Ministry of Education and Science of Ukraine
Sumy State University
Medical Institute

5197

PRACTICAL TRAINING WORKBOOK FOR BIOCHEMISTRY

for students of specialty *222 «Medicine»*

In two parts

Part 2

Student of _____ group

_____

(name)

Variant _____

Sumy
2021

Practical training workbook for biochemistry / compilers: S. A. Goncharova, L. I. Grebenik, L. O. Primova, N. V. Bozhko. – Sumy: Sumy State University, 2021. – 59 p.

The Department of Biophysics, Biochemistry, Pharmacology and Biomolecular Engineering MI

Lesson 28 **Date_____**

Theme: METABOLISM OF SIMPLE PROTEINS AND AMINO ACIDS. COMMON PATHWAYS OF AMINO ACIDS TRANSFORMATION

Laboratory work «The definition of transaminase activity in blood serum»

The principle of the method: _____
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1. The definition of aspartate aminotransferase activity

Result: _____
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Conclusion:
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2 The definition of alanine aminotransferase activity

Result: _____
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Conclusion: _____
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Diagnostic value of clinical tests _____
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Independent work of students:

<u>Task № 73.</u> Schematically represent (with the writing of the chemical formulas of the reactants) the reactions (*according to your variant number***):**

№ variant	***Reaction***	***№ variant***	***Reaction***
1	transamination of alanine	**10**	transamination of cysteine
2	deamination of glutamate	**11**	decarboxylation of serine
3	decarboxylation of histidine	**12**	transamination of isoleucine
4	transamination of aspartate	**13**	decarboxylation of lysine
5	decarboxylation of glutamate	**14**	deamination of glutamate
6	deamination of serine	**15**	transamination of phenylalanine
7	transamination of tyrosine	**16**	decarboxylation of tyrosine
8	decarboxylation of ornithine	**17**	transamination of tryptophan
9	transamination of leucine	**18**	decarboxylation of tryptophan

<u>Task № 74</u>. Write the reactions of the nutrient digestion stage *(according to your option number).*

№	*Task*
1	Schematically represent the peptide bonds between amino acids that are specifically attacked by pepsin in the following peptide: Ala-Phe-Gly-Asn-Arg
2	Write the reaction catalyzed by maltase
3	Write the reaction of TAG hydrolysis in the intestine. Call the name of the enzyme
4	Schematically represent the peptide bonds between amino acids that are specifically attacked by trypsin in the following peptide: Asp-Glu-Arg-Gly-Phe
5	Write the reaction catalyzed by sucrase
6	Write the reaction of hydrolysis of cholesterol esters in the gastrointestinal tract. Call the name of enzyme
7	Write the reaction of, which does not occur with lactase deficiency
8	Schematically represent the peptide bonds between amino acids that are specifically attacked by elastase in the following peptide: Ala-Glu-Gly-Phe
9	Write the reaction of hydrolysis of glycerophospholipids under the action of phospholipases in the gastrointestinal tract. Call the enzymes
10	Schematically represent the peptide bonds between amino acids that are specifically attacked by pepsin in such a peptide: Ser-Phe-Trp-Asp-Glu
11	Write the reaction that does not occur in sucrose deficiency
12	Schematically represent the peptide bonds between amino acids that are specifically attacked by elastase in such a peptide: Arg-Ser-Asp-Gly-His
13	Schematically represent the peptide bonds between amino acids that are specifically attacked by trypsin in such a peptide: Glu-His-Lys-Asn-Phe
14	Write the reaction catalyzed by lactase
15	Write the reaction of hydrolysis of cholesterol esters in the gastrointestinal tract. Name the enzyme
16	Schematically represent the peptide bonds between amino acids that are specifically attacked by elastase in such a peptide: Arg-Ser-Asp-Gly-His
17	Schematically represent the peptide bonds between amino acids that are specifically attacked by pepsin in such a peptide: Ala-Phe-Gly-Asp-Arg
18	Schematically represent the peptide bonds between amino acids that are specifically attacked by pepsin in such a peptide: Ser-Phe-Trp-Asp-Glu

Task №75. **Explain the concepts of "glycogenic" and "ketogenic" amino acids. Give examples.**

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Task № 76. **What disease can be predicted in a patient if the de Ritis ratio is: а) 6,0; б) 0,5; в) 1,3. Explain the answer.**

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Rating and comments _____

The teacher's signature _____

Lesson 29 **Date**_____

Theme: METABOLISM OF AMMONIA IN HUMAN BODY. AMMONIA DETOXIFICATION AND SYNTHESIS OF UREA

Laboratory work "The definition of urea concentration in blood serum"

The principle of the method: _____
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Result: _____
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Conclusion: _____
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Diagnostic value of clinical tests _____
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Independent work of students:

<u>Task № 77.</u> Complete the sequence of chemical transformations with the missing components. List the names of the enzymes at all stages (*according to your variant number*):

Variant №	***The sequence of transformations***
1	fumarate → X1 → X2 → aspartate
2	ornithine → X1 → argininosuccinate → X2 → urea
3	alanine+ X1 → X2 + glutamate → X3 → NH_3
4	alanine + X1 → X2 + glutamate → X3 → NH_3
5	argininosuccinate → X1 → malate → X2 → aspartate
6	NH_3→ X1 + ornithine → X2 → argininosuccinate
7	oxaloacetate → X1 → argininosuccinate → X2 → malate
8	cysteine + X1 → X2 + glutamate → X3 → NH_3
9	carbomoylphosphate + X1 → citrulline → X2 → arginine

<u>Task № 78.</u> Complete the table «Inherited disorders associated with urea cycle»

Name	***Enzyme deficiency***	***Clinical, biochemical manifestations***
Hyperammonemia Type I		
Hyperammonemia Type II		
Citrullinemia		
Argininosuccinic Aciduria		
Hyperargininemia		

<u>Task №79.</u> Explain the metabolic causes for the increasing of the urea in urine in diabetes.

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Additional task

❖ Explain why patients with severe viral hepatitis (lesions of up to 80% of liver parenchymal cells) are restricted from eating protein foods.

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Rating and comments _____

The teacher's signature _____

Lesson 30 **Date**_____

Theme: SPECIALIZED PATHWAYS OF CYCLIC AND ACYCLIC AMINO ACIDS METABOLISM. DISORDERS OF NITROGEN METABOLISM. BIOSYNTHESIS OF PORHYRINS

Laboratory work "The definition of the creatinine concentration in blood serum by Popper's method"

The principle of the method: _____
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Result: _____
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Conclusion:_____
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Diagnostic value of clinical tests _____
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Laboratory work «The definition of porphyrin precursors in urine by Maiser and Granin method»

1. Qualitative test of Maiser and Granin for the detection of porphyrin precursors, porphobilinogen in urine.

The principle of the method: _____

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Result: _____

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Conclusion: _____

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2. Semi-quantitative method for the determination of coproporphyrins (CP) by Reznik and Fedorov

The principle of the method: _____

_____

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Result: _____

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Conclusion: _____

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Diagnostic value of clinical tests _____

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Independent work of students:

<u>Task № 80.</u> Draw the sequence of creatine metabolism (starting from its synthesis) with an indication of organ localization of processes.

