BOGOMOLETS NATIONAL MEDICAL UNIVERSITY
Educational and scientific Institute of medicine
Department of Physiology

APPROVED
Vice-Rector of the Higher Education Institution Bogomolets National Medical University for Scientific, Pedagogical, and Academic Affairs,
Doctor of Medical Sciences, Professor
Oleh VLASENKO

WORKING PROGRAM OF THE EDUCATIONAL DISCIPLINE
AGE PHYSIOLOGY

Educational level	second (master's)
Discipline	And "Healthcare and Social Security"
Specialty	12 "Medicine"
Educational program	Educational and professional program "Medicine" of the second (master's) level of higher education in specialty 12 "Medicine"

2026 - 20 ic year

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Working program of the academic discipline EC 2.2 "Age Physiology" for students in the direction of training specialists of the second (master's) level, specialty "I2 Medicine" of full-time study.

Program developers: Acting Head of the Department, Candidate of Medical Sciences, Associate Professor Vynohradova -Anyk O.O., Associate Professor, Candidate of Medical Sciences Karvatsky I.M., assistant, candidate of medical sciences Rusalov V.L.

The work program was discussed and approved at a meeting of the Department of Physiology
Minutes No. 147/26 of "26" August 2026

The work program was approved at a meeting of the Cyclic Methodological Commission for Natural Sciences
Protocol No. 1 of "26" August 2026

Acting Head of the Department of Physiology,
Candidate of Biological Sciences ,
Associate Professor O.O. Vynohradova-Anyk

Head of the Cyclic Methodological Commission
in Natural Sciences, Candidate of Biological Sciences ,
Associate Professor L.V. Yanitska

Guarantor of the educational (educational and professional) program
Doctor of Medicine , Professor, V.S. Melnyk

Head of the Department of Educational and Methodological Work,
licensing and accreditation, PhD , Associate Professor I.I. Kucherenko

1. Description of the academic discipline EC 2.2 "Age Physiology"

<table>
<tr><td rowspan="2">Name of indicators</td><td rowspan="2">Field of knowledge, specialty, educational level</td><td colspan="2">Characteristics of the academic discipline</td></tr>
<tr><td>full-time education</td><td>correspondence form of study</td></tr>
<tr><td>Number of credits – 3.0</td><td>Discipline
I Health care and social software</td><td colspan="2">By choice</td></tr>
<tr><td>Modules – 1</td><td rowspan="4">Specialty
I2 Medicine</td><td colspan="2">Year of preparation</td></tr>
<tr><td>Content modules – 3</td><td>2nd</td><td>-</td></tr>
<tr><td>Individual research task</td><td colspan="2">Semester</td></tr>
<tr><td>Total number of hours – 90</td><td>IV-th</td><td></td></tr>
<tr><td rowspan="11">Weekly hours for full-time study:
classrooms – 26
student's independent work – 64</td><td rowspan="11">Educational level
second
(master's)</td><td colspan="2">Lectures</td></tr>
<tr><td>6 hours.</td><td>-</td></tr>
<tr><td colspan="2">Practical, seminar</td></tr>
<tr><td>20 hours.</td><td>-</td></tr>
<tr><td colspan="2">Laboratory</td></tr>
<tr><td>-</td><td>-</td></tr>
<tr><td colspan="2">Independent work</td></tr>
<tr><td>64 hours</td><td>-</td></tr>
<tr><td colspan="2">Individual tasks:</td></tr>
<tr><td colspan="2">-</td></tr>
<tr><td colspan="2">Type of control:</td></tr>
<tr><td>differential balance</td><td>-</td></tr>
</table>

2. Purpose, expected learning outcomes and criteria for assessing learning outcomes

The purpose of teaching the academic discipline "Age Physiology" is to study the functions of various cells, tissues, organs and systems as a whole in order to use the knowledge gained in the study of subsequent medical disciplines and in future professional activities. It lays the foundation for understanding the concept of health, a healthy lifestyle and prevention of dysfunction in the process of life.

