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Federal State Budget Educational Institution
of Higher Education
Pacific State Medical University
of the Ministry of Health of the Russian Federation

APPROVED BY

Director of the Institute of Fundamentals and
Information Technologies in Medicine
_____ / Bagryantsev V.N./
"4th" of April 2025

SUBJECT GUIDE FOR TEACHERS AND STUDENTS FOR

Б1.О.08 Biochemistry

(Name of discipline)

Specialty	**31.05.01 General Medicine for international students (in English)** (code, name)
Degree	Specialist's degree
Profile	02 "Healthcare" (in the field of providing primary health care to the population in medical organizations: polyclinics, outpatient clinics, inpatient/outpatient facilities of the municipal health care system)
Mode of study	**Full-time**
Period of mastering the BEP	**6 years** (nominal length of study)
Institute	of Fundamentals and Information Technologies in Medicine

Vladivostok, 2025

Subject guide for teachers and students for **Б1.О.08 Biochemistry** is based on:

1) Federal State Educational Standard of Higher Education for the specialty approved by the Order No. 988 of Ministry of Science and Higher Education of the Russian Federation
dated August 12, 2020.

2) Curriculum for the specialty 31.05.01 General Medicine for international students (in English), profile 02 "Healthcare" (in the field of providing primary health care to the population in medical organizations: polyclinics, outpatient clinics, inpatient/outpatient facilities of the municipal health care system),
approved by the Academic Council of FSBEI HE PSMU of the Ministry of Health of Russia Report No. 8/24-25 dated March 31, 2025.

Subject guide for teachers and students for the discipline were developed by the writing team of the Institute of Fundamentals and Information Technologies in Medicine of the FSBEI HE PSMU of the Ministry of Health of Russia, under the guidance of the director of the institute Candidate of Medical Sciences Bagryantsev V.N.

Developed by:

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(position held)	(academic degree, academic title)	(full name)

1. GENERAL PROVISIONS

Subject guide for **Б1.О.08 Biochemistry** is a set of recommendations and explanations that facilitate to optimal organization of mastering this discipline.

Regular analysis of lecture materials and work with end-of-the-text questions are necessary for better understanding of the material and systematization of knowledge of **Б1.О.08 Biochemistry**. Particular attention should be paid to emerging questions, confusing terms, and conflicts of points of view during the independent review of the lecture material. If necessary, a student should contact the teacher for advice. Lecture material streamlines students' thinking, while practical classes provide deeper insight into the material of the discipline.

Special attention should be paid to the content of the main provisions and conclusions, explanation of phenomena and facts, and clarification of the practical application of theoretic aspects of topic when preparing for a practical class. During this process students should aim to understand and remember the main provisions of the material under consideration, examples provided, as well as understand the illustrative material.

Collections of assessment tools are used to organize independent study of topics (questions) of the discipline.

Independent work of students is facilitated by the following:

1. availability and accessibility of the necessary educational and reference material;
2. a system of regular quality control of completed independent work;
3. availability of teacher's advice.

Subject guides for self-study are presented as literary sources and illustrative materials. Subject guides for independent work of students include a list of library resources of the educational institution and other materials accessible to students.

Independent work is a type of in-person extracurricular work of teachers and students of **Б1.О.08 Biochemistry**. Control of independent work is conducted by the leading teacher. Evaluation of independent work results is taken into account when conducting interim examination of students throughout the **Б1.О.08 Biochemistry** course.

Continuous assessment during the **Б1.О.08 Biochemistry** course is implemented in order to check indicators of achieving competencies, to stimulate students' academic work, and improve methods of mastering new knowledge. Continuous assessment during the **Б1.О.08 Biochemistry** course is conducted during the semester to assess all types and sections of the academic discipline that encompass the competencies developed by the discipline: classroom questioning, working with tests, preparing reports (slides presentations), and other kinds of independent and classroom work (protocols and reports on practical training results). Continuous assessment of students' knowledge and results of their preparation for practical classes is conducted during every class session.