<u>Task № 81.</u> Schematically indicate the main metabolic pathways of amino acid conversion in the body (*according to your variant number***):**

№ variant	Amino acid	***№ variant***	Amino acid	***№ variant***	Amino acid
1	Ser	**7**	Ala	**13**	Ser
2	Arg	**8**	Tyr	**14**	Met
3	Gly	**9**	Met	**15**	Leu
4	Phe	**10**	Cys	**16**	Tyr
5	Val	**11**	His	**17**	Trp
6	Trp	**12**	Phe	**18**	Ile

<u>Task №82</u>. Fill in the table "Genetic abnormalities of amino acid metabolism" *(according to your variant number)***:** 1 – homocysteinuria, 2 – Maple syrup urine disease, 3 – phenylketonuria, 4 – alkaptonuria, 5 – albinism, 6 – Hartnup`s disease, 7 – cysteinuria, 8 – histidinemia, 9 – cystinosis.

The name of the pathology	**The name of the amino acid**	**Defective enzyme**	**Changes in biochemical parameters of blood and urine**	**The main metabolic and physiological consequences for the body**

<u>Task №83.</u> Explain why with hereditary defects of heme synthesis enzymes, the skin of patients is hypersensitive to sunlight, and urine turns red. Which accumulated intermediates of heme synthesis causes such symptoms? What is the general name of diseases caused by genetic defects of heme synthesis enzymes?

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Additional task

❖ After an insulin injection, a hypoglycemic state develops, which, however, disappears rapidly with glutamic acid. Explain why glutamate normalizes blood glucose levels. Explain the answer with a scheme.

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Rating and comments _____

The teacher's signature _____

Lesson 31 **Date**_____

Theme: BIOSYNTHESIS AND CATABOLISM OF PURINE AND PYRIMIDINE NUCLEOTIDES. DETERMINATION OF THE FINAL PRODUCTS OF THEIR METABOLISM

Laboratory work «The definition of uric acid concentration in blood serum»

The principle of the method: _____

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_____
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Result: _____

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Conclusion _____

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Diagnostic value of clinical tests _____

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Independent work of students:

<u>Task №84.</u> Sketch the origin of atoms in the purine ring

<u>Task №85.</u> Draw a scheme of the catabolism of purine nucleotides. Indicate the reaction, the intensification of which can lead to the development of gout.

Task №86. Explain the biochemical basis of the use of allopurinol for the treatment of gout.

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Task №87. Write the reaction that is violated in Lesch-Nyhan syndrome. Specify the defective enzyme.

Additional task

❖ Schematically depict the sequence of the following reactions. Specify the enzymes that catalyze these transformations *(according to your variant number)***:**

№ variant	Reaction
1	Formation of AMP from IMP
2	Formation of ATP from adenine
3	Synthesis of GTP from hypoxanthine
4	Formation of carbamoyl phosphate in the synthesis of pyrimidine nucleotides
5	Formation of UMP from orotate
6	GMP catabolism
7	Formation of GTP from GDP
8	Catabolism of dTMP to succinyl-CoA
9	Catabolism of AMP

❖ Explain the molecular cause, metabolic and physiological consequences of orotataciduria. What is the treatment of this disease?

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Rating and comments _____

The teacher's signature _____

Lesson 32 **Date**_____

Theme: DNA REPLICATION AND RNA TRANSCRIPTION

Independent work of students:

Task №88. Explain the function of enzymes and proteins of DNA replication and transcription *(according to your variant number)***: 1 - DNA polymerase, 2 - DNA helicase, 3 - DNA topoisomerase, 4 - RNA primase, 5 - SSB protein, 6 DNA -ligase, 7 - RNA polymerase I, 8 - RNA polymerase II, 9 - RNA polymerase III.**

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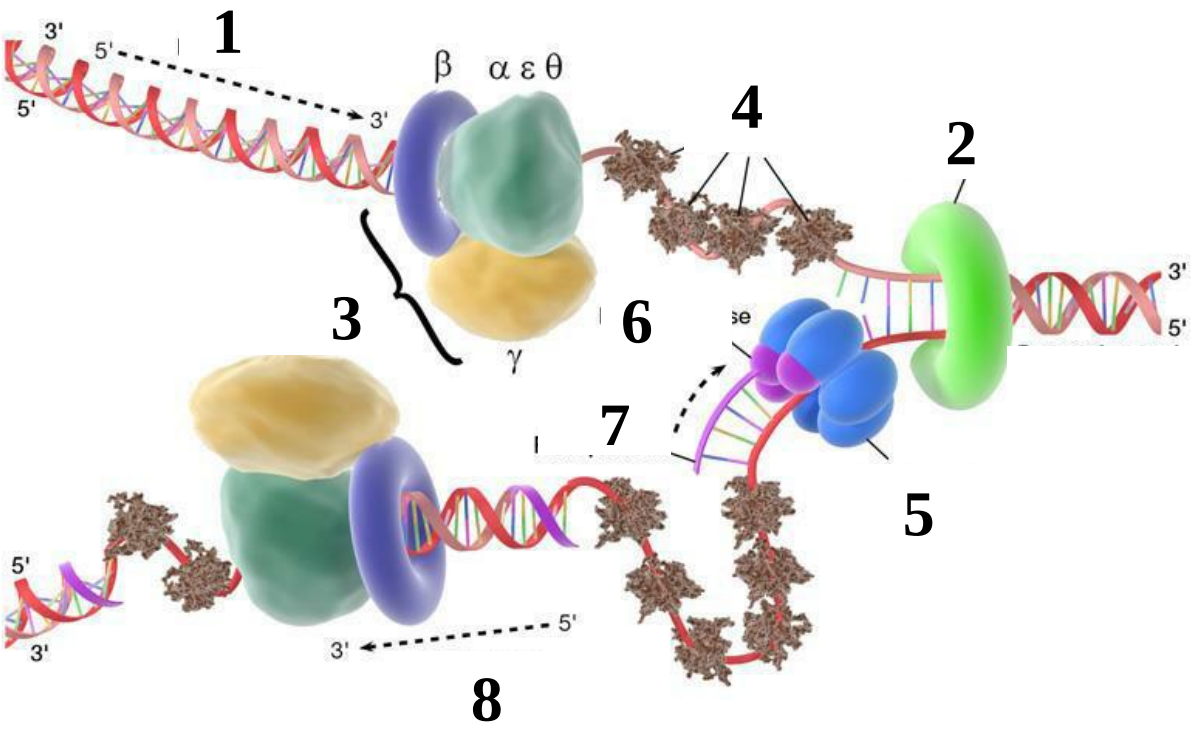
Task №89. Schematically depict the mechanism of splicing involving snRNA. Explain the process.