The expected results of studying the discipline "Age Physiology" in accordance with the requirements of the educational and professional program for students' knowledge and skills are as follows:

know:

● age-related features of body functions and their regulation

● regulated parameters and draw conclusions about the mechanisms of nervous and humoral regulation of physiological functions of the body and its systems

● mechanisms and patterns of functioning of the body's excitable structures

● physiological foundations of methods for studying body functions

be able:

● explain the mechanisms of integrative activity of the organism

● draw conclusions about the state of the physiological functions of the body, its systems and organs

● interpret the mechanisms and patterns of functioning of the body's excitable structures

● analyze the state of sensory processes in ensuring human life

● explain the physiological foundations of methods for studying body functions

List of competencies and learning outcomes that age-related physiology contributes to

Integral competence

Ability to solve complex problems, including those of a research and innovation nature in the field of medicine. Ability to continue learning with a high degree of autonomy.

General competencies (GC):

GC 1. GC1. Ability for abstract thinking, analysis and synthesis.

GC 2. Ability to learn and master modern knowledge.

GC 3. Ability to apply knowledge in practical situations.

GC 4. Knowledge and understanding of the subject area and understanding of professional activity.

GC 5. Ability to adapt and act in a new situation.

GC 6. Ability to make informed decisions.

GC 7. Ability to work in a team.

GC 8. Ability for interpersonal interaction.

GC 9. Ability to communicate in a foreign language.

GC 10. Ability to use information and communication technologies.

GC 11. Ability to search, process and analyze information from various sources.

GC 12. Determination and persistence in achieving goals

GC 13. Awareness of equal opportunities and gender issues.

GC 14. The ability to exercise one's rights and obligations as a member of society, to realize the values of a civil (free democratic) society and the need for its sustainable development, the rule of law, and the rights and freedoms of man and citizen in Ukraine.

GC 15. The ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of

society, technology and engineering, to use various types and forms of physical activity for active recreation and leading a healthy lifestyle.

Special (professional, subject) competencies (PC):

PC 21. Clearly and unambiguously communicate one's own knowledge, conclusions, and arguments on health care problems and related issues to specialists and non-specialists, including students .

PC 23. Ability to develop and implement scientific and applied projects in the field of healthcare.

PC 24. Compliance with ethical principles when working with patients and laboratory animals.

PC 25. Adherence to professional and academic integrity, responsibility for the reliability of the obtained scientific results.

Program Learning Outcomes (PLO):

PLO 1. Have a thorough knowledge of the structure of professional activity. Be able to to carry out professional activities that require updating and integration knowledge. Be responsible for professional development, ability to further professional training with a high level of autonomy.

PLO 2. Understanding and knowledge of basic and clinical biomedical sciences, including level sufficient to solve professional tasks in the field of security health.

PLO 3. Specialized conceptual knowledge that includes scientific achievements in the field of health care and is the basis for conducting research, critical understanding of problems in the field of medicine and related interdisciplinary problems, including the system of early intervention.

PLO 4. Highlight and identify the leading clinical symptoms and syndromes (list 1);

According to standard methods, using preliminary data from the patient's history, patient examination data, knowledge about the person, his organs and systems, establish a preliminary clinical diagnosis of the disease (according to list 2).

PLO 5. Collect complaints, life and disease history, assess the patient's psychomotor and physical development, the condition of organs and body systems, and based on the results of laboratory and instrumental studies, evaluate information regarding the diagnosis (according to list 4), taking into account the patient's age.

PLO 6. Establish a final clinical diagnosis by making a reasoned decision and analyzing the obtained subjective and objective data of clinical, additional examination, conducting differential diagnostics, adhering to relevant ethical and legal norms, under the supervision of the head physician in a healthcare facility (according to list 2).

PLO 8. Determine the main clinical syndrome or what determines the severity of the victim's condition (according to list 3) by making a reasoned decision and assessing the person's condition under any circumstances (in a healthcare facility, outside it), including in emergency

situations and combat operations, in field conditions, in conditions of lack of information and limited time.
PLO 9. Determine the nature and principles of treatment of patients (conservative, surgical) with diseases (according to list 2), taking into account the patient's age, in the conditions of a healthcare institution, outside it and at the stages of medical evacuation, including in field conditions, based on a preliminary clinical diagnosis, adhering to relevant ethical and legal norms, by making a reasoned decision according to existing algorithms and standard schemes, if necessary, expand the standard scheme, be able to substantiate personalized recommendations under the supervision of the head physician in the conditions of a medical institution.
PLO 13 Assess and monitor child development, provide recommendations
on feeding and nutritional characteristics depending on age, organize preventive vaccinations according to the calendar.

2.3. Competency matrix :

	GC	PC		PLO	PLO	PLO
EC 2.2.	1-15	2 1	23-25	1-6	8.9	13

Criteria for evaluating learning outcomes.

