitamin D
D. Vitamin B_{12}
E. Vitamin C

40. It is known that the introduction of the drug dicumarol into the human body causes a sharp decrease in the blood content of prothrombin and a number of other protein clotting factors. Dicumarol is an antivitamin of which vitamin?
A. Vitamin K
B. Vitamin C
C. Vitamin E
D. Vitamin P
E. Vitamin H

Protocol N **Date**

1. The determination of ascorbic acid concentration in vegetables (a potato, cabbage).

THE COURSE OF THE WORK:

Crush 5 g of potato (cabbage or other product) with a scalpel and pound it in a mortar, add 3 drops of 10 % hydrochloric acid solution and gradually 15 ml of distilled water. The mass received pour into a flask for titration. Titrate by 0.001 N DCIP solution up to the appearance of pink coloring, which will not disappear within 30 sec.

The calculation will be carried out according to the formula:

$$X = \frac{0.088 \cdot A \cdot 100}{5} \text{ mg \%, where}$$

X - the content of vitamin C, mg %;
0.088 - the equivalent of ascorbic acid, which is titrated by 0,001N DCIP solution;

À - the quantity of DCIP (ml), used for titration;
100 - recalculation at 100 g of the product;
5 - quantity (g) of the product taken for the analysis.

Compare the received results with the content of vitamin C in foodstuff: in potatoes (6-20 mg%), cabbage (20-50 mg%), apples (20-40 mg%), lemons (40-55 mg%), needles (150-250 mg%), onions (30 mg%), parsley (150 mg%), cauliflower (70 mg%).

RESULTS:

CONCLUSIONS:

1.2. Determination of ascorbic acid content in the urine.

THE COURSE OF THE WORK:

Pour 10 ml of the urine into a flask for titration and add 10 ml of distilled water, then add 20 drops of 10 % hydrochloric acid. Titrate from the tube 0.001N of DCIP solution up to permanent pink coloring. Calculate daily excretion of vitamin C according to the formula:

$$X = \frac{0.088 \cdot A \cdot B}{C}, \text{ where}$$

X - daily excretion of vitamin C, in mg;
0.088 -the equivalent of an ascorbic acid, which is titrated with 1 ml 0.001 N DCIP solution
A – the volume of the indicator spent for titration;
B - daily average volume of the urine: men - 1500ml, women -1200 ml;
C - urine volume taken for titration.

RESULTS:

CONCLUSIONS:

<u>The significance of vitamin C determination in the blood plasma and urine:</u>

In norm the content of vitamin C in the urine is 20-30 mg / daily.

It is very important to define this index during the stage: the latent form of vitamin C Hypovitaminosis. The patient drinks the ascorbic acid - glucose solution, containing a daily norm of vitamin C (correlated with the patient's age). In 2-3 hours later the vitamin C concentration is determined in the patient's urine. If the result correlates with normal value, you can say about the latent form of vitamin C Hypovitaminosis.

Literature (p. 130)

Lesson 9

THEME: BIOCHEMISTRY OF BONE TISSUE AND DENTAL TISSUES. MINERAL AND ORGANIC COMPONENTS OF DENTAL TISSUES. MINERALIZATION, DEMINERALIZATION, REMINERALIZATION.

RELEVANCE OF THE THEME: the skeleton serves not only a mechanical function but also other crucial functions for the organism. It actively participates in metabolism, particularly in maintaining the homeostasis of the mineral composition of biological fluids. Additionally, the skeleton plays a role in hematopoiesis, a function inherent not only in the bone marrow but also in the entire bone tissue as a whole. Teeth, being the most mineralized organs, facilitate the mechanical processing of food, contribute to coherent speech, and serve an aesthetic function. Therefore, understanding the metabolism of bone tissue and teeth, both in normal conditions and pathologies, is essential for a future dentist.

THE PURPOSE OF THE LESSON: to study the theoretical material on the metabolism of bone tissue and teeth in normal and pathological conditions.

QUESTIONS FOR PREPARATION

1. Bone tissue structure.
2. Mechanism of mineralization of bone tissue.
3. Forms of disruption in bone tissue metabolism. Approaches to metabolic correction of osteoporosis.
4. Biochemical tests for assessing bone tissue metabolism.
5. Enamel: inorganic component, organic matrix. Features of metabolism in enamel.
6. Dentin.
7. Cementum.

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. Excessive intake of which microelement in the body causes the development of fluorosis?

A. Iodine
B. Chlorine
C. Fluorine
D. Bromine
E. Copper

2. The alkaline phosphatase in saliva plays a significant role in the mineralization of enamel, causing:

A. Increase in the concentration of inorganic phosphate
B. Decrease in the concentration of inorganic phosphate
C. Decrease in the concentration of calcium
D. Decrease in the concentrations of calcium and phosphorus
E. Reduced resistance of enamel to cariogenic factors

3. Which of the following biochemical processes provides the highest resistance of enamel to caries?
A. Synthesis of fluorapatite
B. Synthesis of hydroxyapatite
C. Synthesis of chlorapatite
D. Synthesis of collagen
E. Synthesis of carbonate apatite

4. A child exhibits disruptions in mineralization processes and enamel opacity. Excessive intake of which microelement causes these changes?
A. Fluorine
B. Iodine
C. Iron
D. Selenium
E. Copper

5. During a preventive examination of students, a dentist found dense deposits of dental calculus on the teeth of some children. Which substance contributes to its formation?
A. Calcium oxalate
B. Calcium phosphate
C. Uric acid
D. Pigments
E. Oxaloacetate

6. In the examination of a patient, it was established that the cause of hypoplasia of the teeth is a deficiency of vitamins A and B. Despite the oral administration of these vitamins, no therapeutic effect was achieved. What could be a possible reason for the impaired absorption of vitamins?
A. Achalasia
B. Hypochlorhydria
C. Hyperchlorhydria
D. Achylia
E. Achlorhydria

7. Which type of apatite constitutes the majority of the mineral component of human teeth?
A. Chlorapatite
B. Carbonate apatite
C. Fluorapatite
D. Hydroxyapatite
E. Strontium apatite

8. What is the primary source of calcium and phosphorus in enamel after eruption?
A. Salivary fluid

B. Gingival fluid
C. Blood plasma
D. Extracellular fluid
E. Drinking water

9. The organic matrix of enamel consists of proteins, including:
A. Collagen
B. Enamelin, amelogenin
C. Elastin
D. Proteoglycans
E. Albumins

10. Indicate the most optimal range of pH fluctuations in saliva for mineralization and remineralization of tooth tissues:
A. 6.8-7.0
B. 7.2-7.4
C. 6.4-6.6
D. 5.8-6.0
E. 6.2-6.4

11. The main source of mineral intake in the formation of subgingival dental calculus is:
A. Salivary fluid
B. Gingival fluid
C. Saliva
D. Blood plasma
E. Blood serum

12. When preparing a tooth crown for the support of a bridge prosthesis, a reaction of the peripheral layer of the dental pulp occurs, resulting in:
A. Increased formation of tertiary dentin by odontoblasts
B. Increased formation of primary dentin by odontoblasts
C. Increased formation of secondary dentin by odontoblasts
D. Increased formation of cementum
E. Increased formation of enamel

13. Which apatite of enamel is more resistant to the action of cariogenic factors?
A. Carbonate apatite
B. Hydroxyapatite
C. Chlorapatite
D. Fluorapatite
E. Strontium apatite

14. Which apatite of enamel is the least resistant to the action of acidic compounds?
A. Carbonate apatite

B. Hydroxyapatite
C. Chlorapatite
D. Fluorapatite
E. Strontium apatite

15. In a 35-year-old woman with chronic kidney disease, osteoporosis has developed. Deficiency of which of the following substances is the main cause of this complication?
A. $1,25(OH)_2D_3$
B. $1(OH)D_3$
C. $25(OH)D_3$
D. Vitamin D_3
E. Vitamin D_2

16. Parathyroid hormone is a hormone of the parathyroid glands that regulates the calcium level in the blood. What effects are characteristic of parathyroid hormone in bone tissue?
A. Decreased synthesis of organic components
B. Inhibition of the tricarboxylic acid cycle
C. Activation of acid phosphatase
D. Promotion of citric acid formation
E. All of the above

17. A 2-year-old child presents with Fanconi syndrome, which includes disturbances in the functions of renal tubules: phosphaturia, aminoaciduria, proteinuria, and vitamin D tolerance. Which process disorder leads to the development of rickets?
A. Hydroxylation of vitamin D
B. Reabsorption of vitamin D
C. Decreased concentration of vitamin D-binding protein
D. Phosphate reabsorption
E. Restoration of vitamin D

18. Parathyroid hormone is a hormone of the parathyroid glands that regulates the level of calcium in the blood. Which of the following effects are characteristic of parathyroid hormone in bone tissue?
A. Reduction of the synthesis of organic components
B. Inhibition of the tricarboxylic acid cycle
C. Activation of acidic phosphatase
D. Facilitation of citric acid formation
E. All of the above

19. In a 2-year-old child, Fanconi syndrome is observed, which includes disturbances in the functions of renal tubules: phosphaturia, aminoaciduria, proteinuria, and vitamin D tolerance. What process disruption leads to the development of rickets?
A. Hydroxylation of vitamin D

B. Absorption of vitamin D
C. Decrease in the concentration of vitamin D-binding protein
D. Phosphate reabsorption
E. Restoration of vitamin D

20. Which biochemical markers in serum reflect osteolysis?
A. Increased activity of acid phosphatase, hypercalcemia, hyperhydroxyprolinemia, increased content of hexuronic acids
B. Increased activity of alkaline phosphatase
C. Increased activity of lactate dehydrogenase, hyperpyruvatemia
D. Increased activity of aspartate aminotransferase, hyperproteinemia
E. Increased activity of alanine aminotransferase, hyperaminoaciduria

PREPARATION FOR THE KROK-1 LICENSURE EXAM

1. A child has impaired formation of tooth enamel and dentin due to a decreased content of calcium ions in the blood. Deficiency of which hormone can cause such changes?
A. Thyrocalcitonin
B. Parathyroid hormone
C. Thyroxine
D. Somatotropic hormone
E. Triiodothyronine

2. The patient has a sharp decrease in the content of Ca^{2+} ions in the blood. This will lead to an increase in the secretion of which hormone?
A. Parathyroid hormone
B. Somatotropic
C. Calcitonin
D. Aldosterone
E. Vasopressin

3. The destruction of tooth enamel and dentin in vitamin C deficiency is largely due to impaired collagen maturation. What stage of procollagen modification is broken in this case?
A. Hydroxylation of proline
B. Glycosylation of hydroxylated residues
C. Formation of polypeptide chains
D. Removal of C-terminal peptide from procollagen
E. Cleavage of the N-terminal peptide

4. A patient with chronic renal failure developed osteoporosis. Disruption of the synthesis of which mineral metabolism regulator in the kidneys is the cause of osteoporosis?
A. Formation of $1,25(OH)_2D_3$
B. Hydroxylation of lysine

C. Hydroxylation of proline
D. Hydroxylation of cortisol
E. Carboxylation of glutamate

5. In a child of the first year of life during a preventive examination revealed a violation of bone mineralization. Insufficient amount of which vitamin can be the reason for this?
A. Folic acid
B. Tocopherol
C. Calciferol
D. Cobalamin
E. Riboflavin

Literature (p. 130)

Lesson 10

THEME: BIOCHEMICAL COMPOSITION AND FUNCTIONS OF BIOLOGICAL FLUIDS OF THE ORAL CAVITY IN NORMAL AND VARIOUS PATHOLOGICAL CONDITIONS.

RELEVANCE OF THE THEME: the mucous membrane of the oral cavity serves as the primary physiological barrier to the majority of exogenous antigens. The local immune status of the oral cavity significantly influences the effectiveness of the body's defense against infections. Investigating the composition and properties of saliva and gingival fluid can serve as an objective criterion for assessing the severity and prognosis of diseases affecting the oral cavity tissues, as well as the effectiveness of their therapy.

THE PURPOSE OF THE LESSON: to study the theoretical material on the biological role and clinical assessment of the chemical composition of saliva and gingival fluid. To develop the ability to conduct research on the activity of salivary amylase at different pH values of the environment.

QUESTIONS FOR PREPARATION

1. Salivary biochemistry: biological role, physical properties, organic, and mineral components.
2. Regulation and mechanisms of salivary secretion. Disorders of salivary secretion.
3. The role of biochemical analysis of saliva in diagnosing oral cavity diseases.
4. Gingival fluid biochemistry: biological role and clinical assessment of gingival fluid composition.
5. Biochemical indicators of normal oral cavity fluid.
6. Changes in oral cavity fluid composition in various pathological conditions.
7. Hormonal regulation of metabolism in the oral cavity organs.

LABORATORY WORKS

The influence of the pH environment on the salivary amylase activity.

