

**MINISTRY OF SCIENCE AND HIGHER EDUCATION
RUSSIAN FEDERATION**

**FEDERAL STATE AUTONOMOUS EDUCATIONAL INSTITUTION OF
HIGHER EDUCATION
NORTH-CAUCASUS FEDERAL UNIVERSITY**

Methodological Guidelines
for Students on arranging and performing independent work
in the Discipline of **Normal physiology**
for Students majoring (Specialty) in 31.05.01 General Medicine

Methodological Recommendations for Studying Theoretical Material

When performing the independent study of theoretical material, the student must follow the rules as set below. The working curriculum of the respective academic discipline shall be recommended to be used as the basis for such activity. According to the schedule of classroom lessons and independent work, a different number of hours is to be allocated for studying individual topics. A significant portion of the student's independent work should be allocated to mastering the material on the covered topic, writing a summary (notes) on the specified theoretical blocks, and searching for additional literature based on the NCFU library and via the Internet system. The lecture material shall not cover all theoretical material; the greater part of it must be mastered through independent work. Given the above, working with the recommended literature is mandatory. Special attention must be paid to the content of the main provisions and conclusions, the explanation of phenomena and facts, and the understanding of the practical application of the theoretical issues under consideration. In the process of this work, the student should strive to understand and memorize the main provisions of the material being considered, the examples illustrating it, as well as to understand the illustrative material. Preparation should be completed by drawing up a plan (summary/notes) on the material (issue) being studied. This allows for the creation of a concentrated, concise representation of the issues being studied. First, studying the recommended literature is to be done. Special attention must be paid to the content of the main provisions and conclusions, the explanation of phenomena and facts, and the understanding of the practical application of the theoretical issues under consideration.

During this work, the student should strive to understand and memorize the main provisions of the material being considered, the examples illustrating it, as well as to understand the illustrative material. Preparation should be completed by drawing up a plan (summary/notes) on the material (issue) being studied. This allows for the creation of a concentrated, concise representation of the issues being studied. If necessary, one should seek (advice) consultation from the instructor. When going to a consultation, it is necessary to thoroughly think through the questions that require clarification. Keeping records contributes to turning reading into an active process, mobilizing motor memory along with visual memory. The following should be born in mind: a student who systematically keeps records creates their own individual stock of auxiliary materials for a quick review of what has been read and for the mobilization of accumulated knowledge. Records are especially important and useful when they reflect the thoughts that arose during independent work.

It is important to develop the students' capacity to compare sources and to think through the material being studied.

Improving note-taking skills among students is of great importance.

The instructor may recommend the following main forms of recording to students: a plan (simple and detailed), excerpts, and theses (abstracts).

The results of note-taking can be presented in various forms.

- A plan is an outline of the read material, a brief (or detailed) list of questions reflecting the structure and sequence of the material.
- A detailed plan fully replaces a summary.
- A summary (notes) is a systematized, logical presentation of the source material. Four types of summaries are distinguished:
 - Outline-summary (Plan-notes) – this is an expanded, detailed plan in which sufficiently detailed records are provided for those points of the plan that need explanation.
 - Textual summary – this is the reproduction of the most important provisions and facts of the source.
 - Free summary – these are clearly and briefly formulated (stated) main provisions resulting from a deep understanding of the material. It may contain excerpts, quotations, and theses; part of the material may be represented by a plan.

- Theme-based summary – this is compiled on the basis of studying a number of sources and gives a more or less exhaustive answer according to a certain scheme (issue).

Methodological Guidelines for the Preparation for Practical Activities

When preparing for practical activities, the recommendation implies studying the control questions for the given lesson and the theoretical material from one's own notes.

The main form of work during the lessons is an interview (discussion). Each student must be ready to speak on all issues raised in the plan and demonstrate maximum activity during their consideration.

The speech must be constructed freely, convincingly, and with arguments. The instructor ensures that the speech is not reduced to a reproductive level (simple reproduction of the text); simple reading of the summary is also not allowed.

It is necessary for the speaker to show their own attitude towards what they are talking about, express their personal opinion and understanding, substantiate it, and be able to draw the correct conclusions from what has been said. In doing so, the student may refer to the entries in the summary, directly to the primary sources, use knowledge of previously studied disciplines, etc. In addition, to obtain a grade at an advanced level, students solve situational tasks based on the results of the mastered topics.

During the execution of practical works, a defense of practical skills is provided, the full list of which is specified in the fund of assessment tools.

Methodological Recommendations for the Preparation of Presentations and Reports

The report must contain elements of novelty; along with the fundamental aspect, an analysis of the current state of the problem under study must be carried out, as well as inclusion in regional issues. The report must include an introduction, a theoretical part, a conclusion, a list of literature, and a presentation that reveals the essence of the topic in graphs, pictures, diagrams, and formulas.

The report is recommended to be submitted on 1 printed sheet. The text of the work must be printed with 1.5 line spacing on one side of a standard sheet (A4) of white paper.

The text and other printed elements of the work must be black, and the contours of letters and signs must be clear, without halos and shading. The font must be Times New Roman, size 14. The titles of chapters and paragraphs are highlighted in bold. The sheet with text must have margins: left – 30 mm, right – 10 mm, top – 20 mm, bottom – 20 mm.

Page numbering of the text is done in the lower right corner of the sheet. It is necessary to number pages starting from the page where the Introduction is printed, on which the number 3 is placed. After that, all pages, including appendices, are numbered.

A space equal to two intervals is placed between the title of the chapter and the title of the paragraph of this chapter, and the title of the paragraph must not be separated from the text of this paragraph by a space. The titles of paragraphs shall be separated from the text of the previous paragraph by a space equal to two intervals. Each chapter, as well as the introduction, conclusions, appendices, and the list of used literature, begin on a new page. The word Chapter is not to be written. Chapters have ordinal numbers within the entire work, designated by Arabic numerals (for example: 1, 2, 3), followed by a period.

The word **PARAGRAPH** or the paragraph symbol (§) is not placed in the title. Paragraphs have ordinal numbers within the chapters, designated by Arabic numerals (for example: 1.1. and 1.2.).

Headings of chapters and paragraphs in the text must be centered; a period shall not be placed at the end of the title of the chapter and paragraph. It is not allowed to hyphenate (transfer) a part of a word in a heading. 4.5. The numbering of tables and figures can be running (continuous) or relate to the number of the chapter and paragraph. For example, if a table or a figure is included in the text of the first paragraph of the second chapter, the numbering is as follows: Table 2.1.1., Fig. 2.1.1.

The last digit means the ordinal number of the table (or figure) in this paragraph.
The table is to be placed as the next page after the first mention of it in the text.

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Methodological Guidelines
for Students on arranging and performing laboratory classes
in the Discipline of **Normal physiology**
for Students majoring (Specialty) in 31.05.01 General Medicine

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INTRODUCTION

Normal physiology studies the functions of the body in its interaction with the environment. Physiology is an experimental science; therefore, its study must strictly be accompanied by the performance of laboratory classes. Their primary objective is to assist students in conducting experiments independently, comprehending their results, and acquiring the skills necessary for a future specialist. To perform laboratory and practical work, students must possess sufficient theoretical background in the relevant section of physiology. Consequently, the execution of laboratory work must be preceded by studying the relevant material using textbooks, lecture notes, and supplementary literature (study guides, monographs, Internet resources, etc.), which will allow for the correct interpretation of the data obtained during practical activities.

The knowledge acquired through mastering the discipline is applied when writing the final qualification paper, during educational and pre-graduation internships, as well as when completing a graduation thesis and in further professional activity.

As a result of mastering the discipline, the learner:

Must know: the mechanisms of maintaining the constancy of the body's internal environment; the mechanisms of adaptation and regulation of physiological functions; the physiology of the blood and circulatory, digestive, respiratory, excretory, thermoregulatory, and locomotive systems, as well as the central and peripheral nervous systems; biochemical processes occurring in excitable tissues; metabolic and energy reactions in human tissues; methods of studying metabolism and energy; the mechanisms of regulating metabolism and cellular homeostasis; the processes of energy transformation in living organisms; the core tenets and current status of the doctrine of higher nervous activity; modern and classical methods of researching higher nervous activity; the role and correlation of biological and social factors in the establishment, development, and manifestation of higher mental functions; the qualitative singularity of human higher nervous activity.

Must be able to: quantitatively and qualitatively evaluate the physiological parameters of the activity of various organs and systems under normal conditions.

Analyze:

- the patterns of functioning of excitable tissues, the central nervous system, and endocrine glands;
- the main parameters of the blood system;
- the specific features of organization and regulation of different stages of respiration;
- the functioning of the cardiovascular, respiratory, excretory, digestive, and thermoregulatory systems in ensuring goal-directed body activity.

Conduct studies of:

- the state of the body's coagulation system, and evaluation of blood groups and Rh factor;
- the basic physiological properties of excitable tissues;
- the reflex activity of the nervous system and autonomic reactivity;
- the functions of sensory systems;
- pain sensitivity;
- higher mental functions;
- individual typological characteristics of a human;
- the performance indicators of somatic and visceral (respiratory, cardiovascular) systems under various functional states of the body.

Must possess skills in:

- experimental skills for studying the physiological functions of the body in health and disease;

the following methods:

- determination of blood groups and Rh factor;
- evaluation of complete blood count (CBC) results;
- evaluation of osmotic fragility of erythrocytes;
- red and white blood cell count (RBC and WBC count);

- ECG analysis (heart rate, wave norms, rhythm, determination of the electrical axis of the heart);
- pulse palpation;
- blood pressure measurement;
- determination of cardiac cycle phase boundaries using comprehensive examination: ECG, sphygmography, and phonocardiography;
- determination of physical working capacity (using the Harvard step test and PWC170 methods);
- spirometry technique;
- pulse oximetry technique.

