

Документ подписан простой электронной подписью

Информация о владельце:

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MINISTRY OF SCIENCE AND HIGHER EDUCATION

RUSSIAN FEDERATION

Federal State Autonomous Educational Institution of Higher Education

NORTH-CAUCASUS FEDERAL UNIVERSITY

APPROVED

Assoc. Prof. Kubanov S.I.

PhD in Medical Sciences

Dean

Faculty of Medicine and Biology

COURSE OUTLINE OF THE DISCIPLINE (MODULE)

General and Medical Enzymology

Name of the discipline (module)

- Specialty: 31.05.01 General Medicine
- Mode of training: Full-time
- Year of commencement of studies: 2026
- Delivered in Semester _4_

Developed by:

Associate Professor of the Department

of Physico-Chemical Biology and Immunology

Andrusenko S.F.

Stavropol 2026

1. Aim and Objectives of Mastering the Discipline

- Aim of mastering the discipline:

The purpose of mastering the discipline is to form part of the professional (PC-13) competencies of the future specialist 05.31.01 Medical practice.

- Objectives of mastering the discipline:

-formation of an understanding of the connections between the structure, function and biological significance of enzymes.

-formation of an idea about enzymes, the relationship of enzyme malfunction with the appearance of hereditary human diseases.

-formation of skills in isolation and purification of enzymes, as well as techniques of modern biochemical analysis, methods of evaluation and selection of methods of analysis adequate to the task.

-developing the ability to form a holistic understanding of the importance of enzymes in medicine.

2. Place of the Discipline (Module) in the Structure of the Training (educational) Program

The discipline General and Medical Enzymology belongs to the part developed by the parties involved in academic relations).

3. List of Potential Learning Outcomes for the Discipline (Module), Correlated with the Outcomes of Mastering the Educational Program

Code and definition of the competence	Code and definition of the indicator	Planned learning outcomes for the discipline (module) describing the stages of competency and indicator development
He is able to carry out laboratory and instrumental research methods to study the properties of substances and processes involving them, process and interpret the results obtained using theoretical knowledge and practical skills in solving scientific problems.	ID-1 PC-13 Systematizes and analyzes the results of chemical, biological, physical, and medical experiments, observations, measurements, and calculations of the properties of substances and materials.	P5 Acquisition of special medical skills and their application in practical healthcare

4. Volume of the Academic Discipline (Module) and Control *

Volume of classes: Total: 4 ECTS credits, 144 academic hours.	Full-time type of study, in academic hours
Face-to-face work	

Lectures / including practical training	16
Laboratory works / including practical training	48
Independent work	80
Forms of control	
Credit (Pass/Fail)	

** The discipline (module) provides for the use of e-learning and remote learning technologies (unless otherwise set by the educational standard).*

5. Content of the Discipline (Module), Structured by Topics (Sections) with an Indication of the Hours and Types of Classes

#	Section (topic) of the discipline and brief content	Competencies and indicators to be developed	Full-time training				Forms of current control of academic progress
			Contact work of students with the teacher / of them practical skills training, hours			Independent work, hours	
			Lectures	Practical classes	Laboratory work		
1	Topic 1.Introduction to enzymology Prospects for the development of enzymology. Stages of development of enzymology. Ribozymes are catalysts of a non–protein nature: diversity, structural features, and mechanism of action.	ID-1 PC-13	2		6	10	Test

2	Topic 2. Methods of isolation and research of enzymes Sources of enzymes Methods for determining enzymatic activity. Methods for determining amino acids in the active center of enzymes and determining their role in the catalytic action. The use of genetically engineered methods for the determination of amino acids in the active center of the enzyme	ID-1 PC-13	2		6	10	Test, protection of laboratory work
3	Topic 3. General properties and structure of enzymes The structural organization of enzymes. One- and two-component enzymes. Principles of spatial organization of the apoenzyme. The structural organization of the active center of enzymes. The allosteric center	ID-1 PC-13	2		6	10	Test, protection of laboratory work
4	Topic 4. Nomenclature and classification of enzymes Principles of enzyme classification. General characteristics of enzyme classes. Nomenclature of enzymes. Oxidoreductases. General characteristics of the class. Examples. Hydrolases. General characteristics of the class. Examples. Transferases. General characteristics of the class. Examples. Synthases (lyases). General characteristics of the class. Examples. Isomerases. General characteristics of the class. Examples. Synthetases (ligases). General characteristics of the class. Examples. Translocases. Examples. Comparative characteristics of classes	ID-1 PC-13	2		6	10	Test, protection of laboratory work

5	Topic 5. Theories of enzyme action and mechanisms of enzymatic reactions The interaction of the enzyme with the substrate. Basic and transitional states. Formation of the enzyme-substrate complex and its role in catalysis. Multipoint binding of the substrate. Types of enzymatic catalysis and causes of high catalytic activity of enzymes. Effects of convergence and orientation. The effect of conformational conformity. Theory of conformational correspondence of enzyme and substrate and theory induced conformational conformity. Acid-base catalysis (specific and generalized). Intramolecular acid-base catalysis. Covalent catalysis. Nucleophilic catalysis. The mechanism of catalytic action of serine proteases. Chymotrypsin: activation mechanism and characterization of the stages of catalysis. Principles and features of functioning, organization and regulation of multi-enzyme complexes. Induction and repression of enzymes.	ID-1 PC-13	2	6	10	Test, protection of laboratory work
6	Topic 6. Kinetics of enzymatic reactions Methods for determining enzymatic activity. Quantitative characteristics of enzymes. The rate of the enzymatic reaction. Factors affecting the reaction rate. The Michaelis constant. Graphs of the dependence of enzyme activity on substrate concentration described by various equations.	ID-1 PC-13	2	6	10	Test, protection of laboratory work

7	Topic 7. Inhibitors and activators of enzymes Cofactors: coenzymes and prosthetic groups, their most important types and representatives. Cofactors of oxidoreductases. Characteristics of the main representatives. Transferase cofactors. Characteristics of the main representatives. Cofactors of synthesis and isomerization. Characteristics of the main representatives. The role of metals in the catalytic action of enzymes. Examples of metalloenzymes and enzymes activated by metals.	ID-1 PC-13	2		6	10	Test, protection of laboratory work
8	Topic 8. Enzymopathies. Enzyme diagnostics. Enzyme therapy Pathological changes in enzyme activity. Diseases in which, due to changes in the activity of enzymes, the course of the corresponding biochemical reactions in the body is disrupted and metabolic diseases develop. Diagnosis of a disease (or syndrome) based on the determination of enzyme activity in human biological material (biological fluids, tissues). Tasks of enzyme diagnostics. Methods of enzyme diagnostics. Objects of enzyme diagnostics: blood (serum, plasma), biological fluids (urine, cerebrospinal fluid, exudates, etc.), tissue biopsies. The use of enzymes as therapeutic drugs. Enzyme complexes. Substitution therapy or an element of complex treatment for gastrointestinal diseases, thrombosis and thromboembolism, oncological diseases	ID-1 PC-13	2		6	10	Test, protection of laboratory work
	TOTAL in Semester		16		48	80	
	TOTAL		16		48	80	

6. Assessment Tools Fund for the Discipline (Module)

The assessment tools fund (ATF) for the discipline General and Medical Enzymology is based on the list of competencies to be mastered, indicating the stages of their formation in the process of mastering the discipline (module). The ATF provides an objective control over the achievement of the planned learning outcomes. The ATF includes:

- A description of indicators and criteria for evaluating competencies at various stages of their formation, a description of evaluation scales;

- Methodological materials determining the procedures for evaluating knowledge, skills, abilities and (or) work experience characterizing the stages of competency formation;
- Standard control tasks and other materials necessary for assessing knowledge, skills, and the level of mastery of the formed competencies in the process of mastering the discipline (module).

The ATF is an appendix to this discipline (module) program.

7. Methodological Guidelines for Students on Mastering the Discipline

When starting work, each student must take into account the following provisions.

The discipline (module) is structured on a thematic principle; each topic represents a logically completed section.

The lecture material is dedicated to the consideration of key, basic provisions of the courses and the clarification of learning tasks assigned for the independent work of students.