Interim assessment aims to determine the level of mastery of competency indicators. It is conducted in the exam format after the student has mastered all sections of **Б1.О.08 Biochemistry** and takes into account learning outcomes for all types of student work over the entire period of mastering the **Б1.О.08 Biochemistry** course.

Time allotted for interim assessment is indicated in the schedule.

Assignments given during practical classes, as well as assignments aimed to prepare students for continuous and interim assessment, are included in the collection of assessment tools for **Б1.О.08 Biochemistry**. If necessary, students should contact the teacher for advice. It is necessary to thoroughly think over questions that need clarification before seeking teacher's advice.

2. SUBJECT GUIDES FOR LECTURE CLASSES

Table 1. Subject Guides for **Б1.О.08 Biochemistry** Lectures

Topic No.1 Structure and functions of proteins. The role of proteomics in assessing pathological conditions	
Duration of the lecture (in academic hours):	2
Purpose of the lecture: 1. tell students about the structure and functions of proteins in the body; classification and physicochemical properties of proteinogenic amino acids; classification of proteins (simple and conjugated, globular and fibrous, monomeric and oligomeric); physicochemical properties of proteins (solubility, ionization, hydration, precipitation); levels of structural organization of proteins (primary, secondary, supersecondary, tertiary and quaternary structures, domains, supramolecular structures); role of chemical bonds maintaining protein structures (disulfide, ionic, hydrogen, hydrophobic bonds); relationship between protein structure and function (structural, catalytic, transport, receptor, regulatory, protective, contractile); mechanisms of active center formation in proteins and its specific interaction with the ligand, and possible conformational changes and cooperative interactions of hemoglobin subunits compared to myoglobin; conformational lability of proteins required for understanding their structural-functional instability and tendency towards denaturation, the possibility of protein renaturation; 2. define key terms: proteins, proteids, ligands, prosthetic group, proteinopathy, hemoglobinopathy, sickle cell anemia, protein nativeness, proteomics, proteinuria, albuminuria, dialysis; 3. examine methods of protein precipitation (salting out, denaturation), purification of protein solutions (dialysis), the use of denaturing agents as antiseptics and sterilization means.	
Lecture plan, order of presentation of its sections: 1. Structure and functions of proteins 2. Classification of proteins: simple and complex, globular and fibrillar, monomeric and oligomeric 3. Physicochemical properties of proteins: solubility, ionization, hydration, precipitation 4. Levels of structural organization of proteins: primary, secondary, supersecondary, tertiary, and quaternary structures, domains, supramolecular structures 5. Bonds that support protein structures: disulfide, ionic, hydrogen, hydrophobic. The relationship between structure and function 6. Denaturation and renaturation of proteins 7. Myoglobin and hemoglobin. Conformational changes and cooperative interactions of hemoglobin subunits 8. The role of proteomics in the assessment of pathological conditions	
Recommended reading: 1. Биологическая химия с упражнениями и задачами : учебник [Электронный ресурс] / под ред. С. Е. Северина, А. И. Глухова. - 3-е изд., стереотипное. - М. : ГЭОТАР-Медиа, 2023. - 624 с. URL: http://studentlibrary.ru 2.Биохимия с упражнениями и задачами [Электронный ресурс]: учебник / под ред. А. И. Глухова, Е. С. Северина - М. : ГЭОТАР-Медиа, 2019. - 384 с. URL: http://www.studentlibrary.ru/ 3. Дрюк, В. Г. Биологическая химия : учеб. пособие [Электронный ресурс] / В. Г. Дрюк, С. И. Скляр, В. Г. Карцев. - 2-е изд., перераб. и доп. - М. : Юрайт, 2019. URL: https://urait.ru/ 4. Нельсон, Д. Основы биохимии Ленинджера. В 3 т. Т. 1. Основы биохимии, строение и катализ [Электронный ресурс] / Д. Нельсон, М. Кокс; пер. с англ. - 4-е изд. - М. : Лаборатория знаний, 2020. - 749 с. URL: http://www.studentlibrary.ru 5. Кольман, Я. Наглядная биохимия [Электронный ресурс] / Я. Кольман, К.-Г. Рём, пер. с англ. Т.П. Мосоловой. - 6-е изд. (эл.). - М. : Лаборатория знаний, 2019. - 514 с. URL: http://www.studentlibrary.ru	