<u>Task №90.</u> Analyze the DNA replication scheme and sign its numbered components.



*1*_____ *5*_____
*2*_____ *6*_____
*3*_____ *7*_____
*4*_____ *8*_____

<u>Task №91.</u> Fill in the table "Antibiotics - inhibitors of transcription and replication"

Process	*The name of the antibiotic*	*Stage*	*Molecular mechanisms of antibiotic action*
Replication			
Transcription			

Rating and comments _____

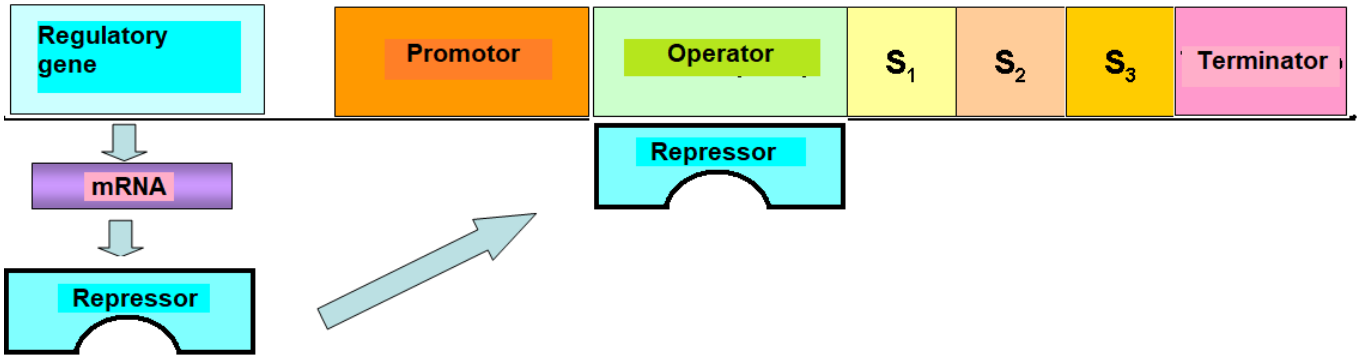
The teacher's signature _____

Lesson 33 **Date_____**

Theme: PROTEIN BIOSYNTHESIS ON THE RIBOSOMES. ANTIBIOTICS AS INHIBITORS OF TRANSCRIPTION AND TRANSLATION. REGULATION OF GENE EXPRESSION. MOLECULAR MECHANISMS OF MUTATIONS. DNA REPAIR. RECOMBINANT DNA

Independent work of students:

<u>Task №92.</u> Analyze the schematic representation of the Lac operon.



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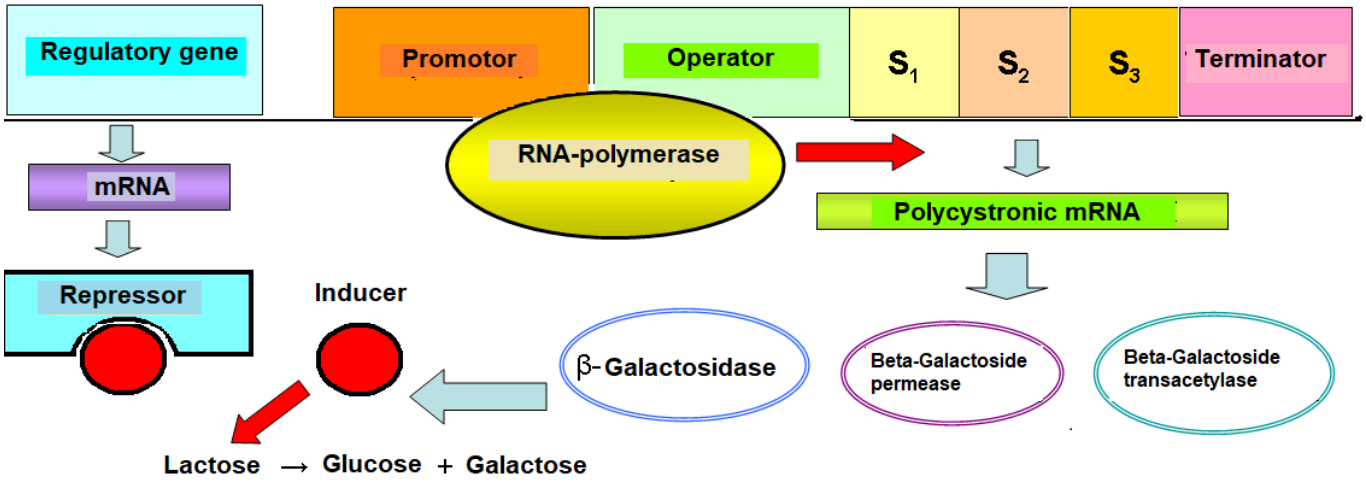

B

Explain:
a) functional purpose of the following components:
Operator - _____

_____

_____

Promotor - _____

_____

_____

Regulatory gene - _____

_____

_____

Repressor - _____

_____

_____

б) in what state is the Lac operon in Fig. A and B (explain the answer).

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<u>Task №93.</u> Fill in the table "Stages of protein synthesis"

The name of the stage	***Molecular components that ensure its implementation***	***Enzymes the stage***	***The result of the stage***	***Antibiotics that affect the process***

<u>Task №94.</u> Draw the structure of the Trp operon

Additional task

❖ Describe the reaction of formation of Tre-tRNA^{Tre}. Write the name and class of the enzyme.

Rating and comments _____

The teacher's signature _____

Lesson 34 **Date_____**

Theme: MOLECULAR-CELLULAR MECHANISMS OF PROTEIN-PEPTIDE, CATECHOLAMINES, STEROID HORMONES ACTION

Independent work of students:

Task №95. Fill in the table "Classification of hormones according to chemical structure".

Class	***Features of structure, origin***	***Location of receptors***	***Mechanism of action***	***Examples***

<u>Task №96</u>. Schematically show the mechanism of action of the hormone. Give an explanation *(according to your variant number).*

№ variant	***Hormone***	***№ variant***	***Hormone***	***№ variant***	***Hormone***
1	glucagon	***7***	aldosterone	***13***	testosterone
2	oxytocin	***8***	adrenalin	***14***	vasopressin
3	gastrin	***9***	estradiol	***15***	adrenalin
4	cortisol	***10***	serotonin	***16***	glucagon
5	angiotensin II	***11***	corticosterone	***17***	ghrelin
6	thyroxine	***12***	calcitonin	***18***	progesterone

<u>Task №97</u>. Draw the structure of cAMP. Write the reactions of formation and cleavage of cAMP (specify the names of enzymes for these reactions).