Laboratory works are aimed at gaining practical experience in the relevant subject area.

The independent work of students is aimed at the independent study of additional material, preparation for practical and laboratory classes, as well as the execution of all types of independent work.

In order to successfully master the discipline, it is important to complete all types of independent work employing the recommended sources of information.

8. Educational, Methodological, and Informational Support for the Discipline

8.1. List of Main and Additional Literature Required for Mastering the Discipline

8.1.1. List of Main Literature:

1. Andrusenko, S.F. General and medical enzymology : textbook / S.F. Andrusenko. Moscow : KNORUS Publ., 2023. 242 p.
2. Basic Biochemistry course // Edited by A.I. Glukhov, A.E. Gubareva. Moscow: GEOTAR- Media, 2020. 584 p.
3. Fedorin, D. N. Enzymes: structure, properties, classification / D. N. Fedorin, N. V. Selivanova, A. T. Eprintsev. Voronezh : VSU, 2020. 113 p. — Text : electronic // Lan : electronic library system. — URL: <https://e.lanbook.com/book/433136>

8.1.2. List of Additional Literature:

1. Rogozhin, V. V. Enzymology. Practicum : a textbook for universities / V. V. Rogozhin, T. V. Rogozhina. Saint Petersburg : Lan Publ., 2025. 340 p. ISBN 978-5-507-51488-5. — Text : electronic // Lan : electronic library system. — URL: <https://e.lanbook.com/book/450725>
2. Breshchenko, E. E. Biochemistry: biologically active substances. Vitamins, enzymes, hormones : a textbook for universities / E. E. Breschenko, K. I. Melkonyan ; edited by I. M. Bykov. — 3rd ed., ster. — St. Petersburg : Lan, 2024. — 136 p. — ISBN 978-5-507- 47791-
3. — Text : electronic // Lan : electronic library system. — URL: <https://e.lanbook.com/book/419102>
3. Fundamentals of enzymology: a textbook / S. N. Afonina, I. V. Karnaukhova, E. N. Lebedeva [et al.]; edited by A.V. Sgibnev. Orenburg : OrGMU, 2022. 97 p. — Text : electronic // Lan : electronic library system. —URL:<https://e.lanbook.com/book/340538>
4. Avetisov, A. K. Applied catalysis : textbook / A. K. Avetisov, L. G. Bruk ; edited by O. N. Temkin. — Saint Petersburg : Lan, 2020. — 200 p. — ISBN 978-5-8114- 3854-9. — Text : electronic // Lan : electronic library system. — URL: <https://e.lanbook.com/book/126902>
5. Biochemistry: a textbook / A.V. Strygin, B. E. Tolkachev, A.M. Dotsenko, E. I. Morkovin. Volgograd : VolgSMU, 2022. 132 p. ISBN 978-5-9652-0820-3. Text : electronic // Lan : electronic library system. — URL: <https://e.lanbook.com/book/338252>
6. Karpenko, L. Y. Biological chemistry : a textbook / L. Y. Karpenko, A. A. Bakhta, A. I. Kozitsyna. — Saint Petersburg : SPbGUVU, 2022. — 228 p. — Text : electronic //Lan : electronic library system. — URL: <https://e.lanbook.com/book/366575>

7. Fundamentals of biochemical analysis: laboratory practice: a textbook / compiled by O. S. Kotlyarova, S. M. Chydym. Novosibirsk : NGAU, 2020. 77 p. — Text: electronic // Lan : electronic library system. — URL: <https://e.lanbook.com/book/257708>
8. Lelevich, S. V. Theory and practice of laboratory biochemical research : textbook manual for vocational education / S. V. Lelevich. — 4th ed., ster. — Saint Petersburg : Lan, 2024. — 304 p.— ISBN 978-5-507-50169-4. — Text : electronic // Lan : electronic library system. — URL: <https://e.lanbook.com/book/414779>
9. Kuznetsov, O. E. Laboratory tests in the clinic : a textbook for vocational education / O. E. Kuznetsov, S. A. Lyalikov. — 3rd ed., erased. — Saint Petersburg : Lan, 2024. — 500 p. — ISBN 978-5-507-51527-1. — Text : electronic // Lan : electronic library system.— URL: <https://e.lanbook.com/book/422633>
10. Laboratory workshop on biochemistry for students of medical and pediatric faculties : a textbook / O. L. Nosareva, E. A. Stepovaya, E. V. Shakhristova, L. V. Spirina. — 3rd ed., supplement. and ispr. — Tomsk : SibSMU, 2023. — 165 p. — Text : electronic // Lan : electronic library system. — URL: <https://e.lanbook.com/book/369047>

8.2. List of Educational and Methodological Support for the Independent Work of Students in the Discipline

Methodological guidelines on the discipline "General and medical enzymology" for students of specialty 05/31/01 Medical practice [Electronic version], Stavropol: NCFU (electronic version)

8.3. List of Resources of the Information and Telecommunications Network **Internet** Required for Mastering the Discipline

1. <http://biomolecula.ru/> Biomolecula website.
2. <http://diss.rsl.ru/> Electronic Library of RSL dissertations
3. <http://elibrary.ru/> Scientific electronic Library
4. <http://isir.ras.ru/> Integrated Information Resource System Of The Russian Federation Academies of Sciences
5. <http://link.springer-ny.com/search.htm> The system of access to bibliographic information of the biochemistry database
6. <http://pubs.acs.org/> Journals of the American Chemical Society
7. <http://ru.wikipedia.org/wiki> Free encyclopedia "Wikipedia"
8. <http://www.inbi.ras.ru/> A.N. Bach Institute of Biochemistry of the Russian Academy of Sciences
9. <http://www.library.ru/> Virtual Library
10. <http://www.molbiol.ru/> Classical and Molecular Biology
11. <http://www.nlr.ru/> Russian National Library
12. <http://www.rusbiotech.ru/> Russian biotechnologies and bioinformatics
13. <http://www.viniti.msk.su/> All-Russian Institute of Scientific and Technical Information (VINITI RAN)
14. www.chem.qmul.ac.uk/iubmb Biochemical classification and nomenclature. Free access on the website of the International Union of Biochemistry and Molecular Biology
15. www.chemport.org Scientific publications in the field of biochemistry, chemistry and related sciences
16. www.febs.org Official website of the Federation of European Biochemical Societies
17. www.ncbi.nlm.nih.gov/Genbank and www.swissprot.com A database of all primary protein structures is freely available
18. www.swissprot.com Free access to the international database on primary and secondary 3D structures of enzymes

9. List of Information Technologies Employed through the Discipline (Module), Including a List of Software and Information Reference Systems

When delivering lectures, computer equipment and demonstrations of multimedia presentation materials are used. In seminars and practical classes, students deliver presentations prepared by them during the hours of independent work.

Information Reference Systems:

Information-reference and information-legal systems used in the study of the discipline:

1.	Electronic library system "University Library Online" - www.biblioclub.ru .
2.	Electronic library system "IPRbooks"
3.	"eLIBRARY.RU ": [Scientific Electronic Library]. – URL: http://elibrary.ru
4.	The GARANT information reference system.roo // Access mode: http://www.garant.ru/

5.	Legal reference system Russian legislation and judicial practice are freely available - http://www.pravo.ru/
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Software:

1.	Alt Workstation 10
2.	Alt Workstation K
3.	Alt Server
4.	Office software package – P7-Office

10. Description of the Material and Technical Resources Required for the Educational Process for the Discipline (Module)

Lecture classes	A classroom equipped with multimedia equipment and technical training facilities.
Laboratory classes	A training laboratory equipped with equipment and technical means of training: a set of training furniture for 14 seats, a magnetic marker board, a projector with a wall bracket, and a computer with the necessary license software. Sets of dishes and reagents
Independent work	A room for the independent work of students, equipped with computer hardware with the capability to connect to the Internet network and provide access to the electronic information and educational environment of the university.

11. Specific Features of Mastering the Discipline (Module) by Persons with Disabilities

Students with disabilities shall be provided with special textbooks, teaching aids, and didactic materials, special technical training facilities for collective and individual use, the services of an assistant (helper) providing the necessary technical assistance to the students, as well as the services of sign language interpreters and tactile sign language interpreters.