Topic No.2 Structure and functions of enzymes. The mechanism of enzymatic catalysis. Cofactors and coenzymes. Vitamins. Specificity of enzyme effect. Inhibition of enzyme activity

Duration of the lecture (in academic hours):	2

Purpose of the lecture:
1. tell students about the structure and functions of enzymes: give a general idea of catalysis and the mechanisms of enzymatic catalysis. Explain how enzyme activity depends on temperature and pH, enzyme and substrate amounts. Talk about enzyme activity units and enzyme specificity. Discuss the kinetics of enzymatic reactions, explain the Michaelis-Menten equation and graph. Introduce the concepts of metalloenzymes and metal-activated enzymes, cofactors, and coenzymes. Provide an overview of water-soluble vitamins (thiamine, riboflavin, nicotinamide, pyridoxine, pantothenic acid, cobalamins, folic acid, biotin) as precursors of coenzymes. Discuss the mechanisms of enzyme inhibition (reversible, irreversible, competitive, non-competitive inhibition);
2. define key terms: enzymes (enzymes), cofactor, coenzyme, inhibitor, organo-specific enzymes, isoenzymes;
3. examine methods of regulating enzyme activity to influence the rate of metabolism; the use of enzymes and enzyme inhibitors as medications.

Lecture plan, order of presentation of its sections:
1. Structure and functions of enzymes
2. Specificity of enzyme action
3. General concepts of the mechanism of enzymatic catalysis
4. Units of enzyme activity
5. Classification and nomenclature of enzymes
6. Metalloenzymes and metal-activated enzymes
7. Cofactors and coenzymes. Water-soluble vitamins as precursors of coenzymes
8. Dependence of enzyme activity on temperature and pH of the environment, amount of enzyme and substrate
9. Kinetics of enzymatic reactions. Michaelis-Menten equation
10. Isoenzymes. Organospecific enzymes

Recommended reading:
1. Биологическая химия с упражнениями и задачами : учебник [Электронный ресурс] / под ред. С. Е. Северина, А. И. Глухова. - 3-е изд., стереотипное. - М. : ГЭОТАР-Медиа, 2023. - 624 с. URL: http://studentlibrary.ru
2.Биохимия с упражнениями и задачами [Электронный ресурс]: учебник / под ред. А. И. Глухова, Е. С. Северина - М. : ГЭОТАР-Медиа, 2019. - 384 с. URL: http://www.studentlibrary.ru/
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5. Кольман, Я. Наглядная биохимия [Электронный ресурс] / Я. Кольман, К.-Г. Рём, пер. с англ. Т.П. Мосоловой. - 6-е изд. (эл.). - М. : Лаборатория знаний, 2019. - 514 с. URL: http://www.studentlibrary.ru