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. What is the average volume of saliva produced per day?
A. 0.5-1.0
B. 1.0-1.5
C. 0.3-0.7
D. 0.8-1.6
E. 1.5-2.0

2. What is the pH range that characterizes oral fluid?
A. 6.4-7.8
B. 6.0-6.4
C. 6.5-7.0
D. 7.0-7.5
E. 7.5-8.0

3. Which enzyme in the oral cavity breaks down polysaccharides?
A. Maltase
B. Sucrase
C. α-Amylase
D. Peroxidase
E. Catalase

4. What are the consequences of reducing the pH of oral fluid to less than 6.4?
A. Activation of starch hydrolysis
B. Demineralization of enamel and development of caries
C. Enhancement of enamel mineralization
D. Weakening of the protective function of the oral cavity
E. Deterioration of the hygiene status of the oral cavity organs

5. One of the important functions of saliva is protective. Which enzyme in saliva possesses high antibacterial properties?
A. Acid phosphatase
B. Alkaline phosphatase
C. Protease
D. Lysozyme
E. Peroxidase

6. Among the protective enzymes of the oral cavity, enzymes that inhibit free radical oxidation play a significant role. Choose these enzymes:
A. Acid and alkaline phosphatase
B. Lysozyme
C. Proteases and nucleases

D. Hyaluronidases and collagenases
E. Myeloperoxidase and lactoperoxidase

7. Name the protease inhibitor synthesized by salivary glands:
A. α_1-Antitrypsin
B. α_2-Macroglobulin
C. Superoxide dismutase
D. Acid-stable protease inhibitor
E. Neuraminidase

8. Which class of immunoglobulins predominates in the saliva that forms local immunity in the oral cavity?
A. Immunoglobulin A
B. Immunoglobulin E
C. Immunoglobulin M
E. Secretory immunoglobulin A
D. Immunoglobulin

9. Which of the hormones synthesized by salivary glands promotes tooth mineralization?
A. Calcitonin
B. Epidermal growth factor
C. Nerve growth factor
D. Parotin
E. Thymocyte-transforming factor

10. Which component of saliva, approximately corresponding to the plasma content, plays the most significant role in the mineralization of hard tooth tissues?
A. Bicarbonate
B. Sulfate
C. Calcium
D. Potassium
E. Sodium

11. Which proteins in saliva prevent the precipitation of calcium-phosphate salts and maintain them in a colloidal state?
A. Proline-rich proteins
B. Amylase
C. Albumin
D. Globulin
E. Sialoglycoproteins

12. What is the main mechanism for the development of multiple caries with hyposalivation?
A. Insufficient secretion of neuropeptides

B. Decrease in hormone levels
C. Insufficient mechanical processing of food
D. Decrease in the mineralizing function of saliva
E. Decrease in vitamin content

13. The course of diabetes mellitus is often complicated by diseases of the oral cavity. One of the mechanisms of their development is changes in the biochemical composition of saliva, namely:
A. Increased residual nitrogen content
B. Increased glucose content
C. Decreased immunoglobulin content
D. Decreased protein content
E. Decreased mineral content

14. In a patient with periodontitis, an examination of mixed saliva revealed an increase in the content of free radical oxidation products (hydroperoxides, malonic dialdehyde). What impact does their excessive formation have on the tissues of the oral cavity?
A. Cell damage
B. Hyposalivation
C. Shift in saliva pH
D. Hypersalivation
E. Change in the chemical composition of saliva

15. Increased levels of which hormones in saliva characterize the development of the body's stress reaction?
A. Testosterone, estradiol
B. Cortisol, adrenaline
C. Parathyroid hormone, calcitonin
D. Thyroid hormones (T_3, T_4)
E. Insulin

16. Upon re-examination of mixed saliva in a patient with periodontitis, a dentist observed an increase in the content of free amino acids. What conclusion can be drawn based on this indicator?
A. Activation of nucleic acid breakdown in periodontal tissues
B. Activation of proteolytic enzymes
C. Activation of free radical processes

17. In a patient with periodontitis, the activity of acid phosphatase and hyaluronidase in saliva increases. What do these changes indicate?
A. Strengthening the catabolism of biomolecules in periodontal tissues
B. Increased excretion of proteins with saliva
C. Violation of hormonal regulation of periodontal tissue metabolism
D. Activation of free radical processes

E. Insufficiency of the protective function of periodontal tissues

18. Which of the following substances has osteotropic effects?
A. Thyroxine
B. Parotin
C. Insulin
D. Nerve growth factor
E. Secretory immunoglobulin A

19. How do the processes of mineralization of hard tooth tissues change in a patient with salivary stone disease?
A. Increase
B. Do not change
C. Decrease
D. Disturbance of the ratio of mineral components of saliva

20. Which protein predominates in the composition of oral fluid?
A. Immunoglobulin A
B. Mucin
C. Lysozyme
D. Albumin
E. α-Amylase

PREPARATION FOR THE KROK-1 LICENSURE EXAM

1. A patient with chronic inflammation of the submaxillary salivary gland has hyposalivation. Violation of the increment of which substance is observed in this case?
A. Glucagon
B. Calcitonin
C. Parotene
D. Parathyrin
E. Somatostatin

2. The activity of parotid salivary glands decreases with age. The activity of which enzyme will decrease in saliva?
A. Phosphatase
B. Amylase
C. Hexokinase
D. Maltase
E. Lysozyme

3. What substance gives saliva a viscous mucous character, performs a protective role, in particular against mechanical damage to the oral mucosa?
A. Lysozyme
D. Amylase

C. Kallikrein
D. Glucose
E. Mucin

4. A periodontist needs to assess the factors of nonspecific resistance of saliva and oral fluid. Which factor should be studied first in the test material?
A. Lysozyme
B. Complement
C. Interferon
D. Secretory IgA
E. Properdin

5. Normally, the pH of saliva is 6.4-7.8. What changes in enamel are caused by a shift in saliva pH to the acidic side?
A. Calcification
B. Mineralization
C. Demineralization
D. Increasing sustainability
E. Fluorosis

6. When eating cookies, sweets in mixed saliva, the level of lactate temporarily increases. Activation of which biochemical process leads to this?
A. Glycogenolysis
B. Hydrolysis of starch
C. Gluconeogenesis
D. Aerobic glycolysis
E. Anaerobic glycolysis

7. During the examination of the patient's oral cavity, the dentist determined dry mucous membrane, numerous erosions. The lack of which vitamin caused this phenomenon?
A. Vitamin A
B. Vitamin P
C. Vitamin H
D. Vitamin PP
E. Vitamin K

8. Periodontitis is accompanied by activation of proteolysis in periodontal tissues. Increase in which component of the oral fluid indicates its activation?
A. Biogenic amines
B. Amino acids
C. Cholesterol
D. Glucose
E. Organic acids

9. To accelerate the healing of a wound of the oral mucosa, the patient was prescribed a drug that is a thermostable protein found in human saliva, tears, breast milk, and can also be found in freshly laid chicken eggs. It is known to be a factor in the body's natural resistance and is called:
A. Imanin
B. Complement
C. Interleukin
D. Interferon
E. Lysozyme

Protocol N **Date**

The influence of the pH environment on the salivary amylase activity

THE PRINCIPLE OF THE METHOD:

The influence of the pH-environment on amylase activity is judged by the starch splitting at various pH values. The degree of starch splitting is determined by iodic test, the optimum of pH corresponds to a negative iodic test.

THE COURSE OF THE WORK:

The saliva volume is dissolved in correlation (1:100). Take 6 test tubes and pour 2 ml of the phosphate buffer with various value of pH: 6,0; 6,4; 6,8; 7,2; 7,6; 8,0 into each test tube. Then add 1 ml of 0,5 % starch solution and 1 ml of the dissolved saliva into each one. Mix the content of test tubes and place them into thermostat at 38°C for 10 minutes. Then pour 1 drop of iodine solution into each tube, and mix. You can observe the colouring in each tube and mark the pH optimum.

RESULTS:

Test tubes number	Value of pH	Color of solution
1	6.0	
2	6.4	
3	6.8	
4	7.2	
5	7.6	
6	8.0	

CONCLUSIONS:

Literature (p. 130)

Lesson 11

THEME: BIOCHEMISTRY OF THE LIVER. MICROSOMAL OXIDATION. XENOBIOTIC BIOTRANSFORMATION.

RELEVANCE OF THE THEME: the liver is a vital organ that plays a central role in the metabolism of proteins, carbohydrates, lipids, vitamins, and minerals. It is also involved in the detoxification of toxic substances of both exogenous (xenobiotics) and endogenous origin. The significant variability in the chemical composition of the liver depends on the nature of nutrition, the state of metabolism, and the peculiarities of neurohumoral regulation of biochemical processes. The assessment of the liver's functional state is necessary for the diagnosis of diseases and the proper selection and monitoring of drug treatment.

The rapid pace of industrial development has led to environmental pollution with chemical compounds from household use, pesticides, herbicides, and so on. All these substances, as well as pharmaceuticals and food additives, are foreign compounds (xenobiotics) to the human body. In the liver tissue (in the endoplasmic reticulum), microsomal oxidation occurs, leading to the hydroxylation of foreign compounds, promoting their further detoxification and elimination from the body.

THE PURPOSE OF THE LESSON: to study the theoretical material on the biochemistry of liver functions in the body and its role in pigment metabolism, as well as the metabolism of proteins, carbohydrates, and lipids in both normal and pathological conditions. To be able to perform and interpret the results of the thymol test.

To study the features of xenobiotic biotransformation, as well as the role of microsomal oxidation in their metabolism.

QUESTIONS FOR PREPARATION

1. Biochemical functions of the liver in humans.
2. The features of carbohydrate, lipids and protein metabolism in the liver tissue.
3. The role of the liver in pigments metabolism.
4. Bile: its formation, chemical composition.
5. The damage of the liver function at some diseases. Laboratory tests to estimate the liver function. Quick`s test.
6. Xenobiotics: the definition, a classification, and biological role.
7. Current conceptions about the mechanism of xenobiotic toxic action.
8. The characteristic of xenobiotic catabolic stages. The role of the liver in xenobiotics metabolism.
9. Microsomal oxidation. Characteristics of microsomal and mitochondrial monooxygenase chains. Biological role of monooxygenase sysmems in humans.
10. Cytochrome P-450: features of structure, mechanism of action. Genetic polymorphism and regulation of the cytochrome P-450 synthesis (inducers and inhibitors).

11. Types of xenobiotic conjugation in hepatocytes (enzymes, conjugation agents, and end-products). Biochemical mechanisms and the role of liver conjugation systems in detoxification of exogenous and endogenous harmful substances.
12. The ways for xenobiotics removal from human body.

LABORATORY WORKS

Thymolic test.

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. In a healthy individual, the liver transforms indirect bilirubin into direct bilirubin. Specify the mechanism of this process:
A. Oxidation using FAD
B. Hydroxylation
C. Methylation
D. Interaction with UDP-Glucuronic Acid
E. Conjugation with glycine

2. For what purpose is the Quick`s test used in clinical practice?
A. To assess the state of bile formation
B. To assess the state of plasma lipoprotein formation
C. To assess the detoxification function of the liver
D. To assess the liver's protein synthesis function
E. To assess free radical processes

3. A series of liver enzymes are involved in the detoxification of toxic products of metabolism. Specify one of them:
A. Pyruvate dehydrogenase
B. Acid phosphatase
C. Alkaline phosphatase
D. UDP-glucuronosyltransferase
E. Aspartate aminotransferase

4. The detoxification of natural metabolites and xenobiotics is impaired in a patient's liver. Name the cytochrome whose activity may be reduced.
A. Cytochrome c_1
B. Cytochrome oxidase
C. Hemoglobin
D. Cytochrome b
E. Cytochrome P450

5. Jaundice is observed in a full-term newborn, with yellow discoloration of the skin and mucous membranes. The likely cause of this condition may be a temporary deficiency of the enzyme:
A. UDP-glucuronosyltransferase
B. Uridine transferase

C. Heme synthetase
D. Heme oxygenase
E. Biliverdin reductase

6. A patient who visited the doctor shows yellowing of the skin, and the patient's urine is the color of dark beer. The serum blood level of which indicator should be elevated?
A. Conjugated bilirubin
B. Unconjugated bilirubin
C. Mesobilirubin
D. Verdohemoglobin
E. Biliverdin

7. A 46-year-old woman with gallstone disease developed jaundice. At the same time, urine became dark yellow, and stool became discolored. The concentration of which substance in the blood serum is most likely increased?
A. Unconjugated bilirubin
B. Conjugated bilirubin
C. Biliverdin
D. Mesobilirubin
E. Urobilinogen

8. A patient shows an increase in both forms of bilirubin (direct and indirect) in the blood plasma, with the complete absence of stercobilinogen in feces and urine. Choose the type of jaundice in this patient:
A. Hemolytic
B. Parenchymal (hepatocellular)
C. Obstructive
D. Neonatal jaundice
E. Gilbert's syndrome

9. Which index is not included in the standard biochemical blood analysis aimed at studying liver functions (liver tests)?
A. Alanine aminotransferase
B. Total bilirubin and its fractions
C. Cholinesterase
D. Creatine kinase
E. Albumin

10. After a blood transfusion, a patient exhibits yellowing of the skin and mucous membranes, increased levels of total and indirect bilirubin in the blood, urobilin in urine, and stercobilin in feces. What type of jaundice is this?
A. Neonatal jaundice
B. Hereditary jaundice
C. Obstructive jaundice