The mastery of the discipline (module) by students with disabilities may be organized jointly with other students, as well as in separate groups.

Mastering the discipline (module) by students with disabilities is to be carried out taking into account the peculiarities of psychophysical development, individual capabilities, and health status.

In order to ensure the accessibility of higher education under the educational program for persons with disabilities, the following is provided during the mastery of the discipline (module):

- 1) for persons with visual impairments:
 - the presence of an assistant offering the student the necessary technical assistance, taking into account individual features (help taking the workplace, moving around, reading and formatting the task, including writing under dictation),
 - written tasks, as well as instructions on the procedure for their execution, are formatted in an enlarged font,
 - special textbooks, teaching aids, and didactic materials (having a large font or audio files), individual uniform lighting of at least 300 lux,
 if necessary, a magnifying device is provided to the student to complete the task;
- 2) for persons with hearing impairments:
 - the presence of an assistant providing the student with the necessary technical assistance, taking into account individual characteristics (helps to take a workplace, move around, read and format the task, including writing with dictation),

- the availability of sound-amplifying equipment for collective use is ensured; if necessary, sound-amplifying equipment for individual use is provided to the student;
 - provision with proper sound means of reproducing information is ensured;
- 3) for persons with musculoskeletal disorders (including severe motor function impairments of the upper limbs or the absence of upper limbs):
- written tasks are performed on a computer with specialized software or are dictated to an assistant;
 - at the request of the student, tasks may be performed verbally.

12. Specific Features of Implementing the Discipline with the Use of Distance Learning Technologies and E-Learning

Subject to Part 1 of Article 16 of the Federal Law of December 29, 2012, No. 273-FZ On Education in the Russian Federation, e-learning shall be viewed as the arrangement of educational activities employing information contained in databases and used in the implementation of educational programs, as well as information technologies, technical means, and information and telecommunication networks that ensure the processing and transmission of the specified information via communication lines, and the interaction of students and pedagogical workers.

Remote (distance) learning technologies are understood as educational technologies implemented mainly with the use of information and telecommunication networks during the indirect (at a distance) interaction of students and pedagogical workers.

The implementation of the discipline may be carried out with distance learning technologies and e-learning in full or in part. The components of the Educational And Methodological Complex (EMC) of the discipline (working program of the discipline, assessment and methodological materials, forms of attestation) implemented with the use of distance learning technologies and e-learning contain an indication of their use.

When arranging educational activities with distance learning technologies and e-learning, asynchronous and synchronous methods of interaction between participants in educational relations via the information and telecommunications network Internet may be offered.

When using distance learning technologies and e-learning, the schedule for the discipline shall indicate: methods of interaction among participants in educational relations via the information and telecommunications network Internet (VCC – videoconferencing, ET – electronic testing); links to the electronic information and educational environment of NCFU, to educational platforms and resources of other organizations to which open access is provided via the information and telecommunications network Internet; for synchronous learning – the time of online classes and instructors; for asynchronous learning – the authors of online courses.

When arranging intermediate attestation with distance learning technologies and e-learning, the Methodological Recommendations on the use of technical means ensuring the objective reliability of results when conducting intermediate and state final attestation for higher education educational programs – Bachelor's Degree programs, Specialist's Degree programs, and Master's Degree programs with distance learning technologies are used (Letter of the Ministry of Science and Higher Education of Russia dated December 7, 2020, # MN-19/1573-AN On sending methodological recommendations).

The implementation of the discipline with the use of e-learning and distance learning technologies is carried out using the electronic information and educational environment of NCFU, to which students are provided access via the information and telecommunications network Internet, or using the resources of other organizations, including platforms providing services for videoconferencing, online meetings, and distance learning (MTS-Link), as well as using the capabilities of social networks to carry out communication between students and instructors.

The educational and methodological support for a discipline shall be ensured with e-learning and distance learning technologies includes the working program presented in electronic form, educational and methodological manuals or a course of lectures, methodological guidelines

for performing various types of educational activities of students provided for by the discipline, and other educational and methodological materials posted in the information and educational environment of NCFU.