The assessment of students' academic performance is regulated by the Regulations on the "Procedure for assessing students' knowledge during current and final discipline control at the O.O. Bogomolets National Medical University" (minutes of the meeting of the Academic Council of the O.O. Bogomolets National Medical University No. 4 dated 11/28/2023).
The Department of Physiology has approved criteria for assessing student learning outcomes, a detailed description of which is provided below.

3. Structure of the academic discipline "Age Physiology"

The study of the academic discipline "Age Physiology" takes 90 hours (3 ECTS credits), of which 26 hours are classroom hours: 6 hours of lectures and 20 hours of practical classes; 64 hours of independent work by students.

The discipline program is structured into 1 module , which includes 3 content modules:

Module 1. “ Age-related physiology ”.

Content modules:

1. Age-related features of the physiology of excitable tissues .

2. Age-related features of the physiology of visceral systems.

3. Age-related features of the physiology of higher integrative functions.

The volume of students' academic workload is described in ECTS credits, which are credited to students upon successful completion of the corresponding module (credit).

The credit transfer system of organizing the educational process requires students to conscientiously and systematically study the discipline throughout the academic year.

The types of students' educational activities according to the curriculum are: a) lectures, b) practical classes, c) independent work of students (IW). Thematic plans of lectures, practical classes, IW ensure the implementation in the educational process of all topics that are part of the content modules.

The topics of the lecture course reveal problematic issues of the relevant sections of physiology.

Practical classes include:

1) research by students of functions in experiments on animals, isolated organs, cells, models or based on experiments recorded in videos, films, presented in computer programs and other educational technologies;

2) solving situational problems (assessment and analysis of function indicators, homeostasis parameters, regulatory mechanisms, etc.) that have an experimental or clinical-physiological focus.

Duration of practical session – 2 academic hours (2 * 45)

The student's educational activity is assessed at each stage of the practical session, and the overall assessment is comprehensive.

During practical classes, students briefly write down protocols of the research they conducted, indicating the topic of the class, the purpose of the research, the progress of the work or the name of the method, the results and conclusions of the research, answers to situational tasks, etc.

Students' current learning activities are monitored in practical classes in accordance with specific goals.

The following means of diagnosing the level of students' training are used: computer tests, solving situational problems, conducting laboratory tests and interpreting and evaluating their results, analyzing and evaluating the results of instrumental studies and parameters that characterize the functions of the human body, its systems and organs; controlling practical skills, and others.

Upon completion of the study of one or more content sections, ***an intermediate control is carried out*** (*control lesson, practical skills*) to identify the level of students' assimilation of the material covered by test control methods, solving situational problems, writing ***test papers*** , etc.

An important form of student learning is ***independent work*** **.** Students perform independent work during preparation for classes, and also work on topics that are not included in the thematic plan of practical classes. Consultations of teachers play a significant role in the organization of VTS. VTS is controlled by the teacher during practical classes and during intermediate and final control.

Upon completion of each module, ***a final test (differential test) is carried out.***

The assessment of a student's performance in the discipline is rating and is given on a multi-point scale **and is defined according to the ECTS system and the traditional scale adopted in Ukraine.**

Description of the curriculum for the discipline "Age Physiology"
for students of the Faculty of Medicine, specialty 22 2 "Medicine"

Structure of the academic discipline	Number of hours, of which				Year of study	Type of control
	Total	Auditorium		CRC		
		Lectures	Practical classes			
	90	**6**	**20**	**64**	**2nd**	**differential balance**
ECTS credits	**3.0**					
"Age physiology": ***Content modules 3***	**90 hours / 3.0 ECTS** credits	**6**	**20**	**64**		
Weekly workload	*4.7 hours / 0.16 ECTS credits*					

Note : 1 ECTS credit – 30 hours.