3rd Semester

LABORATORY CLASS - 1

Topic of the Class: Safety Regulations in the Laboratory.

Objective: To study the layout and equipment of a physiological laboratory and an operating suite, understand the rules of conduct within them, and familiarize oneself with safety regulations.

Knowledge and Skills Acquired by the Student as a Result of Mastering the Topic (Seminar): Will enable the student to successfully conduct research in the laboratory.

Relevance of the Topic: Formulating clear ideas about the rules of working in a laboratory; familiarizing oneself with the instrumentation base and acquiring independent work skills.

Competences or Parts Thereof Being Developed: GPC-5 (General Professional Competence-5).

Plan:

1. Studying the rules of conduct in a physiological laboratory.
2. Familiarization with the equipment used in classes.

TheoreticalPart

Physiology is an experimental science; therefore, its study must strictly be accompanied by the performance of laboratory work. Conducting laboratory work ensures the development of skills in working with diagnostic instruments — devices that allow for the registration of specific physiological processes in the body. In addition, performing a number of biochemical tests involves working with acids and alkalis, which requires knowledge and skills in handling them safely.

Questions and Tasks:

1. The goal and objectives of the subject "Laboratory Practicum in Physiology."
2. Classical and modern research methods.
3. Layout and equipment of a physiological laboratory, rules of conduct within it.
4. Layout and equipment of an operating suite, rules of conduct within it.
5. Safety regulations when working in a physiological laboratory.

LABORATORY CLASS – 2

Topic of the Class: The Frog Nerve-Muscle Preparation as an Object of Research in the Physiology of Excitation.

Objective: To master the technique of preparing a nerve-muscle preparation.

Knowledge and Skills Acquired by the Student as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of the basics of working with laboratory animals and their anatomy;
- skills in utilizing the technique of preparing a nerve-muscle preparation;
- practical skills in working with the frog nerve-muscle preparation using the study of excitation processes as an example.

Competences or Parts Thereof Being Developed:

GPC-5; ID – 1, 2 (Indicator of Achievement – 1, 2).

Relevance of the Topic is due to the fact that students require knowledge of the nerve-muscle preparation technique for their further scientific activity.

Plan:

1. Preparation of the frog nerve-muscle preparation.
2. The effect of various stimuli on the frog nerve-muscle preparation.

Theoretical Part

One of the important properties of living cells is their electrical excitability, i.e., the ability to become excited in response to the action of an electric current. The high sensitivity of excitable tissues to the action of a weak electric current was first demonstrated by L. Galvani in experiments on a nerve-muscle preparation of frog hind legs; a major contribution to the study of the physiology of excitable tissues was also made by A. Volta, C. Matteucci, and E. Du Bois-Reymond.

Questions and Tasks:

1. The concept of physiological rest and the active state of living tissue.
2. The core properties of living matter: irritability, excitability, functional mobility or lability, and their dependence on tissue type.
3. The processes of excitation and inhibition as types of response reactions of living tissue to stimulation.
4. Specific and non-specific manifestations of excitation.
5. Stimulation and stimuli. Classification of stimuli.
6. The advantages of electric current as a stimulus for living tissue.
7. Objects and methods for studying excitation processes. The frog nerve-muscle preparation as an object for studying excitation processes in nervous and muscular tissues.
8. The history of the discovery of "animal electricity" and the development of electrophysiology (L. Galvani, A. Volta, C. Matteucci, E. Du Bois-Reymond, J. Bernstein). The contribution of domestic scientists (I.M. Sechenov, V.Ya. Danilevsky, N.E. Vvedensky, A.F. Samoylov, V.V. Pravdich-Neminsky) to the development of electrophysiology.
9. Modern concepts of the microstructure of the cytoplasmic membrane and its role in the formation of cellular biopotentials.
10. Modern methods of recording biocurrents. Microelectrode technique.
11. Resting membrane potential; the mechanism of cell membrane polarization at rest.
12. Action potential; the ionic mechanism of membrane depolarization during excitation.
13. Analysis of a single excitation wave. Ionic mechanisms of the development of the critical depolarization level, the peak of the action potential, subsequent repolarization phases, and negative and positive after-potentials.
14. Characteristics of phase changes in excitability during the excitation cycle. The biological significance of refractory periods and supernormal excitability in the adaptive activity of living organisms.
15. Definition of the concept of "stimulation threshold" as an indicator of living tissue excitability.
16. Definition of subthreshold and suprathreshold (submaximal, maximal, and supramaximal) stimuli.
17. Laws governing the formation of response reactions:
18. The law of force (intensity-response relationship), the history of its discovery. Classification of stimuli by intensity. The significance of the threshold stimulus intensity for characterizing the property of excitability.
19. The law of stimulation duration, the history of its discovery. Analysis of the "strength-duration" curve. Definition of the concepts of "rheobase," "useful time," and "chronaxie." The values of chronaxie as an indicator of tissue response speed.

20. The law of stimulation gradient. Tissue accommodation and its biological significance.
21. General regularities of rhythmic tissue activity. Concepts of optimal, pessimal, and maximal excitation rhythms.
22. A.A. Ukhtomsky's doctrine on the assimilation of rhythm.
23. Characteristics of local non-propagated excitation and its gradual nature.

LABORATORY CLASS – 3

Topic of the Class: Studying Bioelectric Phenomena.

Objective: To understand the mechanisms of membrane potential formation in excitable tissues; to be able to evaluate changes in membrane ionic permeability and tissue excitability under the influence of various factors.

Knowledge and Skills Acquired by the Student as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of the basics of working with laboratory animals and their anatomy;
- skills in utilizing the technique of preparing a nerve-muscle preparation;
- practical skills in working with the frog nerve-muscle preparation using the study of excitation processes as an example.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic is due to the fact that students require knowledge of the nerve-muscle preparation technique for their further scientific activity.

Plan:

1. Immobilization of a frog by pithing the spinal cord and decerebration (removal of the brain).
2. Studying bioelectric phenomena on a muscle preparation.

Theoretical Part

The primary property of individual elements of the nervous system (NS) is excitability, i.e., the ability to generate a specialized excitation process in response to stimulation. The high sensitivity of excitable tissues to the action of a weak electric current was first demonstrated by L. Galvani in experiments on a nerve-muscle preparation of frog hind legs; a major contribution to the study of the physiology of excitable tissues was also made by A. Volta, C. Matteucci, and E. Du Bois-Reymond.

Questions for Discussion:

1. Electrical phenomena in excitable tissues. The history of their discovery.
2. Resting membrane potential and its origin.
3. Characteristics of electrotonic and local potentials.
4. Action membrane potential and its phases.
5. Correlation of excitability phases with action potential phases. The concept of excitable tissue lability.
6. Methods for evaluating membrane potentials.

LABORATORY CLASS – 4

Topic of the Class: Physiological Foundations of the Parabiotic Process.

Objective: To study the stages of parabiotic processes.

Knowledge and Skills Acquired by the Student as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of the three phases of parabiotic processes;
- an understanding of the processes underlying changes in nerve lability, conductivity, and excitability under the prolonged action of a stimulus on the nerve;
- practical skills in working with a nerve-muscle preparation and recording changes in nerve excitability.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic is due to the fact that students acquire skills in working at an automated physiologist workstation.

Plan:

1. Immobilization of a frog by pithing the spinal cord and decerebration (removal of the brain).
2. Preparation of a nerve-muscle preparation.
3. Recording of all phases of parabiosis.

Theoretical Part

N.E. Vvedensky established on a nerve-muscle preparation that the functional state of a nerve changes under the prolonged action of a stimulus of any nature. This is associated with alterations in the lability, excitability, and conductivity of the nerve. Upon termination of the stimulus exposure, the functional properties of the nerve are restored. N.E. Vvedensky termed this phenomenon "parabiosis" (translated as: "para" – near, "bios" – life) — a state on the verge of tissue life and death, arising when exposed to toxic substances, such as narcotics, phenol, formalin, various alcohols, alkalis, and others, as well as under the prolonged action of an electric current.

Questions for Discussion:

1. Definition of the concept of "stimulation threshold" as an indicator of tissue excitability.
2. Laws governing the formation of response reactions: the laws of force (intensity), duration, and stimulation gradient.
3. Characteristics of local non-propagated excitation and its gradual nature.
4. N.E. Vvedensky's doctrine of parabiosis.
5. Stages of parabiosis.
6. Physiological mechanisms of parabiosis development

LABORATORY CLASS – 5

Topic of the Class: Investigation of Reflex Responses. Analysis of the Reflex Arc.

Objective: To observe the impairment of excitation conduction along a nerve under the influence of chemical exposure, during isolated conduction and two-way conduction of excitation along a nerve fiber.

Knowledge and Skills Acquired by the Student as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of the structure of nervous tissue and its functioning;
- skills in working with laboratory animals.

Competences or Parts Thereof Being Developed: GPC-5; ID – 1, 2.

Relevance of the Topic (Seminar) is due to the fact that a modern student-researcher must know the structure and functioning of nervous tissue, using the frog nerve-muscle preparation as an example.

Plan:

1. Conduction of excitation along an isolated nerve fiber and its impairment.
2. Specific features of the functioning of spinal cord nerve centers.
3. Physiology of the autonomic nervous system.