<u>Task №98</u>. Draw schemes for regulating the secretion of hormones with an example:

a) on the principle of negative feedback

b) on the principle of positive feedback

Additional task

- Fill in the table "Classification of hormones according to the site of synthesis.

Glands with endocrine function	*Hormones which synthesized here*
Hypothalamus	
Pituitary	
The pineal gland	
Thyroid	
Parathyroid glands	
Pancreas	
Adrenal glands	
Gonads	

Rating and comments _____

The teacher's signature _____

Lesson 35 **Date_____**

Theme: BIOCHEMICAL EFFECTS OF PROTEIN-PEPTIDE AND GASTROINTESTINAL TRACT HORMONES

Laboratory work «Color reactions of insulin»

The principle of the method: _____
_____
_____

Result: _____
_____
_____

Conclusion: _____
_____
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Independent work of students:

<u>Task №99.</u> Draw a scheme illustrating the enhancement of glycogenolysis and the inhibition of glycogenesis in the liver by glucagon. Specify the role of protein kinase in this process.

<u>Task №100.</u> Fill in the table "Biochemical effects of insulin" (for all types of metabolism)

Metabolic process	***The effect of insulin (↑, ↓)***	***Changes in the metabolic process***
Glycogenesis		
Glycogenolysis		
Lipogenesis		
Lipolysis		

<u>Task №101.</u> Fill in the table "Biochemistry of hormones of the hypothalamus, pituitary gland, pancreas and digestive tract" *(according to your variant number).*

The name of hormone	***Place of secretion***	***Mechanism of action; secondary intermediaries***	***Biochemical effects: effects on the metabolism of carbohydrates, lipids, proteins; physiological effects***	***Disorders of secretion: the name of pathologies***

№ variant	***Hormone***	***№ variant***	***Гормон***	***№ variant***	***Hormone***
1	corticoliberin	***7***	gonadotropin	***13***	lutropin
2	somatotropic hormone	***8***	oxytocin	***14***	glucagon
3	thyroid stimulating hormone	***9***	prolactin	***15***	secretin
4	somatostatin	***10***	tyroliberin	***16***	gastrin
5	adrenocorticotropic hormone	***11***	opioid peptides	***17***	chorionic somatotropin
6	vasopressin	***12***	insulin	***18***	cholecystokinin

Additional task

- Draw a scheme illustrating the mechanism of action of insulin. Explain this mechanism.

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Rating and comments _____

The teacher's signature _____

Lesson 36 **Date_____**

Theme: HORMONAL REGULATION OF METABOLISM AND CELLULAR FUNCTIONS BY THYROID HORMONES AND CATECHOLAMINES. BIOCHEMICAL EFFECTS OF EICOSANOIDS

Laboratory work «A qualitative reaction to thyroxine and epinephrine»

1 A qualitative reaction to thyroxine

The principle of the method: _____

_____

_____

2 A qualitative reaction to epinephrine

The principle of the method: _____

_____

_____

2.1 Reaction with ferric chloride

The principle of the method: _____

_____

_____

2.2 Diazoreaction

The principle of the method: _____

_____

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Independent work of students:

<u>Task №102</u>. Draw a scheme of the synthesis and secretion of thyroid hormones. Explain the role of TSH in this process.

Task №103. Explain what metabolic processes in the body of a patient with hyperthyroidism lead to fever and weight loss.

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Task №104. Draw a scheme of the mechanism of action of thyroid hormones, which leads to increased protein anabolism.

Task №105. Fill in the table «The metabolic effect of thyroid hormones».

Type of metabolism	*Hyperthyroidism*	*Hypothyroidism*
Protein metabolism		
Lipid metabolism		
Carbohydrates metabolism		

Task №106. Schematically explain what biochemical mechanisms are involved in the implementation of the anti-inflammatory action of aspirin.

Task №107. Write the sequence of reactions for the synthesis of catecholamines (with the image of the structural formulas of intermediates). Explain the role of SAM in this process.

Additional task

❖ Fill in the table "General characteristics of eicosanoids"

Eicosanoids	*Metabolic and biochemical effects*
Prostaglandins	
Prostacyclins	
Thromboxanes	
Leukotrienes	

Rating and comments _____

The teacher's signature _____

Lesson 37 **Date_____**

Theme: THE BIOCHEMICAL EFFECTS OF STEROID HORMONES. HORMONAL REGULATION OF CALCIUM AND PHOSPHATE HOMESOSTASIS

Laboratory work «The definition of Ca^{2+} concentration in blood serum»

The principle of the method: _____

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Result: _____

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Conclusion: _____

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Diagnostic value of clinical tests _____

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Independent work of students:

<u>Task №108</u>. Fill in the table "Hormones – regulators of Ca^{2+} homeostasis"

Name of hormone	***Place of synthesis***	***Effects on target organs***			***Effect on blood concentration (↑ or ↓)***	
		bones	***kidney***	***intestine***	***Ca***	***P***

<u>Task №109.</u> Schematically depict the sequence of reactions of calcitriol synthesis (indicating the organ localization of processes); name the enzymes of reactions.

<u>Task №110.</u> Fill in the table "Steroid hormones"

Hormones	***Mechanism of action (name), target organs***	***Physiological and biochemical effects***	***Names of pathological conditions***
Hormones of the adrenal cortex: - ***Cortisol*** ***- Aldosterone***			
Gonadal hormones: ***- Estrogens*** ***-Androgens***			

Rating and comments _____

The teacher's signature _____

Lessons 38-39 **Date_____**

Theme: EXAMINATION SUBMODULE 3 "METABOLISM OF PROTEINS. MOLECULAR BIOLOGY. BIOCHEMISTRY OF INTERCELLULAR COMMUNICATIONS"

The list of the theoretical questions and practical skills for preparation for the semantic module is given in methodical instructions. [1].

Lesson 40 **Date_____**

Theme: WATER SOLUBLE VITAMINES: B_1, B_2, B_5, B_6, B_{12}. FUNCTIONAL ROLE IN METABOLISM

Laboratory work "The definition of vitamins"

1 The definition of vitamin B_1 (thiamine)

1.1 The oxidation reaction

The principle of the method: _____
_____
_____

1.2 Diazoreaction

The principle of the method: _____
_____
_____
_____

2 The reaction to vitamin B_2 (riboflavin)

The principle of the method: _____
_____
_____
_____

3 The reaction to vitamin B_6 (pyridoxine)

The principle of the method: _____
_____
_____
_____

Independent work of students:

<u>Task № 111.</u> A patient with tuberculosis was treated with isoniazid for a long time. After some time, there was increased peeling of the skin, hair loss, dermatitis. What is the possible cause of this condition? Explain this state of patient.

