

Ministry of Health of the Republic of Belarus  
Educational institution  
"Gomel State Medical University"

Department of Biological Chemistry

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**METHODOLOGICAL RECOMMENDATIONS**

for a practical lesson in the academic discipline "Biological Chemistry"  
for 2<sup>nd</sup> year **students** of the Faculty of Foreign Students  
majoring in 1-79 01 04 "Medical Care"

**Topic:** Control class No. 1 on partitions: "Introduction to biochemistry. Structure and functions of proteins", "Enzymology", and "Biological oxidation".

Duration 4 hours

Approved at the meeting of the Department of Biological Chemistry  
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## 1. TRAINING AND EDUCATIONAL OBJECTIVES, MOTIVATION FOR COMPLETION OF THE TOPIC, REQUIREMENTS FOR THE INITIAL LEVEL OF KNOWLEDGE:

Monitoring educational activities allows you to evaluate the knowledge, skills and abilities acquired, get the necessary help on time and achieve the set learning goals, which creates favorable conditions for the development of cognitive abilities and the activation of independent work in the classroom.

### **The purpose of the class:**

Preview and systematize the material covered.

#### **Class objectives:**

##### ***The student should know:***

1. the main questions of the passed sections “Introduction to Biochemistry”, “Structure and Function of Proteins”, “Enzymology” and “Biological Oxidation”.

##### ***The student must be able to:***

1. systematize the material covered.

## 2. CHECKLIST OF QUESTIONS FROM RELATED SUBJECTS (none)

## 3. CHECKLIST OF CONTROL QUESTIONS FOR THE LESSON

### The first and second question of the variant:

3.1. Subject and tasks of biochemistry. Objects and methods of biochemical research in clinic and experiment, their characteristics (chromatography, electrophoresis, salting out). A brief history of biochemistry. Biochemistry importance for doctor.

3.2. Protein structure. Levels of structural organization of protein. Characteristics of bonds. Oligomeric proteins. Species specificity of proteins. Polymorphism of proteins. Methods of qualitative detection and quantitative determination of protein.

3.3. Protein folding, the role of chaperones. Formation of the native conformation and active site of the protein as a result of folding. Protein biological functions. Pathology of folding (examples).

3.4. Denaturation: mechanisms, using in medical and laboratory practice. Protein renaturation. Methods for protein separation and purification.

3.5. History of enzymology. Properties of enzymes. The similarity and difference between enzymatic and non-enzymatic catalysis. Evidence of protein nature of the enzyme. Separation and purification of enzymes.

3.6. The structure of enzymes. Simple and complex enzymes. Cofactors, coenzymes. The role of vitamins in enzyme structure: structure and mechanism of action of FAD, FMN, NAD(P)<sup>+</sup>, TPP, pyridoxal phosphate (PLP). The value of enzymes in the life processes.

3.7. Stages and mechanism of substrate and enzyme interaction (E. Fisher hypothesis, D. Koshland and modern concepts). Theory of intermediates. Thermodynamics of enzymatic catalysis: Gibbs energy, activation energy, energy barrier).

3.8. The kinetics of enzymatic reactions. Factors influencing the rate of enzymatic reactions (graphs).  $K_M$  – definition and physiological significance.

3.9. The enzyme activity. Regulation of enzyme activity (the role of hormones, cAMP, Ca<sup>2+</sup>, IP<sub>3</sub>). Chemical modification of enzymes (limited proteolysis, phosphorylation-dephosphorylation cycle, etc.). Units of enzyme activity.

- 3.10. Inhibition of the enzymes: competitive, noncompetitive and uncompetitive inhibitors. Mechanism of action and examples of inhibitors.
- 3.11. Allosteric enzymes. Features of the structure and functioning, properties and biological role. Allosteric regulation of TCA cycle enzymes activity.
- 3.12. Nomenclature and classification of enzymes. Examples.
- 3.13. Localization of enzymes in the cell. Marker and organ-specific enzymes (examples of enzymes and the reactions they catalyze). Isozymes: origin, biological role, use in diagnostics, and examples of reactions they catalyze.
- 3.14. The main directions of medical enzymology. Enzymodiagnosics: objects (blood, urea, saliva, liquor, sweat, etc.), goals and objectives. Examples of enzymes used the enzymodiagnosics in myocardial infarction, liver and kidney disease, et al.
- 3.15. Enzymopathies. Causes, mechanisms of primary and secondary metabolic blocks examples thereof, the degree of clinical symptoms, diagnosis and treatment principles.
- 3.16. Enzyme therapy. Using of enzymes for the replacement therapy, treatment of cardiovascular, surgery, and oncological diseases. The concept of liposomes and viral vectors. The use of enzymes in laboratory practice.
- 3.17. Metabolism as a condition of life. The concept of anabolism, catabolism, and metabolism. Substrates of biological oxidation (BO), stages of thereof formation. The history of the development of the theory of biological oxidation. Bakh-Engler and Palladin-Wieland hypotheses.
- 3.18. Conversion and transfer of energy in cells. Redox reactions, redox potential. Enzymes and coenzymes of BO, their structure and role in the energy metabolism.
- 3.19. Macroergic compounds, structure and biological role of ATP, the causes of macroergicity. ATP-cycle – the ways of ATP formation and utilization.
- 3.20. The main ways of oxygen consumption in organism (mitochondrial, microsomal, and peroxysomal). General characteristics of mitochondria (Mt). The concept of tissue respiration.
- 3.21. Krebs tricarboxylic acid cycle (TCA): reactions, enzymes, coenzymes, localization, regulation, biological role, and energy balance of the TCA cycle. Substrate phosphorylation reaction of TCA cycle.
- 3.22. Mitochondrial oxidation. The structure and functions of mitochondrial electron transporting chain (Mt ETC). Mt ETC complexes. Basic principles and mechanisms of functioning of Mt ETC. The link between Mt ETC and TCA cycle.
- 3.23. Oxidative phosphorylation (OP): the mechanisms of coupling, OP points, P/O ratio. P. Mitchell chemiosmotic hypothesis. Uncoupling of oxidation and phosphorylation. Types, mechanism of action and biological role of uncouplers. Low-energy state: characteristics, causes.
- 3.24. Microsomal oxidation. Microsomal electron transporting chain (ETC): localization, structure, biological role, and major electron carriers. The role of microsomal ETC in xenobiotics metabolism. Comparative characteristics of mitochondrial and microsomal ETC.
- 3.25. Peroxide oxidation. Features of the oxygen atom structure and the mechanisms of the reactive oxygen species (ROS) formation. Neutralization of ROS with help of enzymatic and non-enzymatic antioxidant defense (AOD): mechanisms of action and biological role. Peroxide oxidation in norm and pathology.

- Third question of the variant:
- Structure of pentapeptide, its name, and all possible charges by interval method (revise the formulas of 20 amino acids,  $pK_a$  of amino acids).
- Structure of  $NAD^+$ ,  $NADH+H^+$ ,  $NADP^+$ ,  $NADPH+H^+$ , FAD,  $FADH_2$ , FMN,  $FMNH_2$ , ATP.
- The reactions catalyzed by AST, ALT, CK, LDH. Isozymes: CK, LDH.
- Clinical and diagnostical value of amylase,  $\gamma$ -glutamyltransferase, creatine kinase activity, total protein, and iron concentration test in blood plasma.

### 3.26. QUESTIONS FOR SELF STUDY AND ADDITIONAL RESEARCH TASKS (SSART) (none)

### 4. PRACTICAL PART OF THE LESSON (none)

### 5. PROCESS OF THE LESSON.

#### 5.1 Introduction

#### 5.2. Conducting a written test on the topics covered

#### 5.3. Verification of laboratory protocols, SSART assignments.

#### 5.4 The final part of the lesson. Summing up, announcement of assignments (as well as topics of abstracts of SSART) for the next lesson.

SSART to the topic "Carbohydrates-1" are carried out according to the list of the topics;

Control questions on the topic "Carbohydrates-1" include knowledge of the reactions of the following metabolic pathways: fructose metabolism, galactose metabolism, glycogen synthesis, glycogen mobilization.

### 6 QUESTIONS FOR KNOWLEDGE SELF-CONTROL (none)

### 7. LIST OF REFERENCES:

The references are reproduced in the relevant sections of the manuals for the students on the topics of the sections "Introduction to Biochemistry", "Structure and Function of Proteins", "Enzymology" and "Biological Oxidation".