Theoretical Part

The nervous system is a complexly organized and highly specialized system, the main structural unit of which is the nerve cell — the neuron. The primary property of individual elements of the nervous system is excitability, i.e., the ability to generate a specialized excitation process in response to stimulation. Excitation underlies the mechanisms of information reception, transmission, and processing, the integrative activity of the brain, as well as the formation of the body's response reactions. Conduction of excitation along a nerve requires its anatomical and

physiological integrity. The significance of violating the anatomical integrity of a nerve (rupture, transection) for terminating excitation conduction is obvious. An impairment of physiological integrity, while maintaining the full structure of the nerve, can be induced by altering its physiological properties (excitability, conductivity, lability). When certain chemical substances (alcohol, novocaine, potassium chloride solution, etc.) act on living tissue, the permeability of cell membranes to sodium and potassium ions changes at the site of their exposure. This entails changes in the physiological properties of the tissue, similar to what occurs under the cathode during the action of a direct current: an initial increase in excitability is subsequently replaced by its progressive decrease until complete disappearance. At the same time, the area with altered physiological properties becomes unresponsive to the action of new stimuli; consequently, it loses the ability to conduct excitation. Timely removal of the specified chemical substance (before changes incompatible with life occur) is accompanied by a gradual restoration of the physiological properties of the tissue.

Questions and Tasks:

1. The emergence of nerve signaling in the process of living organisms' evolution. Main stages of nervous system development in phylogenesis and ontogenesis.
2. Specific features of neural regulation of functions and its connection with humoral regulation. The adaptive role of neural and humoral regulatory mechanisms.
3. Modern methods of researching the structure and function of the nervous system.
4. Structural and functional organization of the neuron. Classification of neurons by their structure and function.
5. The concept of neuroglia and its functional significance.
6. The structure and properties of nerve fibers; their division into myelinated and unmyelinated fibers. The ultrastructure of the axon (axis cylinder) of a nerve fiber.
7. The mechanism of excitation conduction along myelinated and unmyelinated nerve fibers. Classification of nerve fibers by excitation conduction velocity, their excitability, and lability.
8. Laws governing the conduction of excitation along nerves.
9. The significance of the nervous system in the vital activity of the organism.
10. Division of the nervous system into central and peripheral, somatic and autonomic.
11. Reflex as the core act of nervous activity.
12. The concept of the reflex arc and its morphofunctional organization.
13. The reflex ring as the material substrate of feedback loops between controlled organs and control centers.

LABORATORY CLASS – 6

Topic of the Class: Nerve Centers and Their Main Properties.

Objective: Investigation of the functioning of nerve centers.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge that information about the state and changes of the external environment is processed via sensory systems or analyzers;
- skills in mastering the methodology and familiarizing themselves with the location of taste zones on the tongue surface;
- practical skills obtained in experiments that will enable them to study the physiological functions of the body.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about the functioning of analyzers and alterations in their sensitivity under various methods of exposure.

Plan:

1. Determination of the unidirectional conduction of excitation.
2. Demonstration of the rapid fatigue of nerve centers.

Theoretical Part

Nerve Center. Anatomical and physiological concept of a nerve center. Properties of nerve centers. A nerve center is a collection of interconnected neurons that jointly perform a specific function by transforming incoming excitation into outgoing excitation with altered characteristics. The anatomical concept of a "nerve center" refers to a group of neurons located in strictly defined divisions of the central nervous system that execute a single reflex. For example, the center of the patellar reflex (knee-jerk reflex) is located in the anterior horns of the 2nd–4th lumbar segments of the spinal cord.

Questions and Tasks:

1. Definition of a nerve center (NC).
2. Anatomical and physiological concepts of the NC.
3. Properties of the NC: unidirectional conduction of excitation, summation of excitation, rapid fatigue, transformation of rhythm, and plasticity.

LABORATORY CLASS – 7

Topic of the Class: Measurement of Human Muscle Work (Ergometry).

Objective: To familiarize oneself with the method of determining muscle work using a step test; to identify changes in heart rate depending on the workload; to study the development of fatigue in relation to the pace of muscular effort and determine the degree of muscle endurance; to master the method of dynamometry.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of the mechanisms of adaptation and regulation of physiological functions;
- skills in utilizing the primary methods of physiology when studying other biomedical and medical disciplines;
- practical skills obtained in experiments that will enable them to study the physiological functions of the body.

Competences or Parts Thereof Being Developed: GPC-5; ID – 1, 2.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about methods of human examination and determining the status of specific body systems. In particular, based on heart rate determination results, the work capacity, strength, and endurance of muscles are determined. The dependence of the functional state of the cardiovascular system (CVS) on the intensity and magnitude of the workload is evaluated in the subject.

Plan:

1. Measurement of the strength of the right and left hands.
2. Measurement of the back deadlift strength (back strength).
3. Establishing the magnitude of the developed effort depending on the speed of force application.

Theoretical Part

The muscular system accounts for more than 40% of body weight, and the functional state of this system largely determines the level of human health. Scientific and technological achievements have reduced the proportion of human physical effort required to perform professional and domestic duties. Hypodynamia and hypokinesia have become some of the main causes of a sharp increase in the incidence of cardiovascular (CV) diseases.

Questions and Tasks:

1. Types of muscle tissue, their specific structure, and functions.

2. The concept of a motor unit.
3. Microstructure of a skeletal muscle fiber.
4. Mechanism of muscle contraction.
5. The myoneural (neuromuscular) synapse, its structure, and the mechanism of excitation transmission.
6. Modes of muscle contraction: isotonic, isometric, and auxotonic.
7. Types of tetanus: smooth (fused) and serrated (unfused); optimal and pessimal.
8. What is the essence of the law of average loads?

LABORATORY CLASS – 8

Topic of the Class: Muscle Strength and Endurance.

Objective: To master the methods of dynamometry; to establish the magnitude of maximum voluntary muscle effort depending on sex, age, height, and body weight.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of the mechanisms of muscle contraction and the influence of the emotional state on the strength of muscle contraction;
- knowledge of the importance of physical activity for modern humans;
- skills in determining the strength of muscle contraction and muscle endurance.

Competences or Parts Thereof Being Developed: GPC-5; ID – 1, 2.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about methods for determining muscle endurance.

Plan:

1. Determination of dynamic endurance.
2. Determination of static muscle endurance.
3. Determination of human aerobic endurance.

Theoretical Part

The duration of muscular activity is determined by the intensity of the movements performed. Depending on the pace of the work performed, various mechanisms of energy supply to muscle cells are registered. During intense muscular work, energy supply occurs mainly in the anaerobic mode; during low-intensity work, it occurs in the aerobic mode. In the first case, ATP resynthesis occurs due to high-energy compounds. In the second case, it occurs due to oxidative phosphorylation.

Questions and Tasks:

1. Definition of mechanical muscle work.
2. What is the difference between internal and external muscle work?
3. Methods for determining muscle work in humans.
4. Factors ensuring muscle strength.
5. Physiological mechanism of muscle strength development.
6. The concept of work hypertrophy (compensatory hypertrophy) of muscles.
7. The concept of muscle fatigue, fatigue phases, and their characteristics.
8. "Humoral theories" of muscle fatigue.
9. The significance of the works of I.M. Sechenov and I.P. Pavlov for the development of the doctrine of fatigue.
10. Modern understanding of the factors causing fatigue.
11. The concept of muscle endurance and the factors of its development.
12. Chemism and energetics of muscle contraction.

LABORATORY CLASS – 9

Topic of the Class: The Autonomic Nervous System.

Objective: To become familiar with the method of determining the influence of autonomic nervous system neurotransmitters on an animal's pupil size; to master the technique of determining the state of autonomic balance in humans.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of the mechanisms of autonomic nervous system neurotransmitters' influence on the organs of vision;
- skills in utilizing the primary methods of physiology to determine the functional state of their own body;
- practical skills obtained in experiments that will enable them to study the physiological functions of the body.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about conducting animal experiments and the skill to determine the functional state of the human body using the results of heart rate (HR) and blood pressure (BP) measurements.

Plan:

1. Demonstrating the effect of ANS neurotransmitters — epinephrine (adrenaline) and acetylcholine — on the eyeball.
2. Determining the state of autonomic balance in a healthy person using circulatory parameters — HR and BP.

Theoretical Part

The vegetative (autonomic) nervous system is a part of the nervous system that regulates the function of internal organs, vascular lumen, metabolism, and energy, thereby ensuring body homeostasis.

Questions and Tasks:

1. General structural plan of the ANS. Explain the essence of the term "vegetative"; who proposed this term?
2. Structural features of the sympathetic and parasympathetic divisions of the ANS.
3. Structure and function of autonomic ganglia.
4. Neurotransmitter mechanisms of impulse transmission in the autonomic nervous system.
5. Autonomic reflexes and their difference from somatic ones.
6. Autonomic innervation of organs and tissues.
7. The role of W. Cannon's research in the development of the doctrine of homeostasis.
8. L.A. Orbeli's doctrine on the adaptive-trophic role of the sympathetic division of the ANS.
9. Biological significance of the parasympathetic division of the ANS.
10. The metasymphathetic (enteric) nervous system as a truly autonomous NS.
11. The significance of the cerebral cortex in the regulation of autonomic functions.

LABORATORY CLASS - 10

Topic of the Class: Physiology of the Endocrine System. Physiology of the Pituitary and Adrenal Glands.

Objective: To determine the role of the pituitary-adrenal system in adaptation to physical exertion.

Knowledge and Skills Acquired by the Student as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of the structure, location, and mechanisms of endocrine glands, and their influence on the body;

- skills in evaluating hormone levels in the blood.

Competences or Parts Thereof Being Developed: GPC-5; ID – 1, 2.

Relevance of the Topic (Seminar) is associated with the need to study the secretory mechanism of endocrine glands in laboratory animals during adaptation to physical exertion (using the adrenal glands as an example).

Plan:

1. Studying the mechanisms of hormone secretion.
2. Determining the role of central glands in regulating the secretory activity of peripheral glands.
3. Studying the role of the adrenal glands in adaptation to physical exertion.