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<u>Task № 112</u>. The patient complains of general muscle weakness, pain in the heart. Objective examination revealed inflammatory processes of the mucous membrane of the tongue and lips, keratitis, vascularization of the cornea. Which vitamin hypovitaminosis can cause this condition?

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Task № 113. **Fill in the table "Water-soluble vitamins (B-group) "**

Vitamin	*Chemical name*	*Coenzyme(s)*	*Role in metabolism (type of metabolism, processes, enzymes)*
B_1			
B_2			
B_3			
B_6			
B_{12}			

Task № 114. **It is known that in carcinoid syndrome, which develops due to increased secretion of serotonin by carcinoid tumor cells, pellagra-like symptoms occur. Explain the metabolic cause of these clinical symptoms and indicate the main signs of pellagra.**

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Task № 115. **Explain the cause of aminoaciduria in:**
a) liver disease_____

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_____

б) hypo- and avitaminosis B_2

в) hypo- and avitaminosis B_6

г) hypo- and avitaminosis PP

Additional task

❖ Draw the structural formula of thiamine.

❖ The patient showed a decrease in the acidity of gastric juice, changes in the nervous system. Blood tests revealed hypochromic anemia, the presence of large erythrocytes. Which vitamin hypovitaminosis can be suspected? Give an explanation

Rating and comments _____

The teacher's signature _____

Lesson 41 **Date_____**

Theme: MECHANISMS OF ACTION AND BIOCHEMICAL EFFECTS OF VITAMIN C, PP, H, B_C, P. METHODS FOR DETERMINATION OF VITAMIN C

Laboratory work «Determination of vitamins C i P»

1 Qualitative reaction to vitamin C

1.1 Reaction with 2,6-dichlorophenolindophenol

1.2 Reaction with iodine

The principle of the method: _____

_____

_____

2. The reaction to vitamin PP (nicotinic acid)

The principle of the method: _____

_____

_____

3. The reaction to vitamin P

The principle of the method _____

_____

_____

4. Definition of vitamin C concentration in the urine

The principle of the method: _____

_____

_____

The calculation of vitamin C concentration in urine should be made in accordance with the formula:

$$X = \frac{0{,}088 \times A \times B,}{V}$$

where X is ascorbic acid concentration in the urine, mg/day;
0,088 is recalculating index (1 ml of 0.001 M 2.6-dichlor-phenolindophenol solution is equivalent to 0.088 mg of ascorbic acid);
V is urine volume, taken for titration (10 ml);
B is daily urine volume (1500 ml for men, 1200 ml for women);
A is volume of 0.001 M 2.6-dichlorophenolindophenol, ml.

Conclusion_____

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Diagnostic value of clinical tests _____

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Independent work of students:

<u>Task № 116.</u> Explain why eating large amounts of raw eggs develops vitamin H deficiency?

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<u>Task № 117</u>. Fill in the table "General characteristics of vitamins B_5, B_c, H, P, C.

Vitamin	*Chemical name*	*Coenzyme*	*Role in metabolism (type of metabolism, processes, enzymes)*
B_5			
B_c			
H			
P			
C			

Additional task

❖ Explain why anemia develops with vitamin B_{12} deficiency.

❖ Explain the antioxidant role of vitamin C.

Rating and comments _____

The teacher's signature _____

Lesson 42 **Date_____**

Theme: BIOCHEMICAL EFFECT AND METHODS FOR DETERMINING THE FAT-SOLUBLE VITAMINS. DETERMINATION OF MACRO – AND TRACE ELEMENTS IN BIOLOGICAL MATERIAL.

Laboratory work « Definition of vitamins A, E, K, D»

1. Detection of vitamin A

1.1. Reaction with sulfuric acid

The principle of the method: _____
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_____

2.1. Reaction with ferrous sulfate

2. Detection of vitamin E

2.1 Reaction with ferric chloride

The principle of the method: _____
_____
_____

2.2. Reaction with nitric acid

The principle of the method: _____
_____
_____
_____

3. Determination of vicasol

The principle of the method: _____
_____
_____

4. Bromchloroform test for vitamin D

The principle of the method: _____
_____
_____

5. Qualitative reactions on Ca, Mg, P in blood serum

The principle of the method: _____
_____
_____

6. Determination of inorganic phosphates in blood serum

The principle of the method: _____
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Diagnostic value of clinical tests_____
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7. Determination of magnesium in serum

The principle of the method: _____
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Diagnostic value of clinical tests _____
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Independent work of students:

<u>Task № 118.</u> Schematically depict the "rhodopsin cycle", which explains the participation of vitamin A in the process of light adaptation.

<u>Task № 119.</u> Fill in the table for micro- and microelements *(according to your variant number).*

Name of element	***Metabolic role***	***Features***	
		Deficiency	***Excess***

№ variant	***Name of element***	***№ variant***	***Name of element***	***№ variant***	***Name of element***
1	Na, Zn	***7***	Cl, Cr	***13***	K, Cu
2	K, J	***8***	Mn, Na	***14***	Ca, Mn
3	Ca, Se	***9***	Ca, F	***15***	Fe, Cl
4	Mg, F	***10***	P, Se	***16***	P, Mo
5	P, Cu	***11***	Fe, J	***17***	Mg, Cr
6	Fe, Mo	***12***	Cl, Mg	***18***	Fe, Se

<u>Task № 120.</u> Explain why hemorrhages occur when taking antibiotics and impaired bile acid secretion.

_____
_____
_____
_____
_____

Additional task

- ❖ Fill in the table "Characteristics of fat-soluble vitamins

The name of vitamin	*Daily requirement, sources*	*Role in metabolism*	*Features of hypo- and hypervitaminosis*

Rating and comments _____

The teacher's signature _____

Lesson 43 **Date_____**

Theme: PHYSIOLOGICAL AND BIOCHEMICAL FUNCTIONS OF BLOOD: BUFFER SYSTEMS, ACID-BASE STATUS. RESPIRATORY FUNCTION OF ERYTHROCYTES

Laboratory work
«Determination of haemoglobin in the blood by haemoglobincyanide method with acetonecyanohydrin»

The principle of the method: _____
_____
_____

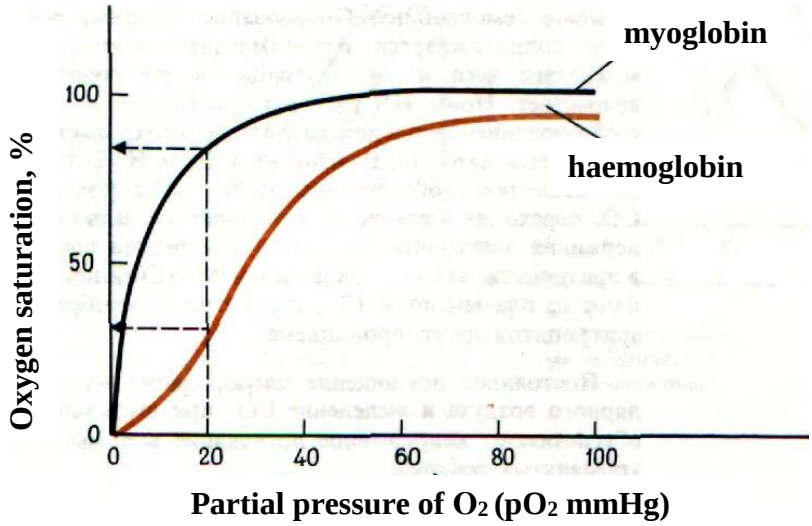
Diagnostic value of clinical tests _____
_____
_____

Independent work of students:

<u>Task №121.</u> Fill table "Molecular disorders of haemoglobin structure"

Haemoglobinosis	***Forms/Views***	***The mechanism of formation and consequences***
haemoglobinopathies		
thalasemias		

<u>Task №122</u>. Explain the curves of the degree of oxygenation on the partial pressure of oxygen for haemoglobin and myoglobin.



<u>Task №123.</u> Name and explain the blood acid-base balance at subsequent changes in metabolic processes *(according to your variant number)*:

№	***Metabolic changes***
1	Diabetes
2	Activation of glycolysis
3	Excessive parenteral arginine
4	Action of the carboanhydrase inhibitor
5	Tissues hypoxia
6	Excessive parenteral lysine
7	Asphyxia
8	Ketoacidosis
9	Excessive parenteral histidine

Additional task

- ❖ Fill in the table "Buffer blood systems"

№	*The name of the buffer system*	*Components*	*Buffer blood capacity, %*	*The mechanism of action*	
				at pH<7	*at pH>7*
1					
2					
3					
4					

Rating and comments _____

The teacher's signature _____

Lesson 44 **Date_____**

Theme: PLASMA PROTEINS: ACUTE-PHASE OF INFLAMMATION PROTEINS, INDICATOR ENZYMES

Laboratory work "Determination of serum total protein"

1 Determination of serum total protein by biuret method
The principle of the method: _____

_____

_____

Diagnostic value of clinical tests _____

_____

_____

_____

2 Electrophoretic separation of blood plasma proteins into fractions

Diagnostic value of clinical tests _____

_____

_____

_____

_____

Independent work of students:

Task №124. Fill in the table "Indicator blood enzymes"

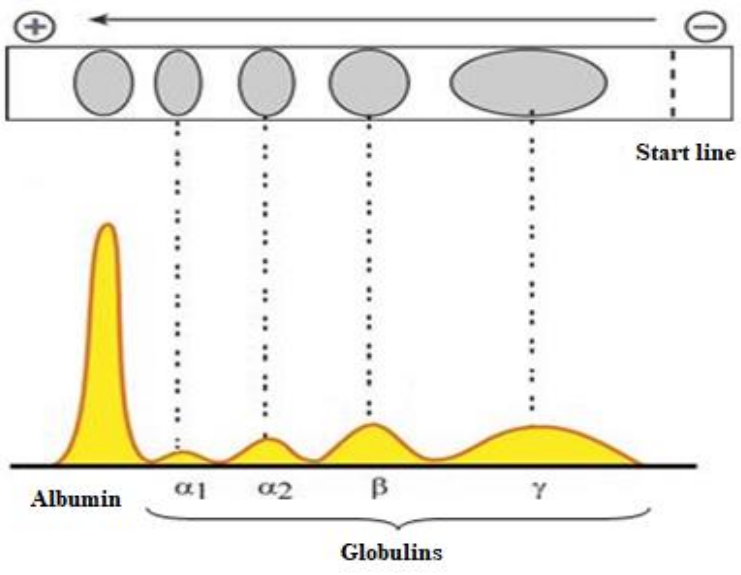
Name of enzyme	*Place of synthesis*	*Type of metabolism*	*The reaction catalyzed by the enzyme*	*Diagnostic significance*
CPK				
AST				
LDH				
ALT				
Alkaline phosphatase				
Acid phosphatase				
α-amylase				

Task №125. Fill in the table "Blood enzymes".

№	*Group of enzymes*	*Name of enzyme (one example)*	*Place of synthesis for this enzyme*	*Reaction catalyzed by this enzyme*
1	***Secretory***			
2	***Indicator***			
2.1	*Organspecific enzymes (*			
2.2	*Nonspecific*			
3	***Excretory***			

Task №126. The figure shows the proteinogram of normal serum proteins. Draw with a colored pencil (!!!) a proteinogram of serum proteins in the following diseases *(according to your variant number)***. Explain the changes.**

№	*Disease*	*№*	*Disease*	*№*	*Disease*
1	Acute inflammatory processes	***4***	Immunodeficiency	***7***	Hepatitis
2	Chronic inflammation	***5***	Nephrotic syndrome	***8***	Cirrhosis
3	Cachexia	***6***	Malignant neoplasms	***9***	Myeloma



Additional task

❖ Inflammatory kidney disease is accompanied by albuminuria and a decrease in the concentration of albumin in the blood (albuminemia) to 1 g l. At the same time hypostases are observed at patients. Explain why nephrosis is accompanied by severe edema.

_____
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Rating and comments _____

The teacher's signature _____

Lesson 45 **Date**_____

Theme: BLOOD COMPOSITION: NON-PROTEIN ORGANIC COMPONENTS. PLASMA LIPOPROTEINS. COAGULATION AND FIBRINOLYTIC SYSTEMS OF BLOOD. PATHOLOGY OF HEMOSTASIS. BIOCHEMISTRY OF IMMUNE PROCESSES AND BIOCHEMICAL MECHANISMS OF IMMUNODEFICIENCY

Laboratory work « Determination of rest nitrogen (nonprotein nitrogen (NPN) in blood serum»

The principle of the method: _____
_____
_____
_____

Diagnostic value of clinical tests _____
_____
_____
_____

Independent work of students:

Task №127. Fill in the table "Non-protein components of blood"

№	*Nonprotein compounds (norma)*	*Type of metabolism*	*Place of synthesis*	*Pathological and physiological conditions in which there is a change in concentration*	
				increase	*decrease*
1	*2*	*3*	*4*	*5*	*6*
Nitrous					
1	*urea*				

1	*2*	*3*	*4*	*5*	*6*
2	*creatine*				
3	*creatinine*				
4	*uric acid*				
Nonnitrous					
1	*glucose*				
2	*lactate*				
3	*pyruvate*				
4	*cholesterol*				
5	*free fatty acids*				
6	*ketone bodies*				

Additional task

❖ What changes in the composition of the blood occur when is?

а) retention azotemia;

_____

_____

_____

_____

б) productive azotemia.