D. Parenchymal jaundice
E. Hemolytic jaundice

11. In a patient with liver cirrhosis, the determination of which excreted substance in the urine can characterize the state of the liver's detoxification function?
A. Hippuric acid
B. Ammonium salts
C. Creatinine
D. Uric acid
E. Amino acids

12. Choose the correct definition of the term "microsomes":
A. Intracellular organelles
B. Vesicles formed from the endoplasmic reticulum during tissue homogenization
C. Components of the nuclear apparatus
D. Components of the intercellular substance
E. Components of mitochondria

13. Choose the organ in which the processes of microsomal oxidation are most intensive:
A. Heart
B. Kidneys
C. Liver
D. Spleen
E. Lungs

14. Monooxygenases (enzyme systems of the microsomal fraction) are sometimes called hydroxylases. This name is associated with the type of reaction they catalyze:
A. Hydration
B. Hydroxylation
C. Dehydrogenation
D. Dehydration
E. Hydroxylation

15. Cytochrome P-450 is a complex protein. Identify its class according to the classification based on chemical structure:
A. Glycoproteins
B. Phosphoproteins
C. Hemoproteins
D. Nucleoproteins
E. Metalloproteins

16. Choose the correct definition of the term "xenobiotics":
A. Foreign compounds inert to the human body

B. Foreign compounds that have specific effects on the human body, involving special metabolic pathways
C. Protein catalysts that stimulate the course of reactions in the cell
D. Allosteric substances
E. Substances regulating metabolism and organism development

17. Detoxification of toxic substances occurs through chemical modification in two phases. Specify Phase II:
A. Hydroxylation
B. Conjugation
C. Phosphorylation
D. Dehydration
E. Dehydration

18. Some substances are detoxified by forming complex ethers with sulfuric acid. Specify the substance through which sulfation is carried out:
A. Thiourea
B. UDP-Glucuronic Acid
C. PAPS (3'-phosphoadenosine-5'-phosphosulfate)
D. Dimethyl sulfate
E. S-Adenosylmethionine

19. Identify the enzyme class of oxidoreductases that is involved in the modification of xenobiotics:
A. Cytochrome b
B. Cytochrome P-450
C. Cytochrome c
D. Cytochrome c_1
E. Cytochrome aa_3

20. The donor of hydrogen atoms for the processes of microsomal oxidation is NADPH. Which process is the main source of NADPH:
A. Glycolysis
B. Krebs cycle
C. Pentose phosphate pathway
D. Gluconeogenesis
E. Glycogenolysis

PREPARATION FOR THE KROK-1 LICENSURE EXAM

1. In a patient undergoing a course of therapeutic fasting, normal blood glucose levels are maintained mainly by gluconeogenesis. From which amino acid is glucose most actively synthesized in the human liver?
A. Alanine
B. Lysine
C. Valine

D. Glutamic acid
E. Leucine

2. A dry-cleaning worker was diagnosed with fatty liver. Violation of liver synthesis of which substance leads to this pathology?
A. Cholic acid
B. Phosphatidylcholine
C. Tristearin
D. Phosphatidic acid
E. Urea

3. The patient's blood albumin concentration is 2.8 g/l, the concentration of lactate dehydrogenase 5 (LDH5) is increased. What is the disease of which organ?
A. Liver
B. Kidney
C. Heart
D. Lung
E. Spleen

4. A 4-year-old child was admitted to the clinic with signs of prolonged protein starvation: growth retardation, anemia, edema, mental retardation. The reason for the development of edema in this child is a decrease in synthesis:
A. Albumin
B. Globulins
C. Hemoglobin
D. Lipoproteins
E. Glycoproteins

5. A patient with signs of acute alcohol poisoning was delivered to the clinic. What changes in carbohydrate metabolism are characteristic of this condition?
A. The rate of gluconeogenesis decreases in the liver.
B. Aerobic glucose breakdown increases in muscles.
C. In the liver increases gluconeogenesis.
Д. Anaerobic glucose breakdown predominates in muscles.
E. Glycogen breakdown increases in the liver.

6. Detoxification of natural metabolites and xenobiotics is impaired in the patient's liver. The activity of which cytochrome can be reduced?
A. Hemoglobin
B. Cytochrome P-450
C. Cytochrome b
D. Cytochrome oxidase
E. Cytochrome c1

7. The patient came to the emergency room because of suppuration of the cut wound. To clean the wound from purulent discharge, the doctor washed it with 3% hydrogen peroxide solution. However, no foam formed. What is the reason for the lack of effect of the drug?
A. Hereditary catalase deficiency
B. Low concentration of H2O2
C. Hereditary deficiency of erythrocyte phosphate dehydrogenase
D. Shallow wound
E. Presence of purulent contents in the wound

8. In the process of metabolism in the human body, reactive oxygen species are formed, including superoxide anion radical. What enzyme inactivates this anion?
A. Superoxide dismutase
B. Catalase
C. Peroxidase
D. Glutathione peroxidase
E. Glutathione reductase

9. A 55-year-old man was brought to the intensive care unit without consciousness. From the words of relatives it became known that the patient mistakenly drank methyl alcohol. What antidote should be used in this case?
A. Ethanol
B. Teturam
C. Naloxone
D. Protamine sulfate
E. Acetylcysteine

Protocol N **Date**

Thymolic (turbidity) test

THE PRINCIPLE OF THE METHOD:

β-Globulins and lipoproteins are precipitated from blood serum at pH = 7.55 by buffer solution that contains reagent thymol. The intensity of turbidity depends on the content of protein fractions and their quantitative ratio.

THE COURSE OF THE WORK:

Add 0.08 ml of blood serum to 4 ml of thymol reagent, mix the contents of the test tube, leave to stand it for 30 mines at room temperature (25^0C), and then the optical density is measured at 660 nm wave length (red optical filter) in cuvettes (10 mm) opposite the control sample (the solution of thymol reagent).

The calculation is made by the graph.

RESULTS:

CONCLUSIONS:

Clinical significance:

Parameters of the thymol test at healthy people equel 0-4 units S-H.

Increase of thymol test parameters serves as the important proof of inflammatory damage in the liver. Test is positive in 90-100 % of cases of a toxic, infectious (virus) hepatitis and Botkin's disease (as early as in a preicteric stage of disease); and also at patients suffering collagenosises, a malaria and some virus infections. At a mechanical jaundice this test is negative in approximately 75 % of cases. This test is useful for differential diagnostics of jaundices.

Literature (p. 130)

Lesson 12

THEME: BIOCHEMISTRY OF MUSCULAR AND CONNECTIVE TISSUES.

RELEVANCE OF THE THEME: the performance of specific functions by muscle and connective tissues is ensured by the corresponding state of metabolic processes within them, which is explained by the peculiarities of their structure. Knowledge of the normal course and disruptions in the metabolism of these tissues is essential for future physicians in the differential diagnosis of pathologies.

THE PURPOSE OF THE LESSON: to study the theoretical material on the biochemistry of muscle and connective tissues: chemical composition, features of metabolism, and modern insights into the molecular mechanisms of muscle contraction. To be able to determine the creatinine content in blood serum.

QUESTIONS FOR PREPARATION

1. Structural organization of the cross-striated muscle.
2. Chemical composition of the cross-striated muscle: proteins, non-proteins and nitrogen-free substances.
3. Composition features of cardiac and smooth muscles.
4. The mechanism of muscle contraction. The role of calcium ions in the muscular contraction and relaxation.
5. Energy sources for muscular activity: creatine phosphate kinase, adenylate kinase ways. Glycolysis (aerobic and anaerobic condition). High fatty acids β-oxidation.
6. Biochemical conception of muscular pathology (myopathy, myocardium infarction).
7. Structural organization of the connective tissue. Intracellular organic matrix of the connective tissue (the main proteins, proteoglycans, glucosaminoglycans): their functions in humans.
8. Synthesis of collagen and elastin; their function in humans.
9. Mucopolysaccharidosises and collagenosises as genetic disorders in humans.

LABORATORY WORKS

Determination of creatinine in the blood serum.

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. Identify the macronutrient necessary for muscle contraction:
A. CTP
B. UTP
C. TTP
D. ATP
E. GTP

2. Identify the main energy substrate of the cardiac muscle:
A. Fructose
B. Fatty acids
C. Amino acids
D. Glycogen
E. Lactose

3. Name the compound deposited in muscle tissue and serves as a source of glucose:
A. Glycogen
B. Creatine
C. Glycolipids
D. Disaccharides
E. Starch

4. Myoglobin facilitates the storage of:
A. Calmodulin
B. Hydrogen
C. Oxygen
D. CO_2
E. Nitrogen

5. Select the creatine kinase isoenzymes characteristic of cardiac muscle:
A. MM-CK
B. MB-CK
C. LDH1
D. MV-CK
E. LDH5

6. Identify the vitamin, a cofactor for prolyl hydroxylase involved in collagen formation:
A. E
B. B_1
C. A
D. C

E. B^5

7. Proteoglycans belong to:
A. Complex proteins
B. Simple proteins
C. Prostaglandins
D. Phospholipids
E. Simple lipids

8. Name the mucopolysaccharide that is broken down by hyaluronidase:
A. Glycogen
B. Glucuronic acid
C. Heparin
D. Hyaluronic acid
E. N-acetyl-D-glucosamine-6-sulfate

9. Identify the amino acid residues in collagen that are modified during post-translational processing:
A. Serine, methionine
B. Proline, lysine
C. Tryptophan, valine
D. Glycine, alanine
E. Glutamate, aspartate

10. Collagenoses include:
A. Rheumatism
B. Diabetes mellitus
C. Myocardial infarction
D. Atherosclerosis
E. Hepatitis

PREPARATION FOR THE KROK-1 LICENSURE EXAM

1. A woman of 30 years old has been ill for about a year, since the first time she had pain in the joints, their swelling, and redness of the skin over them. The preliminary diagnosis is rheumatoid arthritis. One of the probable causes of this disease is a change in the structure of connective tissue protein:
A. Myosin
B. Mucin
C. Collagen
D. Troponin
E. Ovoalbumin

2. Increased fragility of blood vessels, destruction of tooth enamel and dentin in vitamin C deficiency is largely due to impaired collagen maturation. What stage of procollagen modification is affected in this case?

A. Hydroxylation of proline
B. Glycosylation of hydroxylizine residues
C. Formation of polypeptide chains
D. Removal of C-terminal peptide from procollagen
E. Cleavage of the N-terminal peptide

3. In patients with collagenosis, there is a process of destruction of connective tissue. This is confirmed by an increase in blood count:
A. The content of creatine and creatinine
B. The content of oxyproline and oxylysine
C. Transaminase activity
D. The content of urates
E. Activity of LDH isozymes

4. Fibrous elements of connective tissue include collagen, elastin and reticulin. Indicate the amino acid that is only a part of collagen, and the determination of which in biological fluids is used to diagnose diseases of connective tissue.
A. Lysine
B. Proline
C. Glycine
D. Carboxyglutamate
E. Hydroxyproline

5. A 63-year-old woman has signs of rheumatoid arthritis. An increase in the level of which of the following blood parameters will be most significant in confirming the diagnosis?
A. Total glycosaminoglycans
B. Lipoproteins
C. Acid phosphatase
D. Total cholesterol
E. R-glycosidase

6. A patient with progressive muscular dystrophy was examined by biochemical examination of urine. The appearance of which substance in large quantities in the urine can confirm the disease of the muscles in this patient?
A. Porphyrins
B. Hippuric acid
C. Urea
D. Creatinine
E. Creatine

7. A patient with a crush of muscle tissue was delivered to the traumatology department. What biochemical indicator of urine will be increased in this case?
A. Uric acid
B. Glucose

C. Total lipids
D. Creatinine
E. Mineral salts

8. The study of the patient's blood revealed a significant increase in the activity of MB-forms of CK (creatine phosphokinase) and LDH1. What is the most likely pathology?
A. Myocardial infarction
B. Pancreatitis
C. Hepatitis
D. Rheumatism
E. Cholecystitis

9. The patient has muscle atony. Name the enzyme of muscle tissue, the activity of which can be reduced in this condition.
A. γ-Glutamyltransferase
B. Catalase
C. Glucokinase
D. Creatine phosphokinase
E. Transketolase

10. A man with a diagnosis of myocardial infarction was admitted to the intensive care unit. Which of the fractions of lactate dehydrogenase (LDH) will predominate in the blood serum during the first two days?
A. LDH3
B. LDH5
C. LDG1
D. LDG4
E. LDG2

11. As a result of exhausting muscular labor, the buffer capacity of the blood has significantly decreased. The entry of which substance into the blood can cause this phenomenon?
A. Lactate
B. Pyruvate
C. 1,3-Bisphosphoglycerate
D. 3-Phosphoglycerate
E. -

12. In the patient's blood, an increase in the activity of LDH1 LDH2, ALT, creatine kinase was detected. In which organ of the patient is most likely to develop a pathological process?
A. Heart
B. Pancreas
C. Liver

E. Skeletal muscles
D. Kidneys

13. A 46-year-old patient has long suffered from progressive muscular dystrophy (Duchenne). Changes in the level of which blood enzyme is a diagnostic test in this case?
A. Creatine phosphokinase
B. Lactate dehydrogenase
C. Pyruvate dehydrogenase
D. Glutamate dehydrogenase
E. Adenylate kinase

14. A 36-year-old patient suffers from collagenosis. An increase in the content of which metabolite is most likely to be found in the urine?
A. Oxyproline
B. Indocanine
C. Creatinine
D. Urea
E. Urobilinogen

15. A young man of 18 years old was diagnosed with muscular dystrophy. Increase in the serum content of which substance is most likely in this pathology?
A. Creatine
B. Myoglobin
C. Myosin
D. Lactate
E. Alanine

Protocol N **Date**

Determination of creatinine in the blood serum

THE PRINCIPLE OF THE METHOD:

Creatinine reacts with picric acid in the alkaline environment. As the result the yellow-orange coloured compound is obtained. The intensity of coloring is proportional to the concentration of creatinine.