Theoretical Part

Endocrine glands, or glands of internal secretion, are specialized organs that discharge their secretory products directly into the blood or tissue fluid. Currently, endocrine glands include the pituitary gland, the thyroid gland, the parathyroid glands, the adrenal cortex and medulla, the islet apparatus of the pancreas (islets of Langerhans), the gonads, the thymus, and the pineal gland. The placenta also possesses endocrine activity. Furthermore, endocrine cells can be present in certain other organs and tissues, particularly in the digestive tract, kidneys, cardiac muscle, and autonomic ganglia. These cells form the so-called diffuse neuroendocrine system. The common function of all glands of internal secretion is the production of hormones. The term "hormone" originates from the word *hormae*, which means "to excite" or "to urge on."

Questions and Tasks:

1. Define the concepts of "endocrine system" and "hormone."
2. How do hormones differ from other biologically active substances?
3. What is the chemical structure of hormones?
4. Modern concepts of the mechanisms of action of peptide and steroid hormones.
5. The pituitary gland. Structure and hormonal function.
6. The role of the hypothalamus in regulating pituitary functions. Hypothalamic neurosecretion.
7. Direct and feedback loops (positive and negative feedback) in the regulation of endocrine functions.
8. The unity of neural and hormonal regulation of functions and its significance for the organism's adaptation to environmental conditions.
9. The thyroid gland. The significance of thyroid hormones. Calcitonin.
10. The parathyroid glands. The role of parathyroid hormone (PTH) and its interaction with calcitonin and vitamin D in the regulation of calcium metabolism.
11. The adrenal cortex. Mineralocorticoids, glucocorticoids, androgens, and estrogens; their role in maintaining homeostasis.
12. Stress and its biological significance. Stages of the general adaptation syndrome (GAS).
13. Endocrine function of the pancreas. Insulin, glucagon.
14. Male sex hormones.
15. Female sex hormones.
16. Human puberty. Core principles of sex education and sexual enlightenment.

LABORATORY CLASS - 11

Topic of the Class: General Mechanisms of Analyzer Function.

Objective: Investigation of the functioning of analyzers; to become familiar with various methods: cutaneous, tactile, visual, gustatory, and olfactory reception of different analyzers.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge that information about the state and changes of the external environment is processed via sensory systems or analyzers;
- skills in mastering the methodology and familiarizing themselves with the location of taste zones on the tongue surface;
- practical skills obtained in experiments that will enable them to study the physiological functions of the body.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about the functioning of analyzers and alterations in their sensitivity under various methods of exposure.

Plan:

1. Determination of human tactile and cutaneous sensitivity.
2. Studying the localization of taste sensations during stimulation of specific areas of the tongue.
3. Receptor adaptation.
4. Investigation of visual acuity.
5. Determination of the field of vision.
6. Interaction and control in the functioning of various human analyzers.

Theoretical Part

Information about the state and changes of the external environment is processed via sensory systems (analyzers). In 1909, I.P. Pavlov first introduced the term "analyzers" to describe a set of structures that include: a peripheral receptive apparatus (receptors) that transforms the energy of stimulation into a specific process of excitation; a conducting part consisting of peripheral nerves and subcortical conducting centers; and a central division represented by nerve centers located in the cerebral cortex, which analyze the incoming information and form the corresponding sensation.

Taste, just like smell, is based on chemoreception. Taste receptors carry information about the nature and concentration of substances entering the oral cavity. Their excitation triggers a complex chain of reactions in various parts of the brain, leading to the differentiated performance of the digestive organs or the rejection of harmful substances that enter the mouth with food.

Questions and Tasks:

- I.P. Pavlov's doctrine of analyzers.
- Methods for studying analyzers.
- The role of analyzers in perceiving the surrounding world.
- Classifications of receptor structures.
- General properties and regularities of receptor structure activity.

LABORATORY CLASS - 12

Topic of the Class: The Visual Analyzer.

Objective: Investigation of the functioning of the visual analyzer; to become familiar with various methods of determining the functional state of the visual sensory system.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge that humans receive the primary volume of information through the functioning of the visual sensory system;
- skills in determining visual acuity, the visual field, etc.;
- practical skills obtained in experiments that will enable them to study the physiological functions of the body.

Competences or Parts Thereof Being Developed: GPC-5; ID – 1, 2.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about the functioning of the visual analyzer and methods for determining its functional state.

Plan:

1. Determination of human visual acuity.
2. Determination of the field of vision (visual field).
3. Detection of the blind spot on the retina.
4. Determination of the size of the yellow spot (macula lutea).
5. Interaction and control in the functioning of various human analyzers.

Theoretical Part

The visual system is a system that provides 90% of information about the external environment. The importance of this system cannot be underestimated. In the presence of pathology of the visual sensory system, a person's capability to master many types of professional activities is sharply reduced. Impairments can occur at different levels — from receptors to the cortical divisions of the visual system.

Questions and Tasks:

1. Structure of the eye.
2. Structure of the retina.
3. Different functions of retinal cells.
4. Physiological mechanisms of color vision.
5. Adaptation and accommodation.
6. Visual acuity.
7. Binocular vision.
8. Visual field (perimeter of vision).

LABORATORY CLASS - 13

Topic of the Class: The Auditory Analyzer.

Objective: Investigation of the functioning of the auditory analyzer; to become familiar with various methods of determining the functional state of the auditory sensory system.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge that humans receive a significant volume of information through the functioning of the auditory sensory system;
- skills in determining auditory acuity, air and bone conduction, etc.;
- practical skills obtained in experiments that will enable them to study the physiological functions of the auditory sensory system.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about the functioning of the auditory analyzer and methods for determining its functional state.

Plan:

1. Investigation of bone and air conduction.
2. Comparison of bone and air conduction.
3. Investigation of the sensitivity of the auditory analyzer.
4. Binaural hearing.
5. Determination of auditory acuity.

Theoretical Part

The auditory system is an essential component of the means of communication, cognition, and adaptation to the environment. With the complete exclusion of sound stimulation in an anechoic (soundproof) chamber, a hearing person may develop mental activity disorders and even hallucinations after 6–7 days. In the presence of pathology of the auditory sensory system, a

person's capability to master many types of professional activities is sharply reduced. Impairments can occur at different levels — from receptors to the cortical divisions of the auditory sensory system.

Questions and Tasks:

1. Structure of the auditory analyzer.
2. Mechanisms of sound transmission and perception.
3. Electrical phenomena in the cochlea.
4. Factors determining the sensitivity of the auditory analyzer.
5. Spatial localization of sound.
6. Age-related features of the auditory analyzer.

LABORATORY CLASS - 14

Topic of the Class: Reflex as the Core Type of Nervous System (NS) Activity. Foundations of the Doctrine of Higher Nervous Activity (HNA).

Objective: To introduce students to various methodologies for developing conditioned reflexes in humans through: extinction of inhibition, verbal stimuli, and different forms of interaction between signaling systems that develop in the course of individual life.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of higher nervous activity, types of reflexes, and their development;
- skills in utilizing the primary methods of developing conditioned reflexes in humans;
- practical skills obtained in experiments that will enable them to study the physiological functions of the body and behavior.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about higher nervous activity, its structure, and processes. The student learns to develop conditioned reflexes in subjects and subsequently tracks the course of extinctive inhibition.

Plan:

1. Formation of a protective blinking conditioned reflex in humans.
2. Studying human conditioned reflex activity using a verbal stimulus.
3. Conditioned inhibition of conditioned reflexes.

Theoretical Part

The physiology of higher nervous activity (HNA) is the science of the brain mechanisms underlying behavior and the psyche, which are grounded in the reflex theory.

The central concepts in the physiology of HNA are the unconditioned and conditioned reflexes.

An unconditioned reflex is an innate, species-specific reaction of the body that arises reflexively in response to the specific action of a stimulus — a biologically significant trigger (pain, food, cold, etc.) that is adequate for this particular type of activity. Unconditioned reflexes are linked to vital biological needs and are executed within a stable, hardwired reflex pathway.

A conditioned reflex is an individually acquired reaction of the body to a previously indifferent (neutral) stimulus, developed on the basis of an unconditioned reflex. At the core of a conditioned reflex is the formation of new neural connections or the modification of existing ones under the influence of changes in the external and internal environment. These are temporary connections that undergo inhibition when reinforcement is withheld or when the situation changes.

Questions and Tasks:

1. Distinctive characteristics of conditioned and unconditioned reflexes.
2. Classification of conditioned and unconditioned reflexes.
3. Conditions required for the development of a conditioned reflex.

4. Mechanism of conditioned reflex formation. Modern concepts of the convergent nature of conditioned connection closure (P.K. Anokhin).
5. Inhibition of conditioned reflexes.
6. Analytical-synthetic activity of the cerebral cortex.
7. I.P. Pavlov's doctrine of higher nervous activity (HNA) types. Genotypic traits and the formation of the phenotype-character.

LABORATORY CLASS – 15

Topic of the Class: Higher Nervous Activity. The Concept of Nervous System Types.

Objective: To introduce students to various methodologies for determining the types of the nervous system; to master the technique of determining the type of HNA based on the parameters of strength, balance, and mobility of nervous processes.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of higher nervous activity, types of reflexes, and their development;
- skills in utilizing the primary methods of developing conditioned reflexes in humans;
- practical skills obtained in experiments that will enable them to study the physiological functions of the body and determine HNA types.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about higher nervous activity and the possibility of utilizing this knowledge in their future professional activity.

Plan:

1. Determination of the HNA type using an anamnesis-based scheme.
2. Determining the percentage distribution of HNA types within a group.

Theoretical Part

Types of higher nervous activity (HNA) represent a combination of innate (genotype) and acquired (phenotype) properties of the nervous system that determine the nature of the organism's interaction with the environment and are reflected in all body functions. The specific significance of the innate and the acquired — a product of genotype-environment interaction — may vary depending on conditions. Under unusual, extreme conditions, the predominantly innate mechanisms of higher nervous activity come to the forefront.

Questions and Tasks:

1. The role of Hippocrates' works in understanding personality traits.
2. I.P. Pavlov's doctrine of HNA types.
3. Genotypic traits of HNA.
4. Determination of HNA types.
5. HNA types, temperament, and personality structure.
6. The formation of the phenotype-character.

LABORATORY CLASS – 16

Topic of the Class: The Dynamic Stereotype. Inhibition of Conditioned Reflexes.

Objective: To introduce students to various methodologies for developing conditioned reflexes in humans through: extinction of inhibition, verbal stimuli, and different forms of interaction between signaling systems that develop in the course of individual life.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of higher nervous activity, types of reflexes, and their development;
- skills in utilizing the primary methods of developing conditioned reflexes in humans;

- practical skills obtained in experiments that will enable them to study the physiological functions of the body.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about higher nervous activity, its structure, and processes. The student understands the significance of firmly established forms of behavior and realizes the importance of shaping socially meaningful behavioral forms.

Theoretical Part

A dynamic stereotype is a stable, individual complex of conditioned reflex motor or other responses. This response, developed and fixed in the cerebral cortex of a human or an animal, represents a stable sequence of conditioned reflexes produced as a result of repeated exposure to conditioned signals following a specific order. For a dynamic stereotype to form, a complex of stimuli must act on the organism in a specific order and at definite time intervals (external stereotype). For example, a conditioned salivary reflex is developed in a dog to a complex consisting of three stimuli: a bell, a light, and a mechanical stimulus.

Questions and Tasks:

1. The concept of the dynamic stereotype.
2. The role of the dynamic stereotype in the formation of habits and labor skills.
3. The dynamic stereotype as the basis for motor skill formation in complexly coordinated sports.
4. The disruption (breaking) of the dynamic stereotype.

LABORATORY CLASS - 17

Topic of the Class: Physiological Foundations of Behavior.

Objective: To ensure that dominant motivation has the primary influence on the productivity and success of an activity; to evaluate the stability and shiftability of one's voluntary attention; to acquire skills in determining memory capacity.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of dominant motivation;
- skills in evaluating human work capacity when performing tasks that require attention (using the model of a specific type of mental labor — proofreading activity);
- practical skills obtained in experiments that will enable them to study the physiological functions of the body.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about conducting human experiments, the results of which reveal the degree of attention shiftability, and demonstrate that the preliminary formulation of a goal — creating an ideal model of the planned outcome — acts as the governing and directing factor in human actions.

Plan:

1. The significance of memory and dominant motivation in goal-directed activity.
2. The influence of situational afferentation on the outcome of an activity.
3. Determination of the stability and shiftability of voluntary attention.
4. Evaluation of human work capacity when performing tasks that require attention.

Theoretical Part

Dominant motivation determines the direction of behavior; it can persist for a long time (until the need is satisfied) and is characterized by inertia and the capacity to suppress other types of activities driven by alternative motivations. Dominant motivation can be amplified under the influence of extraneous stimuli. Behavior can be considered as an example. The actualization of

any need is associated with the occurrence of certain changes in the internal environment of the body. Those deviations in the internal environment that reach or exceed the initiation threshold for foraging (food-seeking) behavior are defined as the food (biological) need of the organism. Deviations in the internal environment that are fully compensated for by homeostatic control mechanisms cannot be classified as a biological need.

Questions and Tasks:

1. Physiological foundations of behavior.
2. The concept of the body's functional system as a universal framework of behavioral reactions (P.K. Anokhin).
3. The significance of dominant motivation in the formation of the functional system of behavior.
4. The significance of memory and motivation in dominant behavior.
5. The influence of a goal on the outcome of an activity.
6. The influence of situational afferentation on the outcome of an activity.

LABORATORY CLASS - 18

Topic of the Class: Memory and Its Types. Evaluation of Short-Term Memory Capacity.

Objective: To become familiar with the methodologies for determining short-term memory capacity.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

- As a result of mastering the topic, students deepen their knowledge of memory and its types;
- Skills are developed to evaluate human work capacity when performing professional duties that require attention (using the model of a specific type of mental labor — proofreading activity);
- Practical skills obtained in experiments will enable them to study the physiological functions of the body.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about conducting experiments involving volunteers, the results of which reveal short-term memory capacity; the student determines the significance of motivation in information assimilation.

Plan:

1. Determination of short-term memory capacity.
2. Determination of short-term memory capacity in individuals with different types of HNA.
3. Establishing the influence of motivation on short-term memory capacity.

Theoretical Part

The accumulation, storage, and reproduction of information are general properties of neural networks. The biological significance of these processes for the adaptation of individual behavior to the environment cannot be overstated. Without the capacity for learning and memory, neither an individual organism nor a species as a whole could survive, since both planning successful actions and deliberately avoiding mistakes would prove impossible.

Questions and Tasks:

1. Classification of memory.
2. Short-term, intermediate, and long-term memory.
3. The role of specific brain structures in memory formation.
4. Age-related dynamics of memory.
5. Modern recommendations for increasing memory capacity.

4th Semester

LABORATORY CLASS – 19

Topic of the Class: Blood as the Core Component of the Body's Internal Environment.

Objective: To learn how to perform blood sampling in laboratory animals (rats); to demonstrate the methodology for determining the volume ratios of plasma and formed elements of blood, as well as blood changes during saturation with oxygen or carbon dioxide; to demonstrate the types of hemolysis.

Knowledge and Skills Acquired by the Student as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of the body's internal environment;
- skills in interpreting research results and performing the necessary blood testing methods;
- practical skills in utilizing blood sampling methods in laboratory animals (rats), as well as studying various types of hemolysis.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is determined by the fact that the student needs to learn how to perform blood sampling in laboratory animals, use a centrifuge, interpret the obtained data, and visually determine the ratio of plasma to formed elements, as well as the types of hemolysis.

Plan:

1. Determination of the volume ratio of plasma and formed elements of blood.
2. Changes in blood color upon saturation with.
3. Studying various types of hemolysis.

Theoretical Part

The internal environment of the body is represented by tissue (interstitial) fluid, lymph, and blood, whose composition and properties are intimately interconnected. However, the true internal environment of the body is tissue fluid, as it is the only one in direct contact with the body's cells. Blood, being in direct contact with the endocardium and vascular endothelium, maintains their vital activity and intervenes in the functioning of all organs and tissues without exception only indirectly, through tissue fluid. Blood testing is a highly crucial, and often decisive, method in the diagnosis of many diseases. Alterations in the state of the blood subtly reflect the physiological condition and the impact of pathological factors on the organism.

Questions and Tasks:

1. The internal environment of the body: major components and significance. Evolution of the body's fluid media.
2. Blood as the core component of the body's internal environment. Composition and primary functions of blood.
3. Hematopoiesis: its significance, age-related patterns, and mechanisms of regulation.
4. Immunity: its types and mechanisms. Principal components of the human immune system.
5. The blood coagulation system. Hemostasis: primary factors (plasma, platelet, tissue factors) and phases of blood clotting. The concept of anticoagulants, their varieties, and significance.
6. Composition and properties of human blood plasma. Osmotic and colloid-osmotic (oncotic) pressure and the factors determining their levels. Plasma proteins: their types and functions.
7. Lymph formation and lymph circulation. Microcirculation of fluids in the body and its physical foundations.

LABORATORY CLASS – 20

Topic of the Class: Formed Elements of Blood.

Objective: To become familiar with the method of counting the formed elements of blood and studying their microscopic structure (rat blood), as well as to learn how to determine the hemoglobin concentration in the blood using Sahli's method; determination of blood groups.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of methods for counting the formed elements of blood;
- skills in interpreting results and performing the necessary blood testing methods;
- practical skills in utilizing blood sampling methods in laboratory animals (rats), as well as determining hemoglobin concentration in the blood.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student needs to learn how to count the formed elements of blood manually to expand the methodological framework of a researcher.

Plan:

1. Microscopic study of stained blood smears of a frog and a human.
2. Counting the formed elements of blood.
3. Determination of hemoglobin in the blood using Sahli's method.

Theoretical Part

Blood is a liquid connective tissue consisting of a fluid portion — plasma — and cells suspended within it, known as formed elements: erythrocytes (red blood cells), leukocytes (white blood cells), and platelets (thrombocytes). In an adult, the formed elements of blood account for approximately 40–48%, while plasma accounts for 52–60%. Blood represents a liquid tissue. It possesses a red color, which is imparted to it by erythrocytes (red blood corpuscles). The realization of the primary functions of blood is ensured by maintaining the optimal plasma volume, a specific level of cellular blood elements, and various plasma components.

Plasma depleted of fibrinogen is called serum. All formed elements of blood — erythrocytes, leukocytes, and platelets — are produced in the red bone marrow. Despite the fact that all blood cells are descendants of a single hematopoietic stem cell (fibroblasts in the original text), they perform various specific functions; at the same time, their common origin has endowed them with shared properties. Thus, all blood cells, regardless of their specificity, participate in the transport of various substances and perform protective and regulatory functions.

Questions and Tasks:

1. Formed elements of blood, their types, and brief characteristics.
2. Erythrocytes: their structure, count, and functions. Erythropoiesis and its regulation. Erythrocytosis and erythropenia: conditions of their occurrence and significance for the organism.
3. Leukocytes: their types and count. The leukocyte formula (differential white blood cell count). Functions of various types of leukocytes. Leukocytosis and leukopenia: conditions of their occurrence and significance for the organism. Leukopoiesis and its regulation.
4. The lymphocyte as the central figure of immunity. T- and B-lymphocytes: their origin and biological role. Diagram of the interaction between T- and B-lymphocytes in the formation of immune responses.

LABORATORY CLASS – 21

Topic of the Class: Blood Coagulation. The Doctrine of Blood Groups.

Objective: 1. To learn how to determine the blood coagulation rate. 2. Determination of blood groups.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- skills in interpreting results and performing the necessary blood testing methods;
- practical skills in utilizing methods for blood group determination.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student needs to learn how to determine the erythrocyte sedimentation rate and blood groups to expand the methodological framework of a researcher.

Plan:

1. Determination of blood coagulation time.
2. Determination of the blood group.

Theoretical Part

Blood coagulation is a crucial, multi-phase enzymatic reaction by which the body combats blood loss during trauma. The rate of blood clotting depends on the interaction of coagulation, anticoagulation, and fibrinolytic factors. Numerous methodologies exist that allow for the assessment of individual components within these systems.

Human erythrocytes contain specific antigens called agglutinogens. A distinction is made between agglutinogens A and B. The plasma contains antibodies called agglutinins α and β . Corresponding agglutinogens and agglutinins (so-called homologous entities) never coexist in the blood of the same individual. The combination of homologous entities can only occur during blood transfusion from a donor to a recipient.

Questions and Tasks:

1. Platelets (thrombocytes) and their origin. Platelet counts in children and adults.
2. The role of platelets in blood coagulation.
3. The main stages of blood clotting. The interaction of coagulation and anticoagulation systems.
4. Blood groups. Agglutinogens and agglutinins as the baseline for blood group classification.
5. The Rh factor (Rhesus factor) and its significance.

LABORATORY CLASS – 22

Topic of the Class: Determination of the Erythrocyte Sedimentation Rate (ESR).

Objective: To learn how to determine the erythrocyte sedimentation rate and blood groups.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- skills in interpreting research results and performing the necessary blood testing methods;
- practical skills in utilizing methods for determining the erythrocyte sedimentation rate.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student needs to learn how to determine the erythrocyte sedimentation rate and blood groups to expand the methodological framework of a researcher.

Plan:

1. Determination of the erythrocyte sedimentation rate using Panchenkov's method.
2. Determination of blood groups.

Theoretical Part

All formed elements of blood — erythrocytes, leukocytes, and platelets — are produced in the red bone marrow. Despite the fact that all blood cells are descendants of a single hematopoietic stem cell (fibroblasts in the original text), they perform various specific functions; at the same time, their common origin has endowed them with shared properties. Thus, all blood cells, regardless of their specificity, participate in the transport of various substances and perform protective, regulatory, and diagnostic functions, including parameters such as the ESR (historically referred to as ROE). The primary factor influencing the formation of rouleaux (rouleaux

formation) by erythrocytes is the protein composition of the blood plasma. Protein molecules reduce the negative charge of the erythrocyte membrane, which normally promotes their mutual repulsion. This negative potential is also influenced by other factors: plasma pH (acidosis decreases while alkalosis increases ESR), the content of bile acids and pigments (an increase in their concentration leads to a decrease in ESR), blood lipids (an increase in cholesterol levels accelerates ESR), an increase in blood viscosity slows down ESR, and the presence of anti-erythrocyte antibodies accelerates sedimentation. ESR also depends on the number, shape, and size of erythrocytes. Under normal conditions, ESR varies by sex and age: in men, it is 1–12 mm/h; in women, 8–15 mm/h; in newborns, 1–2 mm/h; and in elderly individuals of both sexes, 15–20 mm/h.

Questions and Tasks:

1. Factors determining the ESR.
2. What is the albumin-globulin ratio (protein coefficient)?
3. Physiological norms of erythrocyte sedimentation for individuals of different ages and sexes.
4. ESR in pathological states.
5. Proteins of the agglomerin group.

LABORATORY CLASS - 23

Topic of the Class: Physiology of the Heart. Cardiac Automatism.

Objective: Visual observation of cardiac activity phases; determination of heart rate using an electrocardiogram (ECG) and pulse.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of operating the "Varicard 2.5" software and hardware complex;
- skills in utilizing core physiological methods and the "Varicard 2.5" software and hardware complex;
- practical skills obtained in experiments that will enable them to study the physiological functions of the body.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about cardiac activity by studying the physical phenomena (electrical, mechanical, acoustic) that accompany the functioning of the heart.

Plan:

1. Recording of the frog heart contractions.
2. Studying the automatism of the frog heart.
3. Analysis of the cardiac conduction system using the ligature application method (Stannius ligatures).

Theoretical Part

Blood moves through blood vessels due to the periodic contractions of the heart. The heart and blood vessels constitute the circulatory system. One of the most crucial functions of the heart is the rhythmic pumping of blood into the arteries coming to it from the veins. This function is executed via alternating rhythmic contractions and relaxations of the cardiac muscle fibers. The contraction of the heart occurs as a result of periodically arising excitation processes in the cardiac muscle. Myocardial contraction is called systole, and relaxation is called diastole. The cardiac muscle (myocardium) possesses a range of properties that ensure its continuous rhythmic activity: automatism, excitability, conductivity, contractility, and refractoriness. Excitation in the heart arises periodically under the influence of processes occurring within the heart itself. This phenomenon is termed automatism.

The specialized musculature forms the cardiac conduction system, which consists of: the sinoatrial (SA) node — the first-order pacemaker, located in the atrial wall at the openings of the venae cavae; and the atrioventricular (AV) node — the second-order pacemaker, located in the lower third of the right atrium and the interventricular septum. The atrioventricular bundle (bundle of His) originates from this node; in the area of the heart apex, the bundle curves upward and transitions into the network of cardiac conducting myocytes (Purkinje fibers). In the area of the atrioventricular node, a delay in excitation conduction of 0.04 ms occurs (due to the property of refractoriness / AV delay).

Questions and Tasks:

1. General characteristics of blood circulation in humans and higher animals; its physiological role.
2. Systemic and pulmonary circulation loops (greater and lesser circulation loops) and their purpose.
3. Core principles of hemodynamics; factors ensuring continuous blood flow.
4. Specific features of blood movement through arteries, veins, and capillaries.
5. The heart, its structure, and valvular apparatus.
6. The cardiac cycle, its phases, sequential alternation, and the duration of its individual phases.
7. Core physiological properties of the cardiac muscle.

LABORATORY CLASS - 24

Topic of the Class: Studying the Movement of Blood Through Vessels. Laws of Hemodynamics.

Objective: Observation of blood circulation in the web of a frog's foot; to learn how to determine arterial blood pressure in humans under resting conditions.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of circulatory loops and arterial blood pressure;
- skills in utilizing a microscope to observe blood movement through the vessels of a frog;
- practical skills obtained in experiments that will enable students to measure arterial blood pressure using N.S. Korotkov's method.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires skills in measuring human arterial blood pressure using N.S. Korotkov's method, and will learn to observe the effects of physical exertion on arterial blood pressure and heart rate.

Plan:

1. Blood movement in peripheral vessels.
2. Determination of arterial blood pressure in humans.
3. Determination of peripheral hemodynamic parameters.

Theoretical Part

N.S. Korotkov's method is based on listening to (auscultating) with a stethoscope the sounds (vascular tones) that arise at a specific pressure in the brachial artery below the site of its compression.

The difference between systolic and diastolic pressure is termed pulse pressure. Pulse pressure is an important indicator of the functional state of the cardiovascular system.

Knowing the values of systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse pressure (PP), and heart rate (HR), one can calculate the stroke volume (in mL) and cardiac output (minute volume of blood, in L) in humans using specific formulas.

Questions and Tasks:

1. Specific features of blood movement through arteries, veins, and capillaries, and the factors determining them.
2. Modern concepts of the vasomotor center.
3. Vasoconstrictor nerves and the mechanism of their influence on the vascular lumen.
4. Humoral regulation of vascular tone.
5. Autoregulation of vascular tone.
6. Core principles of hemodynamics.
7. Blood pressure, factors determining its value. Alterations in blood pressure along the vascular bed.
8. Types of arterial blood pressure and methods for their determination.
9. Neural regulation of vascular tone. The vasomotor center.
10. Humoral regulation of vascular tone.
11. Autoregulation of vascular tone.
12. Blood movement through veins.
13. Blood movement in capillaries. Physiological features of microcirculation.

LABORATORY CLASS – 25

Topic of the Class: Studying the Functional Capabilities of the Respiratory System.

Objective: To become familiar with the methodology for determining vital capacity (VC) and its component volumes, as well as the method of pneumotachometry; studying the functional capabilities of the respiratory system; evaluation of human physical working capacity based on maximum oxygen consumption parameters.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of the mechanisms of inspiration and expiration using Donders' model as an example;
- skills in operating dry (air) and water spirometers;
- practical skills obtained in experiments that will enable students to determine VC and its component volumes necessary for evaluating the function of external respiration.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the functional evaluation of the lungs is a crucial part of clinical medicine and performs a range of tasks: diagnosing lung disease and evaluating its severity; evaluating the efficacy of therapy for various pulmonary disorders (e.g., the response of patients with bronchial asthma to bronchodilators); providing insights into the course of a disease based on the results of sequential tests; training patients in proper breathing techniques and convincing them of the need to maintain a healthy lifestyle (e.g., convincing a smoker to quit smoking by demonstrating test results that indicate impaired lung function).

Plan:

1. Studying the mechanism of inspiration and expiration.
2. Determination of vital capacity (spirometry).
3. Studying the functional capabilities of the respiratory system (Rosenthal's test, pneumotachometry).

Theoretical Part

Respiration is a physiological function that ensures gas exchange (O_2 and CO_2) between the environment and the body in accordance with its metabolic needs.