3. SUBJECT GUIDES FOR PRACTICAL CLASSES

Table 2. Subject Guides for Practical **Б1.О.08 Biochemistry** Classes

Topic No.1 Module 1. Levels of protein structural organization. Classification of proteins. Physical and chemical properties of proteins. Functions of proteins. Practical skills training: purification of protein solutions (dialysis), reversible protein precipitation reactions (salting out), irreversible protein precipitation reactions with heavy metal salts, determination of protein in urine by precipitation	
Duration of the practical class (in academic hours):	4
Purpose of the practical class: 1. consolidate acquired knowledge to understand practical and theoretical medical issues: proteinopathies as a consequence of congenital disorders in the structure and function of proteins (hemoglobinopathies, thalassemia, enzyme disorders); the impact of negative environmental pollution factors on the structure and function of proteins (environmental aspects); the importance of protein isolation and purification methods for developing ways to obtain protein preparations from natural sources and their use in the prevention and treatment of diseases (□-globulins, enzymes, interferons), in the functioning of the "artificial kidney" apparatus (hemodialysis); the use of proteins as antidotes for oral poisoning with heavy metal salts; determination of protein concentrations in tissues and biological fluids for the diagnosis and monitoring of disease treatment. The topics and activities are used for the progressive acquisition of skills and abilities; 2. during the discussion, outline the levels of structural organization of proteins; the importance of the primary structure of proteins; the mechanism of formation of the active center in proteins and its specific interaction with the ligand; the causes and consequences of protein denaturation (factors causing denaturation); the use of denaturing factors in medicine (antiseptics, etc.); 3. thoroughly go over definitions and concepts of proteins, proteids, ligands, prosthetic group, proteinopathy, hemoglobinopathy, sickle cell anemia, protein nativity, proteomics, proteinuria, albuminuria, dialysis; 4. study patterns of structural and functional diversity of proteins in order to explain the basic patterns of biological functioning of proteins; the causes and consequences of changes in the protein composition of the body in ontogenesis and in diseases, the nature of molecular diseases. 5. develop knowledge of the properties of proteins necessary for their determination and identification in biological fluids (blood, urine).	
Practical classes requirements: classrooms equipped with laboratory equipment and glassware, blackboards, subject guides for the discipline, and chemical reagents.	
Independent work of the student: preparing a report (slides presentation), working with study materials.	
Methods of evaluation of acquired knowledge and skills: discussing reports, classroom questioning, working with tests.	
Recommended reading: 1. Биологическая химия с упражнениями и задачами : учебник [Электронный ресурс] / под ред. С. Е. Северина, А. И. Глухова. - 3-е изд., стереотипное. - М. : ГЭОТАР-Медиа, 2023. - 624 с. URL: http://studentlibrary.ru 2.Биохимия с упражнениями и задачами [Электронный ресурс]: учебник / под ред. А. И. Глухова, Е. С. Северина - М. : ГЭОТАР-Медиа, 2019. - 384 с. URL: http://www.studentlibrary.ru/ 3. Дрюк, В. Г. Биологическая химия : учеб. пособие [Электронный ресурс] / В. Г. Дрюк, С. И. Скляр, В. Г. Карцев. - 2-е изд., перераб. и доп. - М. : Юрайт, 2019. URL: https://urait.ru/ 4. Нельсон, Д. Основы биохимии Ленинджера. В 3 т. Т. 1. Основы биохимии, строение и катализ [Электронный ресурс] / Д. Нельсон, М. Кокс; пер. с англ. - 4-е изд. - М. :	

Лаборатория знаний, 2020. - 749 с. URL: http://www.studentlibrary.ru
5. Кольман, Я. Наглядная биохимия [Электронный ресурс] / Я. Кольман, К.-Г. Рём, пер. с англ. Т.П. Мосоловой. - 6-е изд. (эл.). - М. : Лаборатория знаний, 2019. - 514 с. URL: http://www.studentlibrary.ru

Topic No.2 Module 1. Structure and functions of enzymes. Mechanism of enzymatic catalysis. Classification and nomenclature of enzymes. Specificity of action, inhibition of enzyme activity.
Practical skills training: the effect of pH, temperature, and inhibitors on catalytic activity

Duration of the practical class (in academic hours):	4

Purpose of the practical class:
1. consolidate acquired knowledge on the structure, properties, functions of enzymes, and the enzymatic composition of organs and blood plasma in the subsequent study of the characteristics of organ and system metabolism;
2. during the discussion, outline the main features of enzyme structure and the characteristics of enzymatic catalysis; types of enzyme specificity; the basics of enzyme classification; enzyme classes (examples of catalyzed reactions); the structure of cofactors and coenzymes, their role in catalysis; the basics of enzyme kinetics; units of enzyme activity;
3. thoroughly go over definitions and concepts of enzymes, cofactors, coenzymes, inhibitors, activators, organ-specific enzymes, and isoenzymes;
4. study patterns of structure, properties, and functions of enzymes and the enzyme composition of organs and blood plasma in relation to issues of diagnosis, prevention, and treatment of diseases associated with enzyme dysfunction;
5. develop knowledge of the structure, properties, functions of enzymes and the enzyme composition of organs and blood plasma in relation to issues of diagnosis, prevention, and treatment of diseases associated with enzyme dysfunction.