THE COURSE OF THE WORK:

Collect reaction micstures according to scheme:

Solution	Test sample, ml	Control sample, ml
Blood serum	1.0	-
Distilled water	2.0	3.0
1.22 M solution of trichloroacetic acid	1.0	1.0
Mix, centrifuge 5 min at 3000 rpm		
Supernatant	2.0	2.0
2.3 N sodium hydroxide solution	1.0	1.0
0.04 M solution of picric acid	1.0	1.0

Let them stay for 20 min at room temperature, measure the optical density (in cuvettes 10 mm, wave length 500-560 nm) against the control sample.

Standard test is made as an experimental one, but 1 ml of working standard solution where the concentration of creatinine is 0.1 mmol/L is taken instead of blood serum. The test should not be centrifuged.

Calculation under the formula:

X = (Eexp/ Est) •177, where

X - creatinine content in the blood serum, μmol/L;

Eexp - extinction of experimental sample against control one;

Est - extinction of standard sample against control one. It is equal 0.2;

177 - concentration of creatinine in the standard solution, μmol/L.

RESULTS:

CONCLUSIONS:

Clinical significance:

The average creatinine content in blood serum for women- 53-97 μmol/L; for men - 80-115 μmol/L; in urine-4,4 - 17,7 mmol/day or 0,5-2,0 g/day.

The level of creatinine in the blood increases after eating meat food, hard muscular work, after removal tourniquet, feverishness conditions, at pneumonia. Creatinine content is decreased during muscular atrophy, leucemia, in the old age. The level of creatinine in the blood serum increases during kidney insufficiency and diffusing diseases of kidneys, and also at corking uric ways, intestinal impassability, a heavy diabetes, heart diseases, at liver atrophy, at a mechanical jaundice, hypofunction of adrenal glands, starvation and pregnancy.

Parallel determination of creatinine concentration in blood and urine is very important at the research of kidney functions.

Literature (p. 130)

Lesson 13

THEME: BIOCHEMISTRY OF BLOOD. PLASMA PROTEINS, LIPOPROTEINS, ENZYMES. NON-PROTEIN COMPONENTS OF PLASMA.

RELEVANCE OF THE THEME: the study of the functions and chemical composition of blood in both normal and pathological conditions is crucial for understanding its role in coordinating the interactions of metabolic processes in various organs and unifying them into a cohesive system. Analyzing the major protein fractions in plasma and serum, studying blood buffer systems, and investigating disruptions in the acid-base balance – pathological conditions characterized by the excessive accumulation of acidic (acidosis) and alkaline (alkalosis) compounds in the body play a significant role in their correction.

Non-protein components of blood plasma are categorized into nitrogenous (those that remain in plasma and serum after protein precipitation – residual nitrogen) and non-nitrogenous (carbohydrates, lipids, organic acids, and electrolytes). These components have specific concentration values and ratios in a healthy individual. Deviations from these indicators, as determined through blood analysis, indicate the presence of pathologies.

THE PURPOSE OF THE LESSON: to study the protein composition of blood plasma and serum, classify plasma enzymes, and understand their significance for the differential diagnosis of diseases. Explain the functions of the anticoagulant and fibrinolytic systems of blood. Acquire the ability to determine the activity of aspartate aminotransferase in serum and interpret the results according to the normal activity of this enzyme. To study the theoretical material on non-protein components of blood plasma in normal and certain pathological conditions. To develop practical skills in quantitatively determining sodium and chloride levels in serum.

QUESTIONS FOR PREPARATION

1. A comparative characteristic of chemical composition for blood plasma and blood serum.
2. Biochemical functions of blood plasma proteins. Characteristics of the main fractions of blood plasma proteins (albumins, α-, β-, γ-globulins). Hypo-, hyper-, para- and dysproteinemia. Dislipoproteinemia.
3. The enzymes of blood: classification, diagnostic role. Acute phase proteins in the blood plasma in some diseases.
4. Buffer systems of the blood. Acid-base balance of the blood and its disorders (respiratory and metabolic acidosis, alkalosis).
5. The main organic non-protein nitrogen-containing and non-azotic components of plasma, the characteristic and significance of their determination in pathology.
6. Common notions about mineral composition of blood plasma in normal and in pathology.
7. Cell and biochemical organization of the immune system. Humorous components of the immune system. Cytokines as regulators of the immune system. Molecular mechanisms of antivirus action of interferons.

LABORATORY WORKS

1. Determination of total protein content in the blood serum (Biuretic method
2. Determination of sodium in blood serum
3. Determination of chloride in biological fluids (serum or urine)

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. Specify a biological function not typical for blood:

A. Enzymatic
B. Energetic
C. Transport

D. Respiratory
E. Regulatory

2. Specify indicative blood enzymes:
A. Aspartate aminotransferase
B. Amidinase
C. Carboxylase
D. L-malatedehydrogenase
E. Phosphatase

3. Hypoproteinemia is observed in:
A. Vomiting
B. Diarrhea
C. Nephrotic syndrome
D. Burns
E. Myeloma

4. Choose compounds in blood plasma that play a key role in maintaining oncotic blood pressure:
A. Methemoglobin
B. Hemoglobin
C. Lactate
D. Bile pigments
E. Albumins

5. Decrease in the content of which protein fraction of blood plasma is accompanied by a decrease in the body's defense mechanisms:
A. γ-Globulins
B. Albumins
C. α-Globulins
D. β-Globulins
E. Prolamins

6. Dysproteinemia is:
A. Appearance of "non-specific" proteins in the blood
B. Increase in the total protein content in the blood
C. Decrease in the total protein content in the blood
D. Change in the percentage ratio of protein fractions
E. Increase in hemoglobin in the blood

7. Name the blood plasma protein that binds to hemoglobin during erythrocyte hemolysis:
A. Transferrin
B. Haptoglobin
C. Trypsin inhibitor

D. Interferon
E. Albumins

8. Specify the protein that appears in pathological conditions accompanied by inflammation and tissue necrosis:
A. Albumins
B. Globulin
C. Ceruloplasmin
D. Transferrin
E. C-reactive protein

9. Specify the protein used as a dosage form in the treatment of viral infections:
A. Interferon
B. Transferrin
C. Cryoglobulins
D. Haptoglobin
E. Macroglobulin

10. Specify the factor of the blood coagulation system, the synthesis of which involves vitamin K:
A. Thromboplastin
B. Fibrinogen
C. Prothrombin
D. Fibrinolysin
E. Kallikrein

11. Specify the blood protein that transports copper cations in blood plasma:
A. Fibrinogen
B. Thrombin
C. Ceruloplasmin
D. Albumin
E. Fibrinolysin

12. Specify blood buffer systems:
A. Phosphate
B. Bicarbonate
C. Protein
D. Hemoglobin
E. All of the above

13. Choose components of the bicarbonate buffer system:
A. Bicarbonate anion
B. Carbonate anion
C. Anions in positions A, B
D. Carbonic acid

E. Oxide anion

14. Specify non-protein nitrogenous compounds:
A. Uric acid
B. Creatine
C. Creatinine
D. Urea
E. All of the above

15. Increase in which metabolites in the blood leads to an acidosis state:
A. Ammonium salts
B. Ketone bodies
C. Glucose
D. Lactose
E. Uric acid

16. Specify the non-protein nitrogenous component of blood, an increase in the content of which is associated primarily with the pathological condition of "azotemia":
A. Uric acid
B. Ammonia
C. Indican
D. Urea
E. Creatine

17. Name the class of blood lipoproteins that predominantly transport free cholesterol and cholesterol esters to peripheral tissues:
A. Low-Density Lipoproteins (LDL)
B. Very-Low-Density Lipoproteins (VLDL)
C. High-Density Lipoproteins (HDL)
D. Intermediate-Density Lipoproteins (IDL)
E. Chylomicrons

18. Choose blood plasma indicators, the excess level of which is associated with the pathological condition of hyper-β-lipoproteinemia type IIa:
A. LDL and Total Cholesterol
B. VLDL and Total Cholesterol
C. HDL and Total Triglycerides
D. IDL and Total Cholesterol
E. Chylomicrons and Total Triglycerides

19. Name blood plasma indicators whose content is determined in case of impaired aldosterone secretion by the cortical layer of the adrenal glands:
A. Total Cholesterol and Triacylglycerides
B. Total Calcium and Phosphates

C. Urea
D. Ions of Sodium, Potassium, and Chlorides
E. Adrenaline

20. Specify non-protein indicators of blood plasma, the content of which increases in severe forms of insulin-dependent diabetes:
A. Glucose
B. Pyruvate
C. Ketone bodies
D. Cholesterol
E. All of the above

PREPARATION FOR THE KROK-1 LICENSURE EXAM

1. A 38-year-old patient has rheumatism in the active phase. Determination of which laboratory indicator of blood serum has a diagnostic value in this pathology?
A. Creatine
B. Urea
C. C-reactive protein
D. Uric acid
E. Transferrin

2. A patient who is being treated for viral hepatitis B has signs of liver failure. Which blood changes indicate a violation of protein metabolism and are most likely to be observed in this case?
A. Absolute hyperfibrinogemia
B. Absolute hypoalbuminemia
C. Absolute hyperalbuminemia
D. Protein composition of the blood is unchanged
E. Absolute hyperglobulinemia

3. A person performing heavy physical work in conditions of high ambient temperature has changed the amount of plasma proteins. What exactly is happening in this case?
A. Dysproteinemia
B. Absolute hypoproteinemia
C. Paraproteinemia
D. Absolute hyperproteinemia
E. Relative hyperproteinemia

4. In a patient 12 hours after an acute attack of chest pain, a sharp increase in serum AST activity was found. Indicate the pathology for which this shift is characteristic:
A. Diabetes mellitus
B. Diabetes insipidus
C. Myocardial infarction
D. Collagenosis

E. Viral hepatitis

5. In the study of the patient's serum, an increase in the level of alanine aminotransferase (AlAt) and aspartate aminotransferase (AsAt) was found. What changes in the body at the
cellular level can lead to such a situation?
A. Violation of the enzymatic systems of cells
B. Damage to the genetic apparatus of cells
C. Destruction of cells
D. Violation of the function of energy supply of cells
E. Violation of intercellular relationships

6. A patient with thrombophlebitis is prescribed a complex therapy that affects different stages of thrombosis. Which of the following agents helps to restore vascular patency?
A. Neodicumarin
B. Fibrinolysin
C. Acetylsalicylic acid
D. Dipyridamole
E. Heparin

7. A 62-year-old woman complains of frequent pain in the chest and spine, rib fractures. The doctor suggested myeloma (plasmacytoma). Which of the following pathological conditions will be associated with myeloma?
A. Paraproteinemia
B. Hypoproteinemia
C. Hyperalbuminemia
D. Hypoglobulinemia
E. Proteinuria

8. A 27-year-old patient has pathological changes in the liver and brain. A sharp decrease in blood plasma and an increase in urine copper content were detected. The diagnosis is Wilson's disease. The activity of which enzyme in the blood serum should be investigated to confirm the diagnosis?
A. Alcohol dehydrogenase
B. Xanthine oxidase
C. Leucine aminopeptidase
D. Carbonic anhydrase
E. Ceruloplasmin

9. In hepatitis, myocardial infarction in the blood plasma of patients sharply increases the activity of alanine and aspartate aminotransferases. What are the reasons for the increase in the activity of these enzymes in the blood?
A. Lack of pyridoxine
B. Damage to cell membranes and release of enzymes into the blood

C. Increase in the rate of decay of amino acids in tissues
D. Increase in the rate of synthesis of amino acids in tissues
E.Increase in the activity of enzymes by hormones

10. A person suffers from diabetes mellitus with fasting hyperglycemia of more than 7.2 mmol/l. The level of which blood protein allows to estimate the level of hyperglycemia retrospectively (for the previous 4-8 weeks before the examination)?
A. Glycosylated hemoglobin
B. Ceruloplasmin
C. C-reactive protein
D. Fibrinogen
E. Albumin

11. The patient's fasting blood glucose is 5.6 mmol/l, an hour after a sugar load – 13.8 mmol/l, and after 3 hours – 9.2 mmol/l. What pathology is characterized by such indicators?
A. Hidden form of diabetes mellitus
B. Thyrotoxicosis
C. A healthy person
D. Acromegaly
E. Itzenko-Cushing's disease