_____

_____

_____

_____

Rating and comments _____

The teacher's signature _____

Lesson 46 **Date_____**

Theme. BIOCHEMICAL FUNCTIONS OF LIVER. DETERMINATION OF ACTIVITY OF SORBITOL DEHYDROGENASE AND γ-GLUTAMYLPEPTIDASE IN BLOOD SERUM

Laboratory work «Determination of sorbitoldehydrogenase (SDH) activity in blood serum by unified method with resorcinol »

The principle of the method: _____
_____
Diagnostic value of clinical test _____
_____
_____

Laboratory work «The sedimentary tests»

1 Thymol test
The principle of the method: _____
_____
Diagnostic value of clinical test _____
_____
_____

2 Veltman's test
The principle of the method: _____
_____
Diagnostic value of clinical test _____
_____
_____

Laboratory work «Determination of activity of γ-glutamyltranspeptidase (GGTP) in blood serum»

The principle of the method: _____
_____
Diagnostic value of clinical test _____
_____
_____

Independent work of students:

<u>Task №</u> 128. Draw a scheme illustrating the involvement of the liver in lipid metabolism and explain the scheme.

Task № 129. Draw a scheme illustrating the involvement of the liver in the metabolism of proteins and amino acids and explain the scheme.

Task № 130. Draw a scheme illustrating the involvement of the liver in the metabolism of carbohydrates and explain the scheme.

Additional task

- Draw a scheme illustrating the involvement of the liver in cholesterol metabolism and explain the scheme.

❖ Explain the clinical and diagnostic value of serum cholinesterase determination.

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Rating and comments _____

The teacher's signature _____

Lesson 47 **Date**_____

Theme: THE ROLE OF LIVER IN THE METABOLISM OF BILE PIGMENTS. PATHOBIOCHEMISTRY OF JAUNDICE. BIOTRANSFORMATION OF XENOBIOTICS AND ENDOGENOUS TOXIC SUBSTANCES

Laboratory work «Quantitative determination of the total, direct and indirect bilirubin in serum by Indrashek method»

The principle of the method: _____
_____

Diagnostic value of clinical tests _____
_____
_____

Independent work of students:

<u>Task №</u> 131. Draw a scheme of bilirubin metabolism (formation, neutralization, excretion). Name the enzyme that catalyzes the bilirubin conjugation reaction.

<u>Task №</u> 132. Explain the changes of the indicators (*according to your variant number***).**

№	*Changes in indicators*
1	Increasing concentration of urobilin and stercobilin in feces in hemolytic jaundice
2	Increasing concentration of urobilinogen in urine and decreasing stercobilin in feces in parenchymal jaundice
3	Increasing concentration of bilirubin in the blood and its absence in the urine in hemolytic jaundice
4	Increasing concentration of bilirubin in the blood and urobilin in the urine in parenchymal jaundice
5	Increasing concentration of bilirubin in the blood and its presence in the urine with mechanical jaundice
6	The presence of urobilin in the urine of jaundice in newborns
7	Change in the concentration of individual fractions of bilirubin in the blood in hemolytic jaundice
8	Change in the concentration of individual fractions of bilirubin in the blood in parenchymal jaundice
9	Changes in the concentration of individual fractions of bilirubin in the blood in obstructive jaundice

<u>Task № 133.</u> Write the chemistry of indican synthesis in hepatocytes. Explain the diagnostic value of determination of indican in urine.

<u>Task № 134.</u> Draw the chemistry of the reaction underlying the Quick-Pitel test.

Additional task

❖ In the form of which metabolites bilirubin is excreted from the body?

❖ Fill in the table "Change in laboratory parameters for jaundice » (↑, ↓, N).

Parameters		*Jaundices*		
		hemolytic	*parenchymal*	*obstructive*
Blood	*direct bilirubin*			
	indirect bilirubin			
	alkaline phosphatase			
	ALT i AST			
Urine	*urobilinogen*			
	bilirubin			
Feces	*stercobilin*			

❖ Explain the biochemical and physiological significance of the induction of microsomal oxygenases.

_____
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Rating and comments _____

The teacher's signature _____

Lesson 48 **Date**_____

Theme: TESTS ON SITUATIONAL TASKS FROM "STEP - 1": IV SEMESTER

References for preparation

1. Biochemical review questions for Step-1 examination of medical students (Part I) / L. A. Primova, L. I. Grebenik, I. V. Chorna, I. Yu. Vysotsky. – Sumy: Pub. SumSU, 2010 :
part 1 – P. 3–14 (All questions); P. 22–47 (All questions);
part 2 – P. 48 (questions 1, 2, 4, 6, 8, 10-48); P. 73 (questions 1, 2, 4, 5-12, 14-40);
part 3 – P. 83 (questions 11-13); P. 95 (questions 53-58); P. 96 (questions 59-110).

Lesson 49 **Date_____**

Theme: FUNCTIONAL ACTIVITY IN THE KIDNEYS. CHEMICAL COMPOSITION OF URINE

Laboratory work « Qualitative reactions on pathological components of urine »

1 Quantitative reaction on protein in urine

The principle of the method: _____
_____
_____

Diagnostic value of clinical tests _____
_____
_____

2 Qualitative test on blood pigments in urine (benzidine test)

The principle of the method: _____
_____
_____

Diagnostic value of clinical tests _____
_____
_____

3 Qualitative test on glucose in urine (Trommer`s reaction)

4 Qualitative reaction on ketone bodies

4.1 Legal's test for acetone and acetoacetic acid

The principle of the method: _____
_____
_____

4.2 The Gerhard's reaction on acetoacetic acid

The principle of the method: _____
_____
_____

Diagnostic value of clinical tests _____
_____
_____

5 Qualitative reaction on bile pigments

5.1 Gmelin's test

The principle of the method: _____
_____
_____

Record the results in the table

№	*The name of the reaction*	*The result of the experiment in vitro*			
		1	*2*	*3*	*4*
1					
2					
3					
4					
5					

Conclusions_____

_____

_____

_____

Independent work of students:

<u>Task № 135</u>. Fill in the table "Normal and pathological components of urine".

Urine component (name)	***Origin (type of metabolism, process)***	***Pathological conditions in which it is observed***	
normal urine components		***increase***	***decrease***
pathological components of urine		***appearance***	

<u>Task №136.</u> Draw a scheme that explains the mechanism of functioning of the renin-angiotensin-aldosterone system.

Additional task

❖ Fill in the table "Kidney enzymes".

Kidney enzymes	*Examples*	*Biological role*
specific		
nonspecific		

❖ Fill in the table "Hormonal mechanisms of regulation of water-salt metabolism".

Hormonal system	*Mechanism of action with changes in water supply*	
	limitation	*excess*

Rating and comments _____

The teacher's signature _____

Lesson 50 **Date_____**

Theme: BIOCHEMICAL TRANSFORMATIONS IN THE MUSCLES. DETERMINATION OF SERUM CREATININE

Laboratory work «Determination of creatinine in blood serum by Popper's method»

The principle of the method: _____
_____
_____

Diagnostic value of clinical tests _____
_____
_____

Independent work of students:

Task №137. Fill in the table "Muscle proteins"

Proteins	***Examples***	***Features of structure, biological role***
Proteins of sarcolemma		
Sarcoplasmic proteins		
Myofibril proteins		

Task № 138. Fill in the table "ATP resynthesis pathways"

Ways of ATP resynthesis	*Chemical reaction*	*Biological role (starting conditions)*
Anaerobic conditions		
Creatine phosphokinase		
Glycolytic		
Myokinase (adenylate cyclase)		
Aerobic conditions		
Oxidative phosphorylation		

Task №139. Fill in the table "Sources of energy in the muscles"

Type of muscle tissue	*Type of metabolism*	*Main energy substrates*
White muscles		
Red muscles		
Heart muscle		

Additional task

- Explain changes in metabolism in the heart muscle in coronary heart disease.

_____
_____
_____
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❖ Fill in the table "Nitrogenous and nitrogen-free components of muscle tissue"

Chemical composition	*Name*	*Biological role*
Nitrogenous non-protein components		
Nitrogen-free organic substances		
Mineral salts		

Rating and comments _____

The teacher's signature _____

Lesson 51 **Date**_____

Theme: FEATURES OF CHEMICAL COMPOSITION AND METABOLISM IN THE CONNECTIVE TISSUE. DETERMINATION OF SIALIC ACIDS IN BLOOD SERUM

Laboratory work «Determination of sialic acids in blood serum »

The principle of the method: _____

_____

_____

Diagnostic value of clinical tests _____

_____

_____

Independent work of students:

Task №140. Fill in the table "Chemical composition of connective tissue"

The name of the chemical compound	*Features of the structure*	*Biochemical and physiological functions*
Collagen		
Elastin		
Glycosamine glycans		

Task № 141. Fill in the table "Pathobiochemistry of connective tissue"

Pathology	*Biochemical mechanisms of occurrence*	*Clinical and biochemical diagnostics*
Mucopolysaccharidosis		
Collagenosis		

Task № 142. Explain the mechanism of the effect of vitamin C hypovitaminosis on connective tissue metabolism.

_____
_____
_____
_____

Additional task

❖ An increased amount of hydroxyproline was detected in the urine. Which metabolic disorders does this indicate? Explain the answer.

_____
_____
_____
_____

Rating and comments _____

The teacher's signature _____

Lesson 52 **Date**_____

Theme: FEATURES OF CHEMICAL COMPOSITION AND METABOLISM IN THE NERVOUS TISSUE

Laboratory work «Determination of cholinesterase activity (CE) in blood serum»

The principle of the method: _____
_____

Diagnostic value of clinical tests _____
_____
_____
_____

Independent work of students:

Task № 143. Schematically depict the sequence of reactions of the GABA shunt.

Task № 144. Draw the scheme and explain the main pathways of ATP formation in nervous tissue.

Task № 145. Fill in the table "Characteristics of neurotransmitters"

Neurotransmitter	*Synthesis chemistry, enzyme*	*Mechanism of action (receptors)*	*Effects*
Acetylcholine			
Dopamine			
Norepinephrine			
Histamine			
GABA			
Taurine			
Serotonin			

Additional task

❖ Explain why the level of serotonin in the brain is lower in winter than in summer. How is serotonin metabolism related to melatonin metabolism?

_____
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Rating and comments _____

The teacher's signature _____

Lesson 53 **Date**_____

Theme: TEST OF SITUATIONAL TASKS FROM "STEP-1": III-IV SEMESTERS

References for preparation

1. Primova L. O. Biochemical review questions for Step-1 examination of medical students (Part 1) / L. O. Primova, L. I. Grebenic. – Sumy : Pub. SumSU, 2010. – P. 3–22 (All questions), P. 48-80 (2003, questions 1, 8, 11, 18, 23, 25, 42, 44, 45, 47; 2004, questions 5, 9, 14, 16, 17; 2005, questions 3, 4, 7-10, 12, 15, 16, 22, 25, 26, 30; 2006, questions 1, 6, 7, 9, 12, 20, 21, 22, 37, 41, 43, 46; 2009, questions 3, 4, 8, 24, 31, 38;

part 1 – P. 3–14 (All questions); P. 22–47 (All questions);

part 2 – P. 48 (questions 1, 2, 4, 6, 8, 10-48); P. 73 (questions 1, 2, 4, 5-12, 14-40);

part 3 – P. 83 (questions 11-13); P. 95 (questions 53-58); P. 96 (questions 59-110).

2. Marks B. Dawn Biochemistry / Dawn B. Marks. – Baltimore, Philadelphia : Williams & Wilkins, 1994. – P. 39-43, 123-127, 175-180.

3. Wilson G. N. Biochemistry and Genetics : Pretest®Self-Asses-sment and Review. – New York : McGraw-Hill, 2002. P. 85-100 (Questions 100, 108-113, 119, 125, 126, 128-130, 132, 133, 135, 136, 139), P. 119-127 (Questions 143,151-163), P. 141-153; 173-183 (All questions).

Lesson 54-55 **Date**_____

Theme: EXAMINATION SUBMODULE 4 "BIOCHEMISTRY OF TISSUES AND PHYSIOLIGICAL FUNCTIONS"

The list of theoretical questions and practical skills for preparation for the content module is given in methodical instructions [1].

Lesson 56 **Date _____**

Theme: INTERRELATION OF METABOLISM IN ORGANS AND BODY SYSTEMS

Independent work of students:

<u>Task №</u> 146. Draw a general scheme of the integration of the main metabolic processes of metabolism of proteins, carbohydrates and lipids in the human body.

<u>Task №</u> 147. Draw a scheme illustrating the change in metabolism when eating ketogenic food. Explain the scheme.

Task № 148. Draw a scheme illustrating the relationship of metabolic processes in the liver, kidneys and muscles.

Rating and comments _____

The teacher's signature _____

Literature

1. Methodical instructions for Lessons on discipline “Bioilogical chemistry”: in two parts / L. O. Primova, L. I. Hrebenyk, I. V. Chorna, N. M. Inshyna. – Sumy: SumSU, 2020. – Part 2. – 124 p.

2. Biochemical review questions for Step-1 examination of medical students (Part I) / L. A. Primova, L. I. Grebenic, I. V. Chorna, I. Yu. Vysotsky. – Sumy : Publishers SumSU, 2010. – 105 p.

Електронне навчальне видання

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ДЛЯ ПРАКТИЧНИХ ЗАНЯТЬ ІЗ БІОЛОГІЧНОЇ ХІМІЇ

для студентів спеціальності 222 *«Медицина»*

У двох частинах

Частина 2

(Англійською мовою)

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