Practical classes requirements: classrooms equipped with laboratory equipment and glassware, blackboards, subject guides for the discipline, and chemical reagents.

Independent work of the student: preparing a report (slides presentation), working with study materials.

Methods of evaluation of acquired knowledge and skills: discussing reports, classroom questioning, working with tests.

Recommended reading:
1. Биологическая химия с упражнениями и задачами : учебник [Электронный ресурс] / под ред. С. Е. Северина, А. И. Глухова. - 3-е изд., стереотипное. - М. : ГЭОТАР-Медиа, 2023. - 624 с. URL: http://studentlibrary.ru
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4. GUIDELINES FOR CONTINUOUS AND INTERIM ASSESSMENT

Table 3. Guidelines for Conducting Continuous and Interim Assessment during the **Б1.О.08 Biochemistry** Course

Type of assessment	Assessment format
Continuous assessment	- conducting and evaluating oral or written quizzes during lectures and practical classes; - assessment and evaluation of completion and results of assignments given during practical classes; - assess and evaluate completion and results of individual assignments and exam tasks given during practical classes; - assessment and evaluation of the quality of lecture notes and practical training result reports.
Interim certification	is conducted in the format of oral exam and a test on a computer; it allows to assess the development of students' competencies correlating with types of professional activity.

5 ASPECTS OF THE IMPLEMENTATION OF THE COURSE FOR STUDENTS WITH DISABILITIES AND SPECIAL NEEDS

5.1. Availability of accessible environment

For students with disabilities and special needs, if a written application is submitted, lectures and practical classes are carried out taking into account health limitations, individual capabilities and medical status (hereinafter referred to as individual characteristics) of the student. Compliance with the following general requirements is ensured: teaching aids for collective and individual use are provided, required technical assistance is provided by an assistant, buildings and premises where lectures and practical classes are taking place meet accessibility requirements, other arrangements lack of which makes it impossible or difficult to master the discipline are made.

5.2. Compliance with general requirements

When lectures and practical classes are carried out at the written application of the student, the following general requirements are met: lectures and practical classes for students with disabilities and special needs take place at the same location as for students who do not have disabilities, if this does not cause difficulties for students; an assistant (assistants), who provide(s) students with the necessary technical assistance taking into account individual characteristics of the student, is (are) provided; necessary teaching aids are provided, taking into account individual characteristics of the student.

5.3. Availability of the internal policies and procedures of FSBEI HE PSMU of the Ministry of Health of Russia to students with disabilities in a form accessible to them.

All internal policies and procedures of FSBEI HE PSMU of the Ministry of Health of Russia concerning the discipline are made available to students with disabilities in a form accessible to them.

5.4. Increase in the duration of interim assessment of students with disabilities and special needs in relation to the established duration

Format of the interim assessment of academic performance within the scope of the discipline for students with disabilities and special needs is selected taking into account individual characteristics (orally, by writing on paper, by typing on a computer, as a test, etc.). The duration of the interim assessment in relation to the established duration is increased at the written application of the student with disabilities. Time limit for the student's preparation for the test is increased by at least 0.5 hours

6. STAFFING REQUIREMENTS OF THE DISCIPLINE

Academic teaching personnel that ensure the implementation of the discipline education process meet the requirements of the Federal State Educational Standard of Higher Education for the 31.05.01 General Medicine for international students (in English) specialty; list of the aforementioned personnel is available on the website of the educational organization.