

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 2nd year **students** of the Faculty of Foreign Students
majoring in 1-79 01 04 "Medical Care"

Topic: Biochemistry of muscular tissue and myocardium.

Duration 4 hours

Approved at the meeting of the Department of Biological Chemistry
(Protocol No. 10 dated 29.08.2025)

Gomel, 2025

1. LEARNING AND EDUCATIONAL GOALS, MOTIVATION FOR MASTERING THE THEME, REQUIREMENTS FOR THE INITIAL LEVEL OF KNOWLEDGE:

Muscle tissue makes up 40% of a person's body weight. Biochemical processes occurring in the muscles have a great impact on the entire body. The main function of muscles is mechanical movement, in which chemical energy is converted into mechanical energy at constant pressure and constant temperature. No artificial mechanism is capable of this.

The purpose of the class: to acquaint with the biochemical features of the metabolism of muscle tissue and myocardium; continue to acquaint with the role of muscle tissue in the interorgan exchange of substrates; deepen the concept of the mechanisms of electromechanical coupling; to form ideas about the main elements of the pathogenesis of hypokinetic syndrome and about hypokinesia as a risk factor in the development of various diseases; to form ideas about the mechanisms of development of heart failure and the biochemical rationale for the treatment of heart failure; to form the skills and abilities of determining the concentration of creatinine in the urine by a pseudokinetic two-point method. To promote the development of a sense of pride in the chosen profession and to form a culture of caring for one's health.

Class objectives:

The student must know:

1. features of the metabolism of muscle tissue and myocardium
2. biochemical basis of muscle contraction, mechanism of electromechanical coupling
3. the main elements of the pathogenesis of hypokinetic syndrome
4. The role of muscle tissue in interorgan substrate exchange: Cori's glucose-lactate cycle and Felig's glucose-alanine cycle
5. mechanism of development of heart failure, adaptive changes in the structure and metabolism of the myocardium

The student must be able to:

1. determine the concentration of creatinine in the urine by a pseudokinetic two-point method and evaluate the diagnostic significance of the result.

2. CONTROL QUESTIONS FROM RELATED DISCIPLINES

2.1 Morphofunctional characteristics of muscle tissue; sarcomere, myofibrils, membrane apparatus of muscle tissue; the concept of "motor plaque", the system of T-tubules, triads; contractile apparatus of smooth muscles (normal anatomy and histology).

2.2 Mechanisms of electrogenesis in muscle tissue; "oar" mechanism of muscle contraction; mechanisms of neurohumoral regulation of muscle contraction (normal physiology).

2.3 Metabolism and mechanism of action of secondary mediators; reactions of energy metabolism and its regulation; (pathological physiology).

2.4 Colorimetric analysis (general chemistry).

3. CONTROL QUESTIONS ON THE TOPIC OF THE CLASS

3.1 The role of muscle tissue in interorgan substrate exchange: Cori's glucose-lactate cycle and Felig's glucose-alanine cycle. Restriction of motor activity (hypokinesia), the main elements of the pathogenesis of hypokinetic syndrome. Hypokinesia as a risk factor in the development of various diseases.

3.2 Morphofunctional characteristics and features of energy production in red and white muscle fibers: the presence of a depot of glycogen and TG, the presence of enzymes that stabilize the level of ATP (isoenzymes of creatine kinase, adenylate kinase, enzymes of the purine nucleotide cycle, AMP deaminase), the presence of an oxygen depot (comparative characteristics of the dissociation curves of oxymyoglobin and oxyhemoglobin).

3.3 Theory of muscle contraction. The mechanism of electromechanical coupling (the role of second messengers, sarcoplasmic reticulum membranes, Ca^{2+} ions, calmodulin, muscle tissue proteins, ATPases). Features of Ca^{2+} metabolism in muscle tissue: the presence of an intracellular Ca^{2+} depot (the role of dihydropyridine and ryanodine receptors, calsequestrin and calmitin proteins). relaxation mechanism. Features of smooth muscle contraction. The mechanism of formation of the rigor complex (rigor mortis).

3.4 Features of myocardial metabolism. The mechanism of development of heart failure, adaptive changes in the structure and metabolism of the myocardium.

3.5 *The main functions of the muscular system (movement, stimulation of metabolism, vegetative functions, etc.).*

3.6 *Specific muscle proteins and their characteristics:*

3.6.1 *Contractile: actin and myosin.*

3.6.2 *Regulatory (non-contractile):*

✓ *Primary: Tropomyosin, troponins (I, C, T)*

✓ *Minor: Myomesin; creatine kinase; M-, C-, F-, H-, I-proteins; actinins, filamin, paratropomyosin.*

3.7 *Cytoskeletal proteins:*

✓ *Titin-1, Titin-2, Nebulin, Vinculin, Desmin (Skeletin), Vimentin, Sinemin, Z-Protein, Z-nin, Dystrophin.*

3.8 *Dipeptides (carnosine, anserine), their structure and biological role.*

3.9 *Biochemical rationale for the treatment of heart failure:*

✓ *drugs that increase myocardial contractility (cardiac glycosides and their mechanism of action, phosphodiesterase inhibitors, Ca^{2+} desensitisers, etc.)*

✓ *drugs that reduce the load on the myocardium (vasodilators, diuretics, etc.)*

✓ *drugs that block neuroendocrine regulation of the myocardium (β -blockers, etc.).*

✓ *drugs that improve myocardial metabolism (coronarolytics, energy metabolism substrates, riboxin, phosphocreatine, antihypoxants, antioxidants, anabolics, Ca^{2+} antagonists and etc.).*

4. *Biochemical changes in the body during muscular work.*

4.1 *Biochemical and molecular basis of muscle fatigue.*

4.2 *Biochemical and molecular bases for the use of pharmacological agents in sports.*

5. PRACTICAL PART OF THE CLASS

Laboratory work No. 1 "Determination of the concentration of creatinine in urine by a pseudokinetic method" is performed practically using a set of reagents (Vital). This work

is also being worked out theoretically according to the publication "Biological Chemistry: Workbook" (in 2 hours, part 2) / A.N. Koval [et al.]. - Gomel: GomGMU, 2020. - Part 2 - 88 p.

6. PROCEDURE OF THE CLASS

5.1 Introduction

5.2 Theoretical part of the class: control questions are considered, an oral survey of students is conducted, the tasks of the UIRS are analyzed.

5.3 Practical part of the class: laboratory work No. 1 "Determination of the concentration of creatinine in the urine by the pseudokinetic method" is performed experimentally and using a workbook in biological chemistry.

5.4 Control of mastering the topic.

5.5 The final part of the class. Summing up, checking protocols, announcing tasks (topics of SSART abstract messages) for the next class.

7. QUESTIONS FOR SELF-CHECKING KNOWLEDGE

Self-control of knowledge on the topic "Biochemistry of muscle tissue and myocardium" is carried out by computer testing using the Moodle platform.

8. LITERATURE

1. Биохимия : учебник / под ред. Е.С. Северина. – 5-е изд., испр. и доп. – М.: ГЭОТАР-Медиа, 2020. – 768 с.: ил.
2. Схемы и реакции основных метаболических путей : учеб.-метод. пособие для студентов учреждений высш. образования, обучающихся по специальностям 1-79 01 01 "Лечеб. дело", 1-79 01 04 "Мед.-диагност. дело" / М-во здравоохранения РБ, УО "ГомГМУ", Каф. общей, биоорганической и биологической химии ; А.И. Грицук [и др.]. – Гомель: ГомГМУ, 2018. – 127 с. – Рек. УМО по высш. мед., фармацевт. образованию.
3. Baynes, J. W. Medical biochemistry / J.W. Baynes, M. H. Dominiczak ; ELSEVIER . – 2019. – 682 p.
4. Ferrier, D. R. Lippincott's Illustrated Reviews: Biochemistry / D. R. Ferrier ; Wolters Kluwer . – 2014. – 552 p.
5. Chatterjea, M. N. Textbook of Medical Biochemistry / M. N. Chatterjea, R. Shinde ; Jitendar P Vij. – 2012. – 876 p.
6. Vasudevan, D. M. Textbook of Biochemistry for Medical Students / D. M. Vasudevan, S. Sreekumari, K. Vaidyanathan ; Jitendar P Vij. – 2011. – 657 p.
7. Marks, D. B. Board Review Series: Biochemistry / D. B. Marks ; Harwal Publishing . – 1994. – 337 p.