The ratio of the number of hours of classroom lessons to independent and individual work for full-time study is: classroom load – 33%, SRS – 67%

Module 1. "Age Physiology"

Content module 1. Age-related physiology of excitable tissues

Specific objectives:

- *Explain the mechanisms of transport of substances through cell membranes and the role of these processes in ensuring physiological functions*
- *To analyze the clinical aspects of changes in the transport function of cell membranes and their regulatory mechanisms.*
- *Explain the mechanisms of development and propagation of membrane potentials and the role of these processes in ensuring physiological functions;*
- *To analyze the clinical aspects of changes in the parameters of membrane potentials, the speed of their conduction in ensuring the physiological functions of nerve and muscle fibers.*

- *Explain the mechanisms of contraction and relaxation of skeletal, cardiac, and smooth muscle fibers and the role of regulatory mechanisms in ensuring them;*
- *Analyze the clinical aspects of changes in the strength and speed of muscle fiber contraction and the mechanisms of their regulation.*
- *Analyze the state of the functions of the sensory system, its structural elements and auxiliary structures based on criteria differentiated for each sensory system*
- *Analyze age-related features of the formation and functions of sensory systems and clinical aspects of their changes*
- *Describe the mechanisms of reflex regulation of functions and the role of the links of the reflex arc as components of the biological regulation circuit in ensuring the adaptive response of the organism*
- *Analyze the principles of reflex coordination with the participation of the corresponding neural circuits in ensuring the adaptive response of the body*
- *Analyze the role of different levels of the central nervous system in ensuring the systemic activity of the body*
- *Analyze age-related features of nervous regulation of functions*
- *Draw conclusions about the state of the physiological functions of the body, its systems and organs when the concentration of hormones in the body changes*
- *Analyze age-related features of body functions related to the activity of endocrine glands*
- *Analyze the clinical aspects of changes in the nervous and humoral regulation of the functions of the child's body*

Topic 1. Subject and tasks of age physiology. Periods of ontogenetic development of the organism. Age-related features of the physiology of excitable tissues.

Age physiology as a science. History and main stages of development of age physiology. Methods of studying age physiology.

Periods of ontogenetic development of the organism, their characteristics. The concept of growth and development of the organism. Biological age of the organism. Principles of systemogenesis and advanced development of organs and functional systems in children and adolescents.

Modern understanding of the structure and function of cell membranes.

Membrane proteins: receptor proteins, ion channel proteins, transport proteins, pump proteins. Transport of lyophilic (fat-soluble) and hydrophilic (water-soluble) substances through membranes. Dependence of the solubility of substances in lipids on the pH of the medium. Features of the solubility of medicinal substances in lipids and its use in therapy.

Passive transport of substances through ion channels, their permeability, selectivity, channel gates as mechanisms for regulating their permeability. Types of passive transport, factors that determine them.

Transport of ions through membranes. Ion channels of membranes, their types, functions. Ion pumps of membranes, their functions. Ion gradients of the cell – ionic asymmetry. Receptors of membranes, their functions.

Active transport of substances, its types.

Primary active transport of substances, its energy supply.

The role of sodium-potassium pumps in the transport of sodium and potassium ions, in the regulation of intracellular water volume. The electrogenic nature of the sodium-potassium pump. The role of calcium pumps in the transport of calcium ions through cell membranes, the sarcoplasmic reticulum, and mitochondria.

Secondary active transport and its connection with primary active transport to create a concentration gradient of substances on both sides of the cell membrane. Types of secondary active transport of substances: a) cotransport (symtransport); b) countertransport (countertransport or antiport).

Exocytosis , its role in the transport of substances synthesized in the cell. Exocytosis neurotransmitters across the presynaptic membrane in synapses. Endocytosis , types of endocytosis , its role in transporting substances into the cell.

Irritability, excitability as the basis of tissue response to irritation. Excitation.

Resting membrane potential (RMP), mechanisms of origin, recording methods, RM parameters. Physiological role of RM.

Action potential (AP), mechanisms of origin, recording methods, AP phases, AP parameters. Physiological role of AP.

Changes in cell excitability during the development of PD. Periods of absolute and relative refractoriness , mechanisms of their origin, physiological significance.

Changes in membrane potential under the action of electric current as a stimulus. Local response. Critical depolarization level. Depolarization threshold as a measure of excitability.

The effect of direct current on excitable tissues, its use in clinical practice.

Physiological properties of nerve fibers. Mechanisms of nerve impulse conduction by myelinated and unmyelinated nerve fibers. Patterns of excitation conduction. Speed of excitation conduction, factors on which it depends. Characteristics of nerve fibers of type A, B, C.

Neuromuscular synapse, its structure, functions. Mechanisms of chemical transmission of excitation through the neuromuscular synapse. End plate potential (EPP). Physiological mechanisms of blockade of neuromuscular transmission.

Muscle physiology. Mechanisms of contraction and relaxation of skeletal muscles. Mechanisms of combining excitation and contraction in muscle fibers.

Functions and properties of skeletal muscles. Types of muscle fibