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Federal State Budget Educational Institution
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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.45 Medical physics

(Name of discipline)

Specialty	**31.05.03 Dentistry for international students (in English)** (code, name)
Degree	Specialist's degree
Profile	02 "Healthcare" (in the field of providing health care in patients with dental pathology)
Mode of study	**Full-time**
Period of mastering the BEP	**5 years** (nominal length of study)
Institute	of Fundamentals and Information Technologies in Medicine

Vladivostok, 2025

Subject guide for teachers and students for **Б1.О.45 Medical physics** 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 31.05.03 Dentistry for international students (in English), profile 02 "Healthcare" (in the field of providing health care in patients with dental pathology), 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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1. GENERAL PROVISIONS

Subject guide for **Б1.О.45 Medical physics** 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.45 Medical physics**. 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 subject guides for the students. 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.45 Medical physics**. 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.45 Medical physics** course.

Continuous assessment during the **Б1.О.45 Medical physics** 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.45 Medical physics** course is conducted during the semester to assess all types and sections of the academic discipline that encompass the competencies developed by the discipline: working with tests, solving practice problems, and conducting laboratory classes. 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 test format after the student has mastered all sections of **Б1.О.45 Medical physics** and takes into account learning outcomes for all types of student work over the entire period of mastering the **Б1.О.45 Medical physics** 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.45 Medical physics**. 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.45 Medical physics** Lectures

Topic No.1 Structure and models of biological membranes. Nernst-Planck equation	
Duration of the lecture (in academic hours):	2
Purpose of the lecture: 1. tell students about physical properties and parameters of biological membranes; 2. define and describe the functions of biological membranes; 3. examine the equations describing the transport of substances through biological membranes.	
Lecture plan, order of presentation of its sections: - Basic concepts and the phenomenon of transfer of substances through a membrane - Chemical and electrochemical potential in the cell - Types of transport through the biological membrane - Passive transport: simple diffusion, facilitated diffusion. - Reasons for passive transport - Fick's law - Membrane permeability - Passive transport through pores: lipid pores, protein pores. - Channel-forming carriers - Osmosis. Filtering - Active transport. Active transport functions	
Recommended reading: 1.Medical and biological physics textbook Remizov A.N., GEOTAR-Media, 2014. 656, [1] p. 150 (M.:ГЭОТАР-Медиа) 2. Physics and Biophysics: textbook by V.F. Antonov, E.K. Kozlova, A.M. Chernysh, Moscow : GEOTAR-Media, 2015. 472 p. (M.:ГЭОТАР-Медиа) URL: http://www.studmedlib.ru 3. Medical and biological physics. Test and tasks: studies. handbook for universities [Electronic resource] Vasiliev A. A. M.: Urait, 2024. - 189 p. (M.:ГЭОТАР-Медиа) URL: https://urait.ru/. 4. Medical physics. Course of lectures : studies. manual [Electronic resource] Esaulenko I. E. Dorokhov E. V. M. : GEOTAR-Media, 2021. - 272 p. (M.:ГЭОТАР-Медиа) URL: http://www.studentlibrary.ru/	
Topic No.2 Resting membrane potential. Action potential its distribution	
Duration of the lecture (in academic hours):	2
Purpose of the lecture: 1. tell students about the basics of generation and distribution of bioelectric potentials; 2. define the types of potentials and derivate the equations allowing to determine the characteristic of potentials; 3. examine mechanisms of the action potentials.	
Lecture plan, order of presentation of its sections: - Description of biopotentials - Types of potentials - Rest potentials. Goldman-Hodgkin-Katz equation - Action potential. Mechanism of the action potential - Propagation of the action potential along nerve fibers. Ranvier node intercepts	

Recommended reading:
1.Medical and biological physics textbook Remizov A.N., GEOTAR-Media, 2014. 656, [1] p. 150 (M.:ГЭОТАР-Медиа)
2. Physics and Biophysics: textbook by V.F. Antonov, E.K. Kozlova, A.M. Chernysh, Moscow : GEOTAR-Media, 2015. 472 p. (M.:ГЭОТАР-Медиа) URL: http://www.studmedlib.ru
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Topic No.3 Direct current. Electrical conductivity of biological tissues at direct current

Duration of the lecture (in academic hours):	2

Purpose of the lecture:
1. tell students about electrical conductivity of biological tissues;
2. define electric current, static capacitance, polarizing capacitance;
3. examine types of polarization.

Lecture plan, order of presentation of its sections:
- Biological tissues
- Resistivity of tissues and body fluids
- Characteristics of electric current
- Equivalent scheme of direct current flow through biological tissues
- Types of polarizations

Recommended reading:
1.Medical and biological physics textbook Remizov A.N., GEOTAR-Media, 2014. 656, [1] p. 150 (M.:ГЭОТАР-Медиа)
2. Physics and Biophysics: textbook by V.F. Antonov, E.K. Kozlova, A.M. Chernysh, Moscow : GEOTAR-Media, 2015. 472 p. (M.:ГЭОТАР-Медиа) URL: http://www.studmedlib.ru
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Topic No.4 Alternating current. Equivalent electrical circuits to simulate properties of biological tissues

Duration of the lecture (in academic hours):	2

Purpose of the lecture:
1. tell students about the impedance characteristics of body tissues;
2. define alternating current, capacitance, inductance, resistance, impedance of biological tissue;
3. examine practical use of impedance of biological tissue.

Lecture plan, order of presentation of its sections:
- Alternating current
- Electrical circuit with inductance
- Electrical circuit with capacitance

- Electrical circuit with resistance - Impedance of body tissues - Characteristics of impedance of body tissues - Equivalent electrical circuits of body tissues - Impedance dispersion - Fundamentals of rheography
Recommended reading: 1.Medical and biological physics textbook Remizov A.N., GEOTAR-Media, 2014. 656, [1] p. 150 (M.:ГЭОТАР-Медиа) 2. Physics and Biophysics: textbook by V.F. Antonov, E.K. Kozlova, A.M. Chernysh, Moscow : GEOTAR-Media, 2015. 472 p. (M.:ГЭОТАР-Медиа) URL: http://www.studmedlib.ru 3. Medical and biological physics. Test and tasks: studies. handbook for universities [Electronic resource] Vasiliev A. A. M.: Urait, 2024. - 189 p. (M.:ГЭОТАР-Медиа) URL: https://urait.ru/. 4. Medical physics. Course of lectures : studies. manual [Electronic resource] Esaulenko I. E. Dorokhov E. V. M. : GEOTAR-Media, 2021. - 272 p. (M.:ГЭОТАР-Медиа) URL: http://www.studentlibrary.ru/

3. SUBJECT GUIDES FOR PRACTICAL CLASSES

Table 2. Subject Guides for Practical **Б1.О.45 Medical physics** Classes

Topic No.1 Structure and models of biological membranes. Physical properties and parameters of membranes	
Duration of the practical class (in academic hours):	2
Purpose of the practical class: 1. consolidate acquired knowledge on the structure and models of biological membranes; 2. during the discussion, outline the functions of biological membranes; 3. thoroughly go over definitions of phospholipids, electrical properties of biological membranes 4. study the common structures of biological membranes 5. develop an understanding of biological membrane models.	
Practical classes requirements: classrooms equipped with multimedia equipment, blackboards, laboratory equipment, and subject guides for the discipline	
Independent work of the student: writing a library-research paper, preparing a report on the lecture, working with educational literature, solving typical practice problems.	
Methods of evaluation of acquired knowledge and skills: classroom questioning, working with tests.	
Recommended reading: 1.Medical and biological physics textbook Remizov A.N., GEOTAR-Media, 2014. 656, [1] p. 150 (M.:ГЭОТАР-Медиа) 2. Physics and Biophysics: textbook by V.F. Antonov, E.K. Kozlova, A.M. Chernysh, Moscow : GEOTAR-Media, 2015. 472 p. (M.:ГЭОТАР-Медиа) URL: http://www.studmedlib.ru 3. Medical and biological physics. Test and tasks: studies. handbook for universities [Electronic resource] Vasiliev A. A. M.: Urait, 2024. - 189 p. (M.:ГЭОТАР-Медиа) URL: https://urait.ru/. 4. Medical physics. Course of lectures : studies. manual [Electronic resource] Esaulenko I. E. Dorokhov E. V. M. : GEOTAR-Media, 2021. - 272 p. (M.:ГЭОТАР-Медиа) URL: http://www.studentlibrary.ru/	