12. A one-year-old child lags behind in mental development from his peers. In the morning: vomiting, convulsions, loss of consciousness. Fasting hypoglycemia in the blood. What enzyme defect can this be due to?
A. Sucrose
B. Glycogen synthase
C. Arginase
D. Phosphorylase
E. Lactase

13. The patient's fasting blood glucose is 5.65 mmol/L, 1 hour after a sugar load was 8.55 mmol/L, and 2 hours later – 4.95 mmol/L. Such indicators are typical for:
A. A healthy person
B. A patient with thyrotoxicosis
C. A patient with latent diabetes mellitus
D. A patient with insulin-dependent diabetes mellitus
E. A patient with insulin-independent diabetes mellitus

14. In diabetes mellitus due to the activation of fatty acid oxidation processes occurs ketosis. What disorders of acid-base balance can lead to excessive accumulation of ketone bodies in the blood?
A. Metabolic acidosis
B. There will be no changes
C. Respiratory alkalosis

D. Respiratory acidosis
E. Metabolic alkalosis

15. A 45-year-old woman has Itzenko-Cushing's disease - steroid diabetes. At biochemical examination: hyperglycemia, hypochloremia. Which of the following processes is activated in a woman in the first place?
A. Glycolysis
B. Glycogenolysis
C. Reabsorption of glucose
D. Gluconeogenesis
E. Transport of glucose into the cell

16. During the examination, the patient was found to have an increased retention of low-density lipoprotein in the blood serum. What disease can be expected in this patient?
A. Atherosclerosis
B. Kidney damage
C. Inflammation of the lungs
D. Acute pancreatitis
E. Gastritis

17. During the examination of an adolescent suffering from xanthomatosis, familial hypercholesterolemia was found. The concentration of which lipoproteins is significantly increased in the blood in this pathology?
A. HDL
B. VLDL
C. LDL
D. LDL
E. Chylomicrons

18. A 70-year-old man suffers from atherosclerosis of the vessels of the lower extremities and coronary heart disease. The examination revealed a violation of the lipid composition of the blood. Excess of which lipoproteins in the blood plasma is the main link in the pathogenesis of atherosclerosis?
A. Chylomicrons
B. Low density lipoprotein
C. High density
D. Cholesterol
E. Intermediate density

19. A patient who came to the doctor has yellow skin color, dark urine, dark yellow feces. An increase in the concentration of which substance will be observed in the blood serum?
A. Mesobilirubin
B. Conjugated bilirubin

C. Biliverdin
D. Free bilirubin
E. Verdoglobin

20. A 49-year-old patient, a driver by profession, complains of unbearable compressive pain behind the sternum, which "radiates" to the neck. The pain appeared 2 hours ago. Objectively: severe condition, pallor, weakened heart sounds. Laboratory tests showed high activity of creatine kinase and LDH1. What disease is characterized by such symptoms?
A. Angina pectoris
B. Acute pancreatitis
C. Gallstone disease
D. Diabetes mellitus
E. Acute myocardial infarction

21. The blood plasma of a healthy man contains several dozen proteins. When the body gets sick, new proteins appear, in particular, the "acute phase protein". This protein is:
A. Immunoglobulin G
B. Immunoglobulin A
C. Fibrinogen
D. Prothrombin
E. C-reactive protein

22. Biochemical analysis of the blood of a patient with hepatolenticular degeneration (Wilson-Conovalov disease) revealed a decrease in ceruloplasmin. This patient will have an increased concentration of the following ions in the blood serum:
A. Potassium
B. Calcium
C. Phosphorus
D. Sodium
E. Copper

23. A 49-year-old patient with acute pancreatitis was at risk of pancreatic necrosis, which was accompanied by the entry of active pancreatic proteinases into the blood and tissues and the breakdown of tissue proteins. What protective factors of the body can inhibit these processes?
A. Ceruloplasmin, transferrin
B. Hemoplexin, haptoglobin
C. α_2-Macroglobulin, α_1-antitrypsin
D. Cryoglobulins, interferon
E. Immunoglobulin

24. Electrophoretic examination of the blood serum of a patient with pneumonia showed an increase in one of the protein fractions. Specify it:

A. α_1-Globulins
B. Albumin
C. β-Globulins
D. γ-Globulins
E. α_2-Globulins

25. In a laboratory study of the blood of a 44-year-old patient, it was determined that the plasma protein content is 40 g/l. How will this affect transcapillary water metabolism?
A. Reduced filtration, increased reabsorption
B. The exchange does not change
C. Filtration and reabsorption decrease
D. Filtration increases, reabsorption decreases
E. Filtration and reabsorption increase

Protocol N **Date**

1. Determination of total protein content in the blood serum (Biuretic method

THE PRINCIPLE OF THE METHOD:

The coloured complex is formed under the protein interaction with biuretic reagent. Its colouring intensity corresponds to the protein concentration in the researching test. The optical density of the skilled test is determined on photocolorimeter (PC). The result correlates with the protein concentration in the test tube.

THE COURSE OF THE WORK:

Add 5 ml of the biuretic reagent to 0.1 ml of blood serum and mix, avoiding a foam formation. The optical density is measured in 30 minutes on PC in cuvettes (10 mm of layer) at the 540-560 nm wave length against the control. Control test tube is prepared so: to 5 ml of the worker biuretic reagent add 0.1 ml of 0,9 % sodium chloride solution and it is be processed as an experimental test tube. The calculation is conducted according to the graph.

RESULTS:

CONCLUSIONS:

Clinical significance of serum total protein test:

The normal range for total protein in the blood serum is 65-85 g/L.

Hyperproteinemia is a pathologic condition manifested by an increased content of blood plasma proteins. An increase in the blood plasma protein concentration can be caused by diarrhea in children, by vomiting (due to an obstruction of the upper small intestine), or by extensive burns.

Hyperproteinemia may be caused by an elevated level of α-globulins, for example, hyperproteinemia sequent to an infection or a toxic disturbance of the macrophage system. Among such states may also be classified hyperproteinemia in multiple myeloma (myelomatosis). In the blood serum of patients with myelomatosis, specific “myelomatous” proteins are detected. The occurence in the blood plasma of proteins, normally untypical of the healthy organism, is conventionally referred to as paraproteinemia. Quite often, in such pathology, the concentration of proteins in the blood plasma may be as high as 100-160 g/litre.

Hypoproteinemia, or a decrease in the total concentration of blood plasma proteins, is mainly due to a lowered percentage of albumins. The manifest hypoproteinemia is a permanent and pathogenically important symptom of nephrotic syndrome. The total protein content drops to a level of 30-40 g/litre. Hypoproteinemia is also observed in affected liver cells (acute atrophy of the liver, toxic hepatitis, and other states). Moreover, hypoproteinemia may develop as sequent to a drastically increased permeability of the capillary wall, or protein deficiency (affected gastrointestinal tract, carcinoma, etc.)

It is to be inferred therefore that hyperproteinemia is, as a rule, associated with hyperglobulinemia, and hypoproteinemia, with hypoalbuminemia.

2. Determination of sodium in blood serum

THE PRINCIPLE OF THE METHOD:

Sodium, contained in the sample, binds precipitant reagent. Precipitant reagent ions remaining in solution form a colored complex with thioglycolate (mercaptoacetate). The concentration of sodium is proportional to the difference between the control (without precipitation) and experimental samples.

THE COURSE OF THE WORK:

Collect reaction mixtures according to scheme:

Solution	**Experimental sample, ml**	**Control sample, ml**
Reagent №1	1.0	1.0
Blood serum	0.02	-
Distilled water	-	0.02

Samples are thoroughly mixed and incubated for 5 minutes at a temperature of 18-25^{0}C, and then again stirred (not less than 30 seconds) and incubated for 30 minutes in the dark. Then the samples are centrifuged at 1000 rpm for 10 minutes. Transparent supernatant is used for further analysis.

Mix 0.02 mL of experimental and control samples supernatant with 2 ml of reagent № 2 and the optical density of the experimental and control samples are measured against water at a wavelength of 365 or 405 nm in 5 minutes after mixing.Color is stable for 25 minutes after incubation if the samples are protected from direct light.

Note: the intensity of color of the samples is inversely proportional to the concentration of sodium in the sample.

The calculation of sodium concentration of in the experimental sample is performed according to the formula:

$$C = \frac{E_{contr} - E_{exp}}{E_{contr} - E_{st}} \times 150$$, where

C – concentration of sodium in the experimental sample, mmol/L;

Eexp – extinction of experimental sample;

Econtr – extinction of a control sample;

Est – extinction of the standard sample (the result is given by a laboratory assistant);

150 – sodium concentration in the standard sample, mmol/L.

RESULTS:

CONCLUSIONS:

Clinical significance:

Reference values of sodium concentration in blood plasma are 135 - 155 mmol/dL.

Hyponatremia is reduced sodium concentration in plasma below 135 mmol/L. Contribute to the development of hyponatremia:

- diuretics intake, osmotic diuresis (diseases for which osmotically active compounds in blood such as glucose, urea are accumulated), kidney disease (acute and chronic pyelonephritis, urinary obturation, polycystic kidney disease);
- loss of sodium associated with diseases of the gastrointestinal tract (vomiting, fistula of the small intestine, etc.);
- the use of aminoglycoside antibiotics (gentamicin);
- adrenal insufficiency (Addison's disease);

Hypernatremia is increased concentration of sodium in the blood serum above 150 mmol/L. Always associated with hyperosmolarity. Hypernatremia can cause:

- dehydration when water depletion: prolonged sweating without a pertinent water compensation, loss of water by the gastrointestinal tract (diarrhea, vomiting), skin (burns);
- diabetes insipidus (decreased sensitivity of renal receptors to ADH);
- kidney disease proceeding with oliguria;
- hyperaldosteronism (Cushing's syndrome).

Sodium belongs to a threshold substance and increase its concentration in the blood leads to an increase in its excretion.To assess the balance of sodium in the body need to determine simultaneously its content in blood and urine.

3. Determination of chloride in biological fluids (serum or urine)

THE PRINCIPLE OF THE METHOD:

In strongly acidic medium chloride ion releases thiocyanate ion from mercury thiocyanate (II). Then thiocyanate ion reacts with ions of iron (III) to form a coloured

product.The color intensity of the thiocyanate iron is proportional to the concentration of chloride ions in the sample.

THE COURSE OF THE WORK:

Preparation of urine sample: urine is 2-fold diluted with distilled water and a drop of nitric acid is added to acidic pH.

The analysis is conducted in accordance with the scheme set out in the table below:

Solution	**Experimental sample, ml**	**Control sample, ml**
Working reagent	5.0	-
Blood serum or deluted urine	0.05	0.05
Blank reagent	-	5.0

Combine all the ingredients of the reaction mixture and kept it for 10 minutes at room temperature. Measure the optical density of experimental sample against the control one. Photometry is carried out at a wavelength of 450 (440-480) nm in cuvette of 10 or 5 mm.

The calculation of chloride concentration is carried out according to the formula:

$$C = \frac{E_{exp}}{E_{st}} \times 100,$$ where

C – concentration of chlorides in the experimental sample, mmol/L;

Eexp – extinction of experimental sample;

Est – extinction of the standard sample (the result is given by a laboratory assistant);

100 – chloride concentration in the standard solution, mmol/L.

To calculate the concentration of chloride in the daily urine: the above value is multiplied by 2 (dilution factor) and the volume of daily urine, expressed in liters (get mmol/day).

RESULTS:

CONCLUSIONS:

Clinical significance:

Reference values of chloride concentration: in blood serum is 98-107 mmol/L; in urine is 250 mmol/day

Hypochloremia may cause such diseases and conditions as:

- increased allocation of chlorine in sweat in a hot climate, with fever states, with diarrhea;
- diabetic acidosis, which is usually accompanied by a transition of chlorine from the blood into the tissues;
- renal diabetes, due to the large loss of chloride in the urine.
- diseases of the adrenal glands in violation of the mineralocorticoid formation.

Hyperchloremia is divided into absolute developing under violation of renal excretory function, and the relative associated with dehydration of body and clotting of blood. When nephrosis, nephritis, and especially nephrosclerosis occurs then salts are delayed in the body and hyperchloremia is developed. Insufficient intake of water in the body, diarrhea, vomiting, loss of water and salts with burns can lead to dehydration and development of relative hyperchloremia.

Hyperchloremia may occur during decompensation of the cardiovascular system, the development of edema, comes with food large quantity of sodium chloride. In addition, hyperchloremia possible with alkalosis, with resorption of edema, exudate and transudate.

Literature (p. 130)

Lesson 14

THEME: BIOCHEMISTRY OF NERVOUS TISSUE.

RELEVANCE OF THE THEME: comparison of the chemical composition and metabolism of substances in nervous tissue with other tissues in the human body reveals certain common features, as well as specific characteristics driven by the unique functions of neurons in the central and spinal cord in the human body. Disorders in the metabolism of nervous tissue, resulting from various factors (such as emotional stress, viral infections, mechanical injuries, and genetic abnormalities), lead to the development of severe diseases. The study of the mechanisms underlying the development of these diseases continues to captivate scientists, researchers, and medical professionals specializing in neurology and psychiatry.

THE PURPOSE OF THE LESSON: to study the chemical composition of the tissues of the brain and spinal cord, cerebrospinal fluid, and the peculiarities of protein, carbohydrate, and lipid metabolism in neurons in healthy individuals and in certain diseases.

QUESTIONS FOR PREPARATION

1. Chemical composition of white and gray matters in the brain: proteins, lipids, carbohydrates, and amino acids; specific proteins of the brain. Myelin composition and properties.
2. The features of proteins, lipids and carbohydrates metabolism in the nervous tissue.
3. An energy supply for specific functions of the nervous system.
4. Molecular mechanism of nervous impulse transmission.
5. Neuromediators: classification on chemical structure, their formation and action. The ways for neuromediators inactivation in the brain.The role of monoamine oxidase (MAO). Ammonia utilization in the brain.
6. Opiates-peptides (enkephalins, endorphins): their receptors and functions in humans.

7. Psychotropic preparations influencing on the metabolism of nervous tissue.

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. Identify lipids absent in human nervous tissue:
A. Sphingomyelin
B. Triglycerides
C. Cerebrosides
D. Phospholipids
E. Cholesterol

2. Identify neurospecific proteins:
A. S-100 Protein
B. Histones
C. Protamines
D. Glutelins
E. Globulins

3. The energy needs of the brain are primarily supplied by the oxidation of:
A. Proteins
B. Glucose
C. Triglycerides
D. Glycolipids
E. Higher fatty acids

4. Choose the enzyme involved in serotonin formation:
A. 5-Hydroxytryptophan decarboxylase
B. Dopamine-β-hydroxylase
C. Choline acetyltransferase
D. Tyrosine hydroxylase
E. Glutamate decarboxylase

5. Identify the main pathway of glucose utilization in the brain:
A. Pentose phosphate pathway
B. Lipolysis
C. Anaerobic glycolysis
D. Aerobic glycolysis
E. Glycogenesis

6. Identify the compound used by nervous tissue as an energy substrate in glucose deficiency:
A. Fatty acids
B. Acetoacetate
C. Triglycerides
D. Phospholipids
E. Nucleotides

7. Identify the indicative enzyme of nervous tissue:
A. BB-CPK
B. LDH1
C. MM-CPK
D. Aspartate aminotransferase (AST)
E. Alanine aminotransferase (ALT)

8. Enkephalins belong to the chemical structure of:
A. Carbohydrates
B. Pentapeptides
C. Nucleotides
D. Polypeptides
E. Lipids

9. Identify the amino acid involved in the utilization of ammonia in neurons, converting into an amide:
A. Glutamine
B. Lysine
C. Histidine
D. Alanine
E. Methionine

10. Choose the peptide that exhibits opioid-like analgesic effects:
A. Dopamine
B. Serotonin
C. Glutathione
D. Acetylcholine
E. Endorphin

PREPARATION FOR THE KROK-1 LICENSURE EXAM

1. The pharmacological effects of antidepressants are associated with blocking (inhibition) of an enzyme that catalyzes the breakdown of biogenic amines such as norepinephrine and serotonin in the mitochondria of brain neurons. Which enzyme is involved in this process?
A. Decarboxylase
B. Monoamine oxidase
C. Transaminase
D. Peptidase
E. Lyase

2. A patient with encephalopathy was hospitalized in a neurological hospital and a correlation was found between the increase in encephalopathy and substances that enter the general bloodstream from the intestine. What compounds produced in the intestine can cause endotoxemia?

A. Indole
B. Cystine
C. Ornithine
D. Butyrate
E. Acetoacetate

3. Decarboxylation of glutamate in the CNS produces an inhibitory mediator. Name it:
A. Glutathione
B. GABA
C. Histamine
D. Serotonin
E. Asparagine

4. Decarboxylation of glutamate produces the neurotransmitter gamma-aminobutyric acid (GABA). Upon decay, GABA turns into a metabolite of the citric acid cycle, which is:
A. Fumarate
B. Malate
C. Oxaloacetate
D. Citric acid
E. Succinate

Literature (p. 130)

Lesson 15

THEME: THE ROLE OF KIDNEYS IN THE REGULATION OF WATER AND MINERAL METABOLISM. THE NORMAL AND PATHOLOGICAL COMPONENTS OF URINE.

RELEVANCE OF THE THEME: the main function of the kidneys is to maintain the homeostasis of the human body by regulating the volume of water in the blood plasma and the intercellular space of tissues through the excretion of end products of metabolism and the reabsorption of substances needed by the body. When there are disruptions in the functions of the urinary system, changes in several indicators of the patient's urine and some blood plasma indicators are evaluated to establish a differential diagnosis of diseases affecting the aforementioned system. The analysis of a patient's urine is a mandatory component in compiling the medical history for diagnostic purposes. Therefore, future physicians should thoroughly study the values of diagnostic indicators in the urine of healthy individuals and in pathological conditions.

THE PURPOSE OF THE LESSON: to study the peculiarities of metabolism in renal tissue, taking into account the fundamental functional processes of the kidney –

glomerular filtration, reabsorption, and secretion in the renal tubules. Acquire practical skills in quantitatively determining total acidity, specific gravity of urine, describing the physical properties of urine in a healthy individual, and qualitatively determining certain pathological components of urine for the purpose of establishing a potential diagnosis for a urine donor patient.

QUESTIONS FOR PREPARATION

1. General concepts of water-electrolyte exchange in the human body and the role of the kidneys in its regulation.
2. Biological role and distribution of water in the body.
3. The role of vasopressin, aldosterone, and the renin-angiotensin system in the regulation of sodium, potassium, chloride, and water content.
4. The role of the kidneys in maintaining acid-base balance.
5. Physicochemical properties and indicators of urine in normal and pathological conditions.
6. Chemical composition of human urine in norm.
7. Clinical-diagnostic significance of urine composition analysis in pathological conditions.

LABORATORY WORKS

1. Determination of urine total acidity, pH, relative density.
2. Qualitative reactions for protein in the urine.
3. Qualitative test for blood pigments in the urine.
4. Qualitative reaction for ketone bodies in the urine.
5. Qualitative reaction for glucose in the urine.
6. Qualitative reaction for bile pigments in the urine.

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. The red color of urine may be due to:
A. Absence of glucose
B. Low content of indoxyl sulfuric acid
C. Absence of amino acids
D. Hemoglobinuria
E. Presence of bilirubin

2. Choose a normal component of adult urine:
A. Acetoacetate
B. Uric acid
C. Homogentisic acid
D. Protein
E. Glucose

3. Select a pathological component of urine:
A. Uric acid
B. Sodium ions

C. Potassium ions
D. Ketone bodies
E. Urea

4. Name the substance found in urine during the Quincke test:
A. Hippuric acid
B. Glucuronic acid
C. Acetoacetic acid
D. Pyrovinogranic acid
E. Homogentisic acid

5. Identify a component of urine that decreases in viral hepatitis:
A. Uric acid
B. Urea
C. Protein
D. Direct bilirubin
E. Glucose

6. Specify the disease in which the urine significantly increases the content of urobilin:
A. Fructosuria
B. Alkaptonuria
C. Obstructive jaundice
D. Galactosemia
E. Hemolytic jaundice

7. Disruption of the secretion of this hormone leads to the development of polyuria. Name this hormone:
A. Oxytocin
B. Adrenaline
C. Thyroxine
D. Glucagon
E. Vasopressin

8. Identify a function not characteristic of the kidneys:
A. Urine formation
B. Secretory
C. Antitoxic
D. Bile formation
E. Regulatory for water and electrolyte balance in the body

9. Decrease in the daily diuresis in a patient to volumes less than 1 liter is called:
A. Anuria
B. Polyuria
C. Nocturia

D. Uremia
E. Oliguria

10. Identify the substance whose content increases in urine in gout:
A. Urea
B. Creatinine
C. Creatine
D. Uric acid
E. Hippuric acid

PREPARATION FOR THE KROK-1 LICENSURE EXAM

1. A 50-year-old patient complains of thirst, drinks a lot of water, severe polyuria. Blood glucose is 4.8 mmol/l, there is no glucosuria and ketonemia, urine is colorless, specific gravity is 1.002-1.004. What is the cause of polyuria?
A. Aldosteronism
B. Insulin deficiency
C. Lack of vasopressin
D. Hypothyroidism
E. Thyrotoxicosis

2. A patient with a suspected diagnosis of progressive muscular dystrophy was tested for urine. The presence of which compound in the urine confirms the diagnosis?
A. Creatinine
B. Myoglobin
C. Collagen
D. Creatine
E. Calmodulin

3. A person has a blood glucose content of 15 mmol/l (reabsorption threshold – 10 mmol/l). The consequence of this will be:
A. Decrease in diuresis
B. Reduced secretion of vasopressin
C. Reduction of aldosterone secretion
D. Reduction of glucose reabsorption
E. Glucosuria

4. A two-year-old child with mental and physical retardation, who suffers from frequent vomiting
after eating. Phenylpyruvic acid was found in the urine. What metabolic disorder is the consequence of this pathology?
A. Lipid metabolism
B. Amino acid metabolism
C. Carbohydrate metabolism
D. Water-salt metabolism
E. Phosphorus-calcium metabolism

5. A 13-year-old boy complains of general weakness, dizziness, fatigue. There is a lag in mental development. The examination revealed a high concentration of valine, isoleucine, leucine in the blood and urine. Urine has a specific odor. What is the most likely diagnosis?
A. Maple syrup disease
B. Histidinemia
C. Tyrosinosis
D. Basement membrane disease
E. Addison's disease

6. The infant has coloration of the sclerae, mucous membranes. Homogentisic acid is found in the blood and urine. What can be the cause of this condition?
A. Cystinuria
B. Histidinemia
C. Alkaptonuria
D. Galactosemia
E. Albinism

7. A 52-year-old patient for the past few days has been experiencing pain in the right hypochondrium after eating fatty foods. Visually, yellowing of the sclerae and skin, acholic feces, and "beer-colored" urine are detected. What substance in the patient's urine causes the dark color of the urine in case of obstructive jaundice?
A. Ketone bodies
B. Glucose
C. Stercobilin
D. Urobilin
E. Bilirubin glucuronide

8. The patient has hypersensitivity of the skin to sunlight. His urine becomes dark red in color after standing for a long time. What is the most likely cause of this condition?
A. Porphyria
B. Alkaptonuria
C. Albinism
D. Pelagra
E. Hemolytic jaundice

9. A 65-year-old man with gout complains of pain in the kidneys. Ultrasound examination revealed the presence of kidney stones. An increase in the concentration of which substance is the most likely cause of stone formation in this case?
A. Uric acid
B. Cholesterol
C. Urea
D. Bilirubin
E. Cystine

10. A patient complained of constant thirst. Hyperglycemia, polyuria and increased content of 17-ketosteroids in the urine were detected. Which disease is most likely?
A. Addison's disease
B. Myxedema
C. Glycogenosis type I
D. Steroid diabetes mellitus
E. Insulin-dependent diabetes mellitus

11. A 58-year-old man has a clinical picture of acute pancreatitis. Increase in the urine of which of the following substances will confirm the diagnosis?
A. Urea
B. Residual nitrogen
C. Albumin
D. Amylase
E. Uric acid

12. A woman with primary hyperparathyroidism has recurrent attacks of renal colic. An ultrasound examination revealed the presence of small kidney stones. What is the most likely cause of these stones?
A. Hyperkalemia
B. Hyperuricemia
C. Hypercalcemia
D. Hyperphosphatemia
E. Hypercholesterolemia

13. The patient complains of shortness of breath after exercise. Objectively: anemia, the presence of paraprotein in the gamma-globulin zone. What indicator in the urine should be
to confirm the diagnosis of myeloma?
A. Bence-Jones protein
B. Hemoglobin
C. Bilirubin
D. Antitrypsin
E. Ceruloplasmin

14. A patient who complains of polyuria and polydipsia, found sugar in the urine. The plasma sugar content is normal. What is the mechanism of glucosuria in the patient?
A. Impaired glucose reabsorption in the nephron tubules
B. Impaired glucose filtration in the glomerular department of the nephron
C. Insulin resistance of cell receptors
D. Hyperproduction of glucocorticoids by the glands
E. Insufficient production of insulin by the pancreas

15. A patient suffering from chronic hepatitis was loaded with sodium benzoate to assess the neutralizing function of the liver. The excretion of which substance in the urine is used to assess the neutralizing function of the liver?
A. Phenylacetic acid
B. Citric acid
C. Oxalic acid
D. Valeric acid
E. Hippuric acid

Protocol N **Date**

1.1. Determination of urine specific gravity

The specific gravity of urine samples is measured with the aid of a urinometer. Place the bulb in a cylinder. Add sufficient urine to the cylinder to make the bulb float. Read the specific gravity of the sample from the stem of the urinometer where the meniscus of the urine intersects the calibration lines. Be sure the urinometer is freely floating and does not touch the walls of the cylinder.
RESULTS:

CONCLUSIONS:

Clinical significance:

The specific gravity of urine varies in the region 1,012-1,020 g/ml.

Abnormal specific gravity values may indicative of:

- reduced specific gravity: diabetes insipidus, certain renal diseases, excess fluid intake, diabetes mellitus;
- raised specific gravity: dehydration, adrenal insufficiency, nephrosis, congestive cardiac-failure, liver disease.

Further action required if low or high specific gravity values are found in urine also check urine for pH value of urine, protein.

1.2. Determination of urine total acidity, pH

THE PRINCIPLE OF THE METHOD:

Urine total acidity is estimated in volume of 0.1N of NaOH solution used for titration 100 ml of urine in the presence of phenolphthalein.

THE COURSE OF THE WORK:

Pour 5 ml of urine and 5-10 ml of distilled water into a flask; add 2-3 drops of phenolphthalein, add by drops 0.1N NaOH solution until the pink coloring will appear.
RESULTS:

CONCLUSIONS:

Clinical significance:

Total acidity of normal urine varies within 25-30ml of 0.1N NaOH solution for 100 ml of urine titration. pH of urine varies within 5-7.

The concentration of alkaline components in the urine is increased at vomiting, at high acidity of gastric juice, alkaline therapy, chronic infections of urine excretion ways, during using of big amounts of vegetables, fruit, milk products in diet.

Acidity is increased at a diabetes mellitus, a tuberculosis and kidneys insufficiency.

Estimation of the total acidity takes place during differential diagnostic of alkalosis and acidosis of different aetiology.

2. Qualitative reaction for the protein in the urine.

2.1. Geller's test (with concentrated nitric acid).

THE COURSE OF THE WORK:

Pour 1-2 ml of concentrated nitric acid into a test-tube and stratify cautiously 1-2 ml of urine. A white ring of denaturated protein will appear between two layers of liquid. If there's a little quantity of protein in urine, the ring will form in 2-4 minutes.

RESULTS:

CONCLUSIONS:

2.2. Test with sulphosalicylic acid.

THE COURSE OF THE WORK:

Pour 2 ml of urine into a test-tube and add 5-6 drops of sulfosalicylic acid solution. You can see the appearance of the precipitate at the presence of protein. This test belongs to the most sensitive reactions.

RESULTS:

CONCLUSIONS:

Clinical significance:

The protein appears in the urine during nephritis, some cardiac diseases, during some forms of idiopathic hypertension and during pregnancy pathology.

3. Qualitative test for blood pigments in the urine (Benzidine test)

THE PRINCIPLE OF THE METHOD:

Reaction is based on oxidation of benzidine with active oxygen, which is released from hydrogen peroxide under the action of peroxidase.

THE COURSE OF THE WORK:

Pour 2 ml of fresh unstrained urine into a test-tube. Add an equal quantity of benzidine solution and some drops of hydroxyperoxide. Blue or green coloring products will appear at the presence of blood.

RESULTS:

CONCLUSIONS:

Clinical significance:

The renal hematuria is the main symptom of acute nephritis. The extrarenal hematuria is observed in inflammation or traumatism of the urinary tract.

4. Qualitative reaction for ketone bodies (Legal's reaction for acetone)

THE PRINCIPLE OF THE METHOD:

Acetone and acetoacetate in alkaline environment form with sodium nitroprusside an orange-red coloring complex. After oxidation by glacial acetic acid a cherry- colored compound is formed.

THE COURSE OF THE WORK:

Pour on Petri dish 1 drop of urine, 1 drop of 10% NaOH solution and 1 drop of sodium nitroprusside solution (extempera). An orange-red coloring will appear. Add 3 drops of glacial acetic acid - a cherry-red coloring will appear. The reaction can be carried out in a test-tube as well.

RESULTS:

CONCLUSIONS:

Clinical significance.

An increase of ketone bodies content in urine takes place during diabetes mellitus and during a long-term starvation.

5. Qualitative reaction for glucose in the urine (Trommer's test)

THE COURSE OF THE WORK:

Add 1 ml of 10% NaOH solution and 0.5 ml of 1% copper sulfate solution into 1ml of urine in a test tube. Heat cautiously the mixture of the test tube up to simmer and boil for 1min precisely. A red coloring will appear at glucose presence.

RESULTS:

CONCLUSIONS:

Clinical significance:

Urine contains traces of glucose at healthy people.

Glucosuria is observed in such pathologic state as diabetes mellitus (if glucose concentration in the plasma is more 9 mmol/L). This state is observed during the emotional stress, hyperthyreosis, Cushing's syndrome, during some kidney pathology.

6. Qualitative reaction for bile pigments (Rozen's reaction).

THE PRINCIPLE OF THE METHOD:

Urine bile pigments react with iodine and are oxidized in colour products.

THE COURSE OF THE WORK:

Pour 2-3 ml of urine into a test-tube and cautiously stratify into it some drops of 1% iodine solution in alcohol. A green ring will form between two layers of liquid at pathology state. It will be brown colour at healthy people.

RESULTS:

CONCLUSIONS:

Clinical significance: Bile pigments (bilirubin, biliverdin etc) will appear as alkaline salts in the urine at some types of jaundices.

Literature (p. 130)

Lesson 16

THEME. THE INTEGRATION OF METABOLIC PATHWAYS. GENERAL PRINCIPLES OF METABOLISM REGULATION

RELEVANCE OF THE THEME: metabolism is a complex and highly coordinated network of biochemical reactions essential for maintaining cellular and systemic homeostasis. In the human body, metabolic pathways are intricately interconnected, ensuring the efficient conversion of nutrients into energy and biomolecules necessary for growth, repair, and overall function. Understanding the integration of metabolic pathways and their regulation is crucial for medical professionals, including dentists, as metabolic imbalances are associated with various systemic and oral diseases. For dentistry students, knowledge of metabolic integration is particularly relevant, as metabolic disorders such as diabetes mellitus, obesity, and dyslipidemia have significant implications for oral health. These conditions can contribute to periodontal disease, delayed wound healing, and increased susceptibility to infections. Additionally, an understanding of metabolic pathways aids in comprehending the biochemical basis of enamel and dentin formation, salivary secretion, and bone metabolism.

THE PURPOSE OF THE LESSON: to study the integration of metabolic pathways and the general principles of metabolism regulation, focusing on the interconnection of carbohydrate, lipid, and amino acid metabolism through key intermediates such as acetyl-CoA, NADPH, and Krebs cycle metabolites. Understand the role of nucleoside triphosphates (ATP, UTP, CTP, GTP) in biosynthetic processes and analyze the ATP/ADP ratio as a crucial factor in metabolic control. Examine the hormonal regulation of metabolism and its impact on metabolic homeostasis. Acquire practical skills in analyzing metabolic pathways, interpreting biochemical regulation mechanisms, and applying this knowledge to clinical cases related to metabolic disorders and oral health.

QUESTIONS FOR PREPARATION

1. The key metabolites of carbohydrate metabolism: acetyl-CoA, NADPH, pyruvate; their use in metabolic pathways of lipids and amino acids.
2. The metabolites of Krebs Cycle as intermediate metabolites of carbohydrate, lipid and amino acid metabolisms.
3. The use of nucleoside triphosphates (ATP, UTP, CTP, GTP) in metabolic pathways of carbohydrates, lipids and amino acids.
4. ATP/ADP ratio as the most important control factor for duration of catabolic and anabolic pathways in carbohydrate, lipid and amino acid metabolism
5. Hormones in the control of the use of key metabolites like acetyl-CoA, NADH, NADPH in metabolic pathways of carbohydrate, lipid and amino acid metabolisms.

CHECK UP YOUR HOME PREPARATION USING THE TESTS:

1. ATP is considered as energy source for a lot of synthesises in a cell. Point out the main important process of its formation in humans:

A. Synthesis of ATP from GTP
B. Oxidative phosphorylation
C. Substrate phosphorylation
D. Synthesis of ATP from UTP
E. Creatine phosphate kinase reaction

2. This metabolite is formed in catabolic pathway from glucose and then is used for some lipids synthesis. Name it:

A. Pyruvic acid
B. Acetyl - CoA
C. Phosphoenolpyruvate
D. Lactate
E. Oxaloacetate

3. This metabolite is formed in Pentose Phosphate cycle and then is used for some lipids synthesis. Name it:

A. Malate
B. Acetyl-CoA
C. NADPH
D. NADH
E. Ribose-5-phosphate

4. This vitamin deficiency causes the accumulation of free high fatty acids and the infringement of all processes that they are involved in the liver. Name this vitamin:

A. Rutin
B. Pantothenic acid
C. Pyruvic acid
D. Lactic acid
E. Ascorbic acid

5. Name the process that is inhibited after lipolysis stimulation in the liver:
A. Synthesis of glycogen
B. Pentose Phosphate Cycle
C. Glycolysis
D. Transamination of amino acids
E. Beta-oxidation of high fatty acids
6. Name the process that is not stimulated by insulin in the target tissues:
A. Synthesis of glycogen
B. Oxidative decarboxylation of pyruvate
C. Glycolysis
D. Krebs cycle
E. Beta-oxidation of high fatty acids

7. Name the process that is stimulated in the liver of patient under poinsoning by some xenobiotics:
A. Glycogenesis
B. Pentose phosphate cycle
C. Glycolysis
D. Krebs cycle
E. Ketone bodies synthesis

8. Name the metabolite used for formation of all steroids in humans:
A. Pyruvic acid
B. Cholesterol
C. Aldosterone
D. High fatty acid
E. Oxaloacetate

9. Name the process that is stimulated in the liver cell at the ratio ATP/ADP>1:
A. Glycogenesis
B. Pentose phosphate cycle
C. Glycolysis
D. Krebs cycle
E. Oxidation of high fatty acids

10. Name the process that is stimulated in the liver by glucagon:
A. Glycogenesis
B. Glycogenolysis
C. Glycolysis
D. Krebs cycle
E. Cholesterol degradation

PREPARATION FOR THE KROK-1 LICENSURE EXAM

Lesson 17

THEME: BORDER CONTROL OF KNOWLEDGE ACQUISITION FROM SECTION 2 "MOLECULAR BIOLOGY. BIOCHEMISTRY OF INTERCELLULAR COMMUNICATIONS, TISSUES AND PHYSIOLOGICAL FUNCTIONS"

QUESTIONS FOR PREPARATION

1. Nucleoproteins digestion in the gastro-intestinal tract. Nucleosides absorption in the small intestine.
2. The common representations about biosynthesis of purine nucleotides (phases, energy suppliers, vitamins intake), its regulation.
3. The degradation of purine nucleotides in tissues. The determination of uric acid in the blood serum and urine of patients.
4. The common representations about pyrimidine nucleotides biosynthesis, its regulation.
5. Deoxyribonucleotide synthesis. The formation of dTMP; the inhibitors for this synthesis in cancer treatment.
6. The end-products of pyrimidine nucleotide degradation.
7. Hypo- and hyperuricemia states in patients: the reasons of development and diagnostics. The gout: the diagnostic tests for it and its treatment.
8. Molecular Mechanisms of DNA Replication. Types of Replication. Sequence of Stages and Enzymes Involved in DNA Synthesis in Prokaryotes and Eukaryotes.
9. Mutations and Mechanisms of Action of Mutagens. Concepts of Molecular Diseases.
10. Biological Role and Mechanisms of DNA Repair.
11. Contemporary Insights into the Transcription Mechanism. RNA Polymerases in Prokaryotes and Eukaryotes, Transcription Signals. Post-transcriptional Processing of Primary Transcript (mRNA Maturation in Eukaryotes).
12. Stimulators and Inhibitors of Nucleic Acid Biosynthesis.
13. General Concepts of Genetic Engineering and Its Biomedical Significance.
14. Genetic Code and Its Properties.
15. Ribosomal Protein Synthesis System of the Cell.
16. Structure and Biological Role of RNA (tRNA, mRNA, rRNA) in Protein Biosynthesis (Translation).
17. Mechanism of Translation and Its Stages. Energetic Provision of Protein Synthesis. Post-translational Processing of Polypeptide Chains.
18. Modern Insights into Intracellular Regulation of Gene Expression in Prokaryotes: Regulatory Scheme according to F. Jacob and J. Monod (Operon Hypothesis). Concepts of Gene Induction and Repression Mechanisms.
19. Antibiotics – Inhibitors of Protein Biosynthesis.
20. Chromoproteins: a classification, and biological role.
21. Hemoglobin: types in adults, their structure, properties and biological role.
22. Normal hemoglobin derivatives. Derivatives of hemoglobin formed under carbon monooxide poisoining and influence the strong oxidation agents.

23. Abnormal types of hemoglobin (at sickle-cell anemia and talassemia states).
24. Stages of hemoglobin synthesis, and its regulation.
25. Porphyrins: a scheme of protoprohyrin IX and heme synthesis. Inherited disorders of enzymes for this synthesis. Types of Porphyries.
26. Hemoglobin catabolism in humans: the location of stages, formation of bile pigments. Terminal bile pigments found in feces and urine. The role of the liver in the hemoglobin catabolism.
27. The infringements in the hemoglobin catabolism. Jaundices: types, the reasons of occurance, and diagnostic.
28. General notions about hormones and their properties. The modern methods for their content determination in biological fluids.
29. A Classification of hormones according their chemical nature and the mechanism of action.
30. The determination of target tissue for hormone. Types of receptors; their structure and location in a target cell.
31. Membrane-intracellular mechanism of hormones action: G-proteins, adenylate- and guanylate cyclases, phosphodiesterase, phospholipase C, all the secondary messengers, protein kinases in transmission of hormone action.
32. Hormones of adrenal medulla (epinephrine and nor-epinephrine): structure, synthesis, mechanism of their action, and biological role.
33. Molecular mechanism of insulin action. Receptor tyrosine kinases.
34. Common notions about cytosolic mechanism of lipophilic hormones action: steroidal and thyroid hormones.
35. Hormones of adrenal cortex (glucocorticoids, mineral corticoids): structure, the control of their secretion, the feature of their transport in the blood stream, the influence on the metabolism, the infringements of their secretion. Addison`s disease, Cushing's syndrome.
36. Female sex hormones (estrogens, progesterone): structure, the control of their secretion in each phase of menstrual cycle, the feature of their transport in the blood stream, the influence on the metabolism.
37. Male sex hormones (androgens): structure, the control of their secretion, the feature of their transport in the blood stream, the influence on the metabolism. The infringements of sex hormones` synthesis and secretion.
38. Thyroid hormones (triidothyronine, thyroxin): the features of their synthesis and secretion, their transport in the blood stream, and the influence on the metabolism. The disorders of metabolism at hypo- and hyperthyroidism in patients.
39. Distribution of calcium ions in the body, forms of calcium in human blood plasma
40. Hormonal regulation of calcium and phosphate homeostasis.
41. Feed-back mechanism in the maintenance of hormone levels in the blood. Short and long back communications in the block of hormones secretion.
42. Hypothalamic hormones (liberins and statins): structure, mechanism of their action, and the influence on pituitary gland.

43. Hormones of anterior lobe of pituitary gland (STH, TTH, FSH, LH, prolactin): the features of structure, the regulation of secretion, the influence on target tissues, the disorder associated with their secretion disturbance.
44. Hormones – the products of post-translational modification of proopiomelanocortin (ACTH, MSH, lipotropins, endorphins): the features of structure and function in humans.
45. Hormones of posterior pituitary (oxytocin and vasopressin), their structure and biological role. The disorder vasopressin secretion (diabetes insipidus).
46. Pancreatic hormones (insulin, glucagon): synthesis from precursors, structure and mechanism of action, the influence on the metabolism in target tissues. The disorder of the secretion (diabetes mellitus).
47. Insulin-like growth factors: the location of synthesis, factors for control of their secretion, the characteristic of their influence on the metabolism in comparison with insulin.
48. Eicosanoids (prostaglandins, thromboxans, prostacyclins and leucotrienes): their formation and function in tissues.
49. The regulation of eicosanoids metabolism by some drugs.
50. Mediators and hormones of the immune system (cytokines, interferons): chemical nature, synthesis, biochemical effects.
51. Common notions about Vitamins and their role in metabolism. Provitamins. Classification of vitamins. The features of absorption for water-soluble and fat-soluble vitamins in the gastro-intestinal tract.
52. Hypovitaminosises (vitamins deficiency): exogenous and endogenous reasons of their development. Avitaminosis (examples). Hypervitaminosis state for fat-soluble vitamins.
53. Water-soluble vitamins (H, B_1, B_2, PP (B_3), B_5, B_6, B_9, B_{12}): structure, sources of reception, daily requirement, biological role.
54. Vitamins C and P: structure, mechanisms of function in humans, daily requirement, and clinical symptoms of their deficiency.
55. Vitamin-similar substances (CoQ, carnitine, lipoic acid): structure and function in humans.
56. A group of vitamin A (retinol, retinal, retinoic acid) and β-carotines: structure, sources of reception, daily requirement, biological role; clinical symptoms of deficiency
57. A group of vitamin E (tocopherols): structure, sources of reception, daily requirement, biological role; clinical symptoms of deficiency.
58. A group of vitamin D (D_2, D_3, calcitriols): structure, sources of reception, daily requirement, biological role; clinical symptoms of deficiency in children (1-3 years of age) and in adults. Symptoms of hypervitaminosis.
59. A group of vitamin K (naphtoquinones): structure, sources of reception, daily requirement; the use in blood coagulation system and in the metabolism of bone tissue. Clinical symptoms of deficiency. Analogs and antagonists of vitamin K as preparations.
60. Vitamin F (a complex of unsaturated high fatty acids): structure, sources of reception, daily requirement, biological role; clinical symptoms of deficiency.

61. Interaction of vitamins. Combined vitamin drugs (multi-vitamins) in the prophylactic and treatment of some diseases.
62. Antivitamins: the examples of their mechanism of action.
63. Bone tissue structure.
64. Mechanism of mineralization of bone tissue.
65. Forms of disruption in bone tissue metabolism. Approaches to metabolic correction of osteoporosis.
66. Biochemical tests for assessing bone tissue metabolism.
67. Enamel: inorganic component, organic matrix. Features of metabolism in enamel.
68. Dentin.
69. Cementum.
70. Salivary biochemistry: biological role, physical properties, organic, and mineral components.
71. Regulation and mechanisms of salivary secretion. Disorders of salivary secretion.
72. The role of biochemical analysis of saliva in diagnosing oral cavity diseases.
73. Gingival fluid biochemistry: biological role and clinical assessment of gingival fluid composition.
74. Biochemical indicators of normal oral cavity fluid.
75. Changes in oral cavity fluid composition in various pathological conditions.
76. Hormonal regulation of metabolism in the oral cavity organs.
77. Biochemical functions of the liver in humans.
78. The features of carbohydrate, lipids and protein metabolism in the liver tissue.
79. The role of the liver in pigments metabolism.
80. Bile: its formation, chemical composition.
81. The damage of the liver function at some diseases. Laboratory tests to estimate the liver function. Quick`s test.
82. Xenobiotics: the definition, a classification, and biological role.
83. Current conceptions about the mechanism of xenobiotic toxic action.
84. The characteristic of xenobiotic catabolic stages. The role of the liver in xenobiotics metabolism.
85. Microsomal oxidation. Characteristics of microsomal and mitochondrial monooxygenase chains. Biological role of monooxygenase sysmems in humans.
86. Cytochrome P-450: features of structure, mechanism of action. Genetic polymorphism and regulation of the cytochrome P-450 synthesis (inducers and inhibitors).
87. Types of xenobiotic conjugation in hepatocytes (enzymes, conjugation agents, and end-products). Biochemical mechanisms and the role of liver conjugation systems in detoxification of exogenous and endogenous harmful substances.
88. The ways for xenobiotics removal from human body.
89. Structural organization of the cross-striated muscle.
90. Chemical composition of the cross-striated muscle: proteins, non-proteins and nitrogen-free substances.
91. Composition features of cardiac and smooth muscles.

92. The mechanism of muscle contraction. The role of calcium ions in the muscular contraction and relaxation.
93. Energy sources for muscular activity: creatine phosphate kinase, adenylate kinase ways. Glycolysis (aerobic and anaerobic condition). High fatty acids β-oxidation.
94. Biochemical conception of muscular pathology (myopathy, myocardium infarction).
95. Structural organization of the connective tissue. Intracellular organic matrix of the connective tissue (the main proteins, proteoglycans, glucosaminoglycans): their functions in humans.
96. Synthesis of collagen and elastin; their function in humans.
97. Mucopolysaccharidosises and collagenosises as genetic disorders in humans.
98. A comparative characteristic of chemical composition for blood plasma and blood serum.
99. Biochemical functions of blood plasma proteins. Characteristics of the main fractions of blood plasma proteins (albumins, α-, β-, γ-globulins). Hypo-, hyper-, para- and dysproteinemia. Dislipoproteinemia.
100. The enzymes of blood: classification, diagnostic role. Acute phase proteins in the blood plasma in some diseases.
101. Buffer systems of the blood. Acid-base balance of the blood and its disorders (respiratory and metabolic acidosis, alkalosis).
102. The main organic non-protein nitrogen-containing and non-azotic components of plasma, the characteristic and significance of their determination in pathology.
103. Common notions about mineral composition of blood plasma in normal and in pathology.
104. Cell and biochemical organization of the immune system. Humorous components of the immune system. Cytokines as regulators of the immune system. Molecular mechanisms of antivirus action of interferons.
105. Chemical composition of white and gray matters in the brain: proteins, lipids, carbohydrates, and amino acids; specific proteins of the brain. Myelin composition and properties.
106. The features of proteins, lipids and carbohydrates metabolism in the nervous tissue.
107. An energy supply for specific functions of the nervous system.
108. Molecular mechanism of nervous impulse transmission.
109. Neuromediators: classification on chemical structure, their formation and action. The ways for neuromediators inactivation in the brain.The role of monoamine oxidase (MAO). Ammonia utilization in the brain.
110. Opiates-peptides (enkephalins, endorphins): their receptors and functions in humans.
111. Psychotropic preparations influencing on the metabolism of nervous tissue.
112. General concepts of water-electrolyte exchange in the human body and the role of the kidneys in its regulation.
113. Biological role and distribution of water in the body.

114. The role of vasopressin, aldosterone, and the renin-angiotensin system in the regulation of sodium, potassium, chloride, and water content.
115. The role of the kidneys in maintaining acid-base balance.
116. Physicochemical properties and indicators of urine in normal and pathological conditions.
117. Chemical composition of human urine in norm.
118. Clinical-diagnostic significance of urine composition analysis in pathological conditions.
119. The key metabolites of carbohydrate metabolism: acetyl-CoA, NADPH, pyruvate; their use in metabolic pathways of lipids and amino acids.
120. The metabolites of Krebs Cycle as intermediate metabolites of carbohydrate, lipid and amino acid metabolisms.
121. The use of nucleoside triphosphates (ATP, UTP, CTP, GTP) in metabolic pathways of carbohydrates, lipids and amino acids.
122. ATP/ADP ratio as the most important control factor for duration of catabolic and anabolic pathways in carbohydrate, lipid and amino acid metabolism
123. Hormones in the control of the use of key metabolites like acetyl-CoA, NADH, NADPH in metabolic pathways of carbohydrate, lipid and amino acid metabolisms.

THE QUESTIONS FOR LABORATORY WORKS

1. The determination of uric acid content in the blood serum and in the urine (the principle of the method). Clinical significance of uric acid determination in biological fluids.
2. Determination of total, direct and indirect bilirubins in the blood serum. The principle & clinical significance of the method.
3. The test for bile pigments in the urine (Gmelin`s test). The principle of the method
4. Urobilinogen determination in the urine (Bogomolov`s reaction). The principle of the method
5. The allocation of deoxynucleoproteins from the spleen (the principle of the method).
6. Biuretic reaction and Fol`s test for hormones-polypeptides and proteins (the example: insulin). What structural fragments are proved in insulin molecule by these reactions?
7. Determination of total calcium levels in the blood serum. The principle & clinical significance of the method.
8. The determination of ascorbic acid content in food products and in the urine.
9. The influence of the pH environment on the salivary amylase activity.
10. Thymolic test.
11. Determination of creatinine in the blood serum.
12. Determination of total protein content in the blood serum (Biuretic method
13. Determination of sodium in blood serum
14. Determination of chloride in biological fluids (serum or urine)
15. Determination of urine total acidity, pH, relative density.

16. Qualitative reactions for protein in the urine.
17. Qualitative test for blood pigments in the urine.
18. Qualitative reaction for ketone bodies in the urine.
19. Qualitative reaction for glucose in the urine.
20. Qualitative reaction for bile pigments in the urine.

Literature (p. 130)

LITERATURE

Basic

1. Biological and bioorganic chemistry : national textbook : in 2 books. Book 2. Biological chemistry / Yu. I. Gubsky [et al.] ; ed. by: Yu. I. Gubsky, I. V. Nizhenkovska. - 2nd ed. - Kyiv : AUS Medicine Publishing, 2021. - 544 p.

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2. Gubsky, Yu. I. Biological chemistry : textbook for students of medical and pharmaceutical faculties / Yu. I. Gubsky ; ed. by.: Yu. I. Gubsky. - 2nd ed. - Vinnytsya : Nova Knyha, 2018. - 488 p.
3. Skorobogatova, Z. M. Biochemistry. Short course : study guide. Pt. 1 / Z. M. Skorobogatova ; ed. of the English version: O. V. Matviyenko ; reviewed by.: A. L. Zagaiko, D. A. Novikov ; National Academy of Sciences of Ukraine, L. M. Litvinenko Institute of Physical-Organic and Coal Chemistry. - Kyiv : Biocomposite, 2018. - 108 p.
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6. Biological and bioorganic chemistry : national textbook : in 2 books. Book 1. Bioorganic chemistry / B. S. Zimenkovsky [et al.] ; ed. by.: B. S. Zimenkovsky, I. V. Nizhenkovska ; reviewers: V. P. Chernykh, V. O. Kalibabchuk, V. P. Novikov. - 3rd ed. - Kyiv : AUS Medicine Publishing, 2020. - 288 p.
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