Respiration proceeds in several stages:

1. external respiration — the exchange of O_2 and CO_2 between the external environment and the blood of the pulmonary capillaries. In turn, external respiration can be divided into two processes: gas exchange between the external environment and the lung alveoli, which is

designated as "pulmonary ventilation," and gas exchange between the alveolar air and the blood of the pulmonary capillaries;

2. transport of O₂ and CO₂ by blood;
3. exchange of O₂ and CO₂ between the blood and body cells;
4. tissue (cellular) respiration.

Questions and Tasks:

1. Physiology of the respiratory system, its stages.
2. Mechanism of inspiration and expiration. The role of negative intrapleural pressure.
3. Transport of gases by blood. The oxyhemoglobin dissociation curve under normal conditions and conditions leading to its shifts.
4. Mechanisms of respiration regulation. The concept of the respiratory center, regularities of its functioning.
5. Gas exchange in the lungs and tissues.
6. Pulmonary ventilation. Vital capacity of the lungs and its component volumes.

LABORATORY CLASS – 26

Topic of the Class: Evaluation of Human Physical Working Capacity Based on Maximum Oxygen Consumption Parameters.

Objective: To master the method of indirect determination of human general physical working capacity.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire knowledge of the aerobic and anaerobic mechanisms of energy supply to functioning organs. Practical skills obtained by mastering this methodology will enable students to study the functional state of the body.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge in the field of the physiology of human aerobic working capacity and masters the method for determining human general physical working capacity.

Plan:

1. Becoming familiar with the methodologies for determining human general physical working capacity.
2. Determining the amount of work performed during step climbing (step test).
3. Determination of maximum oxygen consumption.

Theoretical Part

The physiological prerequisite for the prolonged execution of a workload under aerobic conditions is the sufficient delivery of oxygen to the working muscles. Accordingly, the key factor in increasing general endurance lies in adaptive changes within the systems that ensure oxygen transport. First and foremost, these are alterations in the cardiovascular and blood systems. Along with the development of the functional efficiency of the cardiovascular and blood systems, the respiratory system is of great significance. In particular, during the development of general endurance, an increase in VC (vital capacity) and all lung volumes occurs. An equally important parameter is the capacity of tissues to utilize the incoming oxygen. Consequently, the functional state of these systems determines the value as an integrative indicator of the functional status of a number of body systems.

Questions and Tasks:

1. What is the basis for combining the circulatory and respiratory systems under the concept of the "cardiorespiratory system"?
2. What is maximum oxygen consumption (MOS)?
3. Why maximum oxygen consumption is an integral indicator of the cardiorespiratory system?

4. What is the relationship between maximum oxygen consumption, heart rate and operating power?
5. Why is it possible to evaluate the physical performance of the body based on the indicator of maximum oxygen consumption?
6. What methods are used to determine MOS?
7. What factors contribute to the development of high MOS?
8. What causes limit the development of MOS?
9. What are the age-related features of development MOS?
10. What physical exercises promote the high development of MOS?

LABORATORY CLASS – 27

Topic of the Class: Physiology of Digestion. Investigation of Saliva as a Digestive Juice.

Objective: To master the method of mass screening of total salivation in humans; to study the complex-reflex mechanism regulating salivary gland activity in humans.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of digestion mechanisms in various divisions of the digestive system;
- skills in utilizing the salivation measurement method in humans;
- practical skills obtained in experiments that will enable them to study the physiological functions of the body.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge in the field of the physiology of digestion by mastering the method of investigating human salivation and studying the complex-reflex mechanisms that regulate salivary gland activity in humans.

Plan:

1. Digestion in the oral cavity. Adjustment of the activity of various digestive tract divisions via afferent influences from oral cavity receptors.
2. Saliva formation and salivation. Neural and humoral mechanisms regulating these processes.
3. Reflex salivation in humans. Phases of salivation; adaptive nature of salivation.
4. Starch breakdown by salivary enzymes.
5. Swallowing (deglutition), its phases, and mechanisms.

Theoretical Part

Digestion represents a combination of physical and chemical physiological processes that ensure the processing and transformation of food products into simple chemical compounds capable of being assimilated by the body's cells. Digestion occurs within the organs of the digestive system (oral cavity, stomach, small and large intestines). The digestive system performs the following functions: secretory, motor, absorptive, incretory (endocrine), excretory, and others. The diversity of digestive system functions determines the large number of methodological techniques used to study the physiology of digestion.

Questions and Tasks:

1. The significance of digestion. Functions of the digestive organs and methods for their study.
2. The significance of the works of I.P. Pavlov and his school in the development of the physiology of digestion and methodologies for investigating the function of digestive organs.
3. Digestion in the oral cavity. Secretory function of the salivary glands; digestive significance of saliva, its composition, and properties.
4. The complex-reflex mechanism of salivation regulation.

LABORATORY CLASS – 28

Topic of the Class: Investigation of the Digestive Action of Gastric Juice. The Significance and Role of Digestion in the Duodenum.

Objective: To master the methodologies for determining the enzymatic properties of gastric juice.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of digestion mechanisms in various divisions of the digestive system;
- skills in determining the enzymatic properties of gastric juice;
- practical skills obtained in the process of performing laboratory work that will enable them to study the physiological functions of the body.

Competences or Parts Thereof Being Developing: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge in the field of the physiology of digestion by mastering the methods of investigating the enzymatic properties of gastric juice.

Plan:

1. Observation of the digestive action of gastric juice on muscle protein.
2. Detection of chymosin (rennin) in gastric juice.

Theoretical Part

The human body is unable to assimilate proteins, fats, carbohydrates, and a number of other substances consumed with food without their preliminary transformation. This crucial function within the body is performed by the digestive system, and the process of transforming the ingested food is termed digestion.

The digestive process consists of the mechanical and chemical processing of food, the absorption of digestion products into the blood and lymph, and the excretion of unabsorbed and undigested dietary substances from the body. As a result of these processes, food components retain their energy and plastic (structural) value, lose their species specificity, but become accessible for assimilation by the body and integration into metabolism.

Questions and Tasks:

1. Digestion in the stomach. The quantity, composition, and properties of gastric juice.
2. Observation of the digestive action of gastric juice on muscle protein.
3. Phases of gastric juice secretion.
4. The significance of hydrochloric acid (HCl) and other components of gastric juice.
5. Neurohumoral mechanisms of gastric secretion.
6. Motor activity of the stomach. Neural and humoral factors influencing the motor and evacuatory (gastric emptying) functions of the stomach.
7. The significance and role of digestion in the duodenum. Functions of the pancreas.
8. The quantity, composition, and properties of pancreatic juice. Enzymes of pancreatic juice secreted in an active state and in the form of zymogens (proenzymes).
9. Mechanisms regulating pancreatic secretion.

LABORATORY CLASS – 29

Topic of the Class: Physiology of Metabolism. Physiology of Energy Metabolism.

Objective: To become familiar with the methodology for determining the basal metabolic rate (BMR) using tables; to learn how to calculate the basal metabolic rate using Benedict's formulas.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of metabolic and energy reactions in human tissues;
- knowledge of the mechanisms regulating metabolism and cellular homeostasis;

- skills in utilizing the obtained data on primary methods of studying the physiology of metabolism and energy in practical activities; calculating the body's energy expenditure, as well as caloric intake and the consumption of major food components throughout the day; evaluating the dietary ration for compliance with the norms of rational nutrition;
- practical skills obtained in experiments that will enable them to use methods for studying metabolism and energy when working with individuals of various typological backgrounds.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that to compensate for the body's energy expenditure, maintain body weight, and meet the needs of growth and development, it is necessary to receive proteins, lipids, carbohydrates, vitamins, mineral salts, and water from the external environment. Their quantity, properties, and ratio must correspond to the state of the organism and the conditions of its existence. This is achieved through nutrition. It is also necessary for the body to be cleared of the final breakdown products that are formed during the cleavage of various substances. This is achieved by the functioning of the excretory organs.

Plan:

1. Physiology of energy metabolism (using Reed's formula and Benedict's formulas).
2. Physiological foundations of nutrition.

Theoretical Part

In the course of metabolism, cellular structures are continuously formed, renewed, and destroyed, while various chemical compounds are synthesized and broken down. The body maintains a dynamic balance between the processes of anabolism (assimilation) – the biosynthesis of organic substances and components of cells and tissues – and catabolism (dissimilation) – the cleavage of complex molecules within cellular components. The predominance of anabolic processes ensures growth and body mass accumulation, whereas the predominance of catabolic processes leads to the partial destruction of tissue structures and weight loss. Concurrently, a transformation of energy occurs: the potential energy of chemical compounds released during their breakdown is converted into kinetic energy – primarily thermal and mechanical, and partially electrical energy.

Questions and Tasks:

1. Metabolism and energy exchange as the core function of a living organism.
2. The plastic (structural) and energetic role of nutrients.
3. The processes of assimilation and dissimilation of substances.
4. Carbohydrate metabolism: significance, main metabolic stages, and regulation of carbohydrate metabolism.
5. Lipid (fat) metabolism: significance, main metabolic stages, and regulation of lipid metabolism.
6. Protein metabolism: the role of proteins in the vital activity of the body, main metabolic stages, and regulation of protein metabolism.
7. Energy balance in the organism.

LABORATORY CLASS – 30

Topic of the Class: Physiological Foundations of Nutrition. Compiling a Dietary Ration.

Objective: To master the methods of nutritional assessment and the principles of compiling a daily dietary ration.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of nutritional science (nutritional hygiene), as well as the biological and energy value of various food products;

- skills in utilizing the obtained data and primary physiological methods to evaluate the correctness of nutrition and adjust the dietary ration;
- practical skills obtained in experiments that will enable them to use methods for studying balanced nutrition and developing dietary rations when working with individuals with different levels of energy expenditure.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the normal development of a growing organism and the execution of domestic and professional duties are possible only with a constant intake of proteins, lipids, carbohydrates, vitamins, mineral salts, and water from the external environment. Their quantity, properties, and ratio must correspond to the state of the organism and the conditions of its existence. This is achieved through a balanced diet. Proper nutrition, combined with the adherence to work and rest schedules, and an optimal level of physical activity, is the key to robust health.

Plan:

1. Compiling a dietary ration.
2. Daily requirements of an adult, children, and adolescents for proteins, fats, carbohydrates, minerals, and water.
3. Balanced nutrition.
4. Specific features of modern human nutrition.

Theoretical Part

Nutrition plays a pivotal role in maintaining the health and well-being of individuals and the population as a whole, whereas an unhealthy diet heavily contributes to the development of diseases and disability. A balanced diet helps protect the body against all forms of malnutrition, as well as non-communicable diseases (NCDs), including diabetes, cardiovascular diseases, stroke, and cancer.

Healthy eating habits are formed from an early age: for instance, breastfeeding promotes healthy growth in children and stimulates cognitive development. Dietary habits and preferences established during childhood and adolescence often persist into adulthood.

A healthy diet can take many forms, but it must adhere to four fundamental principles:

- **adequacy:** the diet satisfies but does not exceed the body's requirements for macro- and micronutrients, thereby preventing a deficiency in any of them;
- **balance:** total caloric intake corresponds to the body's energy expenditure while maintaining the proper ratio among the three primary energy sources — proteins, fats, and carbohydrates;
- **moderation:** restricted intake of nutrients, ingredients, and food products that can be detrimental to health;
- **variety (diversity):** incorporating a wide spectrum of nutrient-dense food products within each food group, as well as by combining different food groups.

The cornerstone of any balanced diet consists of a variety of natural and minimally processed food products with a low content of harmful fats, free sugars, and sodium (WHO data).

Questions and Tasks:

1. General concept of nutrition and its significance.
2. Daily requirements of an adult, children, and adolescents for proteins, fats, carbohydrates, minerals, and vitamins.
3. Caloric value of various nutrients.
4. Methods of direct and indirect calorimetry.
5. Daily metabolism and its components.
6. Basal metabolic rate (BMR): conditions for BMR determination and factors influencing its value.
7. The magnitude of active (working) metabolism during various types of labor and energy expenditures.
8. Nutritional problems of the global population.

LABORATORY CLASS – 31

Topic of the Class: The Excretory System. Studying the Urine-Forming Function of the Kidneys.

Objective: To establish the dependence of the water-excreting function of the kidneys on the osmotic characteristics of the fluid introduced into the body.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

As a result of mastering the topic, students acquire:

- knowledge of the mechanisms of urine formation;
- skills in utilizing the obtained data in the course of their professional activity.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic is due to the fact that the kidneys participate in the regulation of blood and extracellular fluid volume (volumoregulation); regulation of the concentration of osmotically active substances in the blood and other fluids; regulation of ionic composition; pH stability; regulation of arterial blood pressure; and involvement in metabolism.

Plan:

- The effect of water and hypertonic loading on diuresis.
- The effect of antidiuretic hormone (vasopressin) on water diuresis.

Theoretical Part

In the process of excretion, substances that can no longer be utilized are eliminated from the body — foreign and toxic substances, as well as an excess of water, salts, and organic compounds that have entered with food or formed as a result of metabolism. The kidneys execute homeostatic functions within the body of humans and higher animals.

Questions and Tasks:

1. The nephron as the structural and functional unit of the kidney.
2. The primary processes of urine formation.
3. The composition of primary and secondary urine (glomerular filtrate and final urine).
4. The role of vasopressin/ADH in the regulation of kidney function.
5. The role of aldosterone in the regulation of kidney function.
6. The endocrine (hormonal) function of the kidneys.
7. The concept of renal failure.

LABORATORY CLASS - 32

Topic of the Class: General Patterns of Adaptation to Environmental Factors.

Objective: To become familiar with the methodologies for determining short-term memory capacity, as well as the ability to develop and alter (remodel) a dynamic stereotype.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

- As a result of mastering the topic, students deepen their knowledge of memory and its types, and the role of motivation in achieving a beneficial result;
- Skills are developed to evaluate human work capacity when performing professional duties that require attention (using the model of a specific type of mental labor — proofreading activity), as well as the ability to develop and alter a dynamic stereotype using the "Psychophysicologist" computerized device;
- Practical skills obtained in experiments will enable them to study the physiological functions of the body and its capacity for adaptation.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about conducting experiments involving volunteers, the results of which reveal short-term memory capacity; the student determines the significance of motivation in information assimilation and the ability to develop and alter a dynamic stereotype.

Plan:

- Determination of the adaptive capabilities of the visual analyzer.
- Determination of the functional capabilities and adaptive capacity of the central nervous system using the method of computerized chronoreflexometry.

Theoretical Part

Adaptation is a combination of reactions and mechanisms that ensure the vital activity of the body in various environmental conditions. The status of adaptive mechanisms is one of the key criteria for human health. Adaptive reactions ensure homeostasis, work capacity, the maximum possible lifespan under specific conditions, and reproductive function. These adaptive responses occur under the influence of various social and environmental factors.

The capacity for adaptation is a crucial problem in physiology and medicine. The body's adaptive mechanisms expand the boundaries of extreme conditions for human vital activity (C. Bernard). Adaptive reactions are implemented at the cellular, organ, systemic, and organismal levels. An analysis of various classifications allows for the integration of all adaptive mechanisms into two groups based on two core criteria:

- **firstly**, depending on the time of their formation in ontogenesis — these are innate and acquired adaptive mechanisms;
 - **secondly**, based on the speed of onset and the duration of action.
- Both groups incorporate several specific subgroups.

Questions and Tasks:

1. The concept of adaptation, dysadaptation (maladaptation), and deadaptation.
2. Stages and mechanisms of adaptation.
3. H. Selye's doctrine of the general adaptation syndrome (GAS).
4. Classification of adaptation mechanisms by the speed of their onset and duration of action.
5. Stressors and the stages of the body's resistance.
6. Mechanisms underlying the development of resistance and maladaptation.
7. Supercompensation.
8. Methods for the prevention and correction of dysadaptive disorders.

LABORATORY CLASS - 33-34

Topic of the Class: Statistical Data Processing of Physiological Experiments.

Objective: Mastering the methods of statistical data processing for physiological experiments.

Knowledge and Skills Acquired by Students as a Result of Mastering the Topic (Seminar):

- As a result of mastering the topic, students deepen their knowledge of methods for the statistical processing of experimental results;
- They develop skills in analyzing the outcomes of experimental activities;
- They learn how to graphically represent the results of statistical processing;
- Practical skills obtained in experiments will enable them to study the physiological functions of the body and mechanisms of adaptation to environmental factors.

Competences or Parts Thereof Being Developed: GPC-5.

Relevance of the Topic (Seminar) is due to the fact that the student acquires knowledge about methods for analyzing and processing the results of scientific research; skills in the graphical construction of statistical processing results are developed.

Plan:

1. Methods of statistical data processing for physiological experiments.
2. The concept of a variation series (ordered data set).
3. Conducting statistical processing of student heart rate research results using Student's t-test.

Theoretical Part

Statistical processing of results has two primary objectives:

- to present the results of multiple measurements in a compact form;
- to evaluate the reliability of the obtained results, i.e., the degree of their compliance with the true value of the measured quantity.

To solve these tasks, it is necessary to preliminarily evaluate the significance and reproducibility of the obtained results. The significance of the results is evaluated when, in a series of parallel determinations, one of the results appears questionable because it differs quite significantly from all other results.

Questions and Tasks:

1. Methods of statistical data processing for physiological experiments.
2. The concept of a variation series (ordered data set).
3. The concept of the arithmetic mean, the value of standard deviation, and sigma.

Educational, Methodological, and Informational Support for the Discipline

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

8.1.1. List of Main Literature:

1. Dorokhov Ye., Karpova A., Semiletova V. Normal physiology. Textbook. - Moscow: GEOTAR-MEDIA, 2021. – 512 p.
2. Normal physiology. Textbook. Editor K.V. Sudakov. - Moscow: GEOTAR-MEDIA, 2022. – 728 p.
3. Selected Normal Physiology: учебное пособие на русском и английском языках / М. М. Лапкин, Е. А. Трутнева. – Moscow: GEOTAR-Media, 2021. - 544 p.

8.1.2. List of Additional Literature:

1. Normal physiology: textbook / В.В. Зинчук, О.А. Балбатун, С.Д. Орехов; под ред. В.В. Зинчука. - Minsk: Higher School, 2020. - 496 p.

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

1. Butova O.A. et al., Laboratory workshop on the discipline "Human Physiology ". Stavropol: NCFU, 2007. 262 p.
2. Lisova I.M. Educational and methodical manual: Methodological guidelines for the performance of laboratory work in the discipline "Human Physiology". Stavropol: NCFU, 2018. 25 p.
3. Belyaev N.G. Methodological guidelines on the discipline "Normal physiology" 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 (Module)**

1. <http://rudocor.net/> / - Medical Portal
2. <http://www.e-reading.club/> / - Large Online Library
3. <http://www.pubmed.com/> / - database of full-text articles on medicine
4. <http://www.spravocnikpolekarstvam.ru/> / - free online reference guide
5. <https://dic.academic.ru/> / - Dictionaries and encyclopedias
6. <https://www.rmj.ru/> / - Russian Medical Journal
7. <https://www.studentlibrary.ru/> / - EBS "Student Consultant"