Topic No.2 Structure and models of biological membranes. Nernst-Planck equation	
Duration of the practical class (in academic hours):	2
Purpose of the practical class: 1. consolidate acquired knowledge on the transport of substances through the biological membrane; 2. during the discussion, outline the types of passive transport; 3. thoroughly go over definitions and concepts of passive transport, simple diffusion, light diffusion, diffusion coefficient; 4. study the patterns of transport of substances through a biological membrane; 5. develop an understanding of the structural features of various cell membranes, on the role of the outer cell membrane in the processes of cell movement, on the mechanisms of cellular permeability, on the medical significance of active transport of substances through membranes; on the medical significance of passive transport of substances through membranes	
Practical classes requirements: classrooms equipped with multimedia equipment, blackboards, laboratory equipment, and subject guides for the discipline	
Independent work of the student: writing a library-research paper, preparing a report on the lecture, working with educational literature, solving typical practice problems.	
Methods of evaluation of acquired knowledge and skills: classroom questioning, working with tests.	
Recommended reading: 1.Medical and biological physics textbook Remizov A.N., GEOTAR-Media, 2014. 656, [1] p. 150 (M.:ГЭОТАР-Медиа) 2. Physics and Biophysics: textbook by V.F. Antonov, E.K. Kozlova, A.M. Chernysh, Moscow : GEOTAR-Media, 2015. 472 p. (M.:ГЭОТАР-Медиа) URL: http://www.studmedlib.ru 3. Medical and biological physics. Test and tasks: studies. handbook for universities [Electronic resource] Vasiliev A. A. M.: Urait, 2024. - 189 p. (M.:ГЭОТАР-Медиа) URL: https://urait.ru/. 4. Medical physics. Course of lectures : studies. manual [Electronic resource] Esaulenko I. E. Dorokhov E. V. M. : GEOTAR-Media, 2021. - 272 p. (M.:ГЭОТАР-Медиа) URL: http://www.studentlibrary.ru/	
Topic No.3 Resting membrane potential. Action potential its distribution	
Duration of the practical class (in academic hours):	2
Purpose of the practical class: 1. consolidate acquired knowledge on the resting membrane potential and action potential; 2. during the discussion, outline the mechanisms of active transport in normal and pathological conditions and compare the mechanisms of passive transport in normal and pathological conditions; 3. thoroughly go over definitions and concepts of resting potential, action potential 4. study the physico-chemical features of the structure of membrane structures and the mechanisms of their functioning; the biophysical mechanisms of passive and active transport of substances through the membrane; the study of electrochemical potentials of biological membranes; 5. develop an understanding of the structure of biological membranes; about the structural features of various cell membranes; about the role of the outer cell membrane in the processes of cell movement; about the mechanisms of cellular permeability; about the medical significance of active	

transport of substances through membranes; about the medical significance of passive transport of substances through membranes.
Practical classes requirements: classrooms equipped with multimedia equipment, blackboards, laboratory equipment, and subject guides for the discipline
Independent work of the student: writing a library-research paper, preparing a report on the lecture, working with educational literature, solving typical practice problems.
Methods of evaluation of acquired knowledge and skills: classroom questioning, working with tests.
Recommended reading: 1.Medical and biological physics textbook Remizov A.N., GEOTAR-Media, 2014. 656, [1] p. 150 (M.:ГЭОТАР-Медиа) 2. Physics and Biophysics: textbook by V.F. Antonov, E.K. Kozlova, A.M. Chernysh, Moscow : GEOTAR-Media, 2015. 472 p. (M.:ГЭОТАР-Медиа) URL: http://www.studmedlib.ru 3. Medical and biological physics. Test and tasks: studies. handbook for universities [Electronic resource] Vasiliev A. A. M.: Urait, 2024. - 189 p. (M.:ГЭОТАР-Медиа) URL: https://urait.ru/. 4. Medical physics. Course of lectures : studies. manual [Electronic resource] Esaulenko I. E. Dorokhov E. V. M. : GEOTAR-Media, 2021. - 272 p. (M.:ГЭОТАР-Медиа) URL: http://www.studentlibrary.ru/

4. GUIDELINES FOR CONTINOUS AND INTERIM ASSESSMENT

Table 3. Guidelines for Conducting Continuous and Interim Assessment during the **Б1.О.45 Medical physics** 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.
Interim certification	is conducted in test format; 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 31.05.03 Dentistry for international students (in English) specialty; list of the aforementioned personnel is available on the website of the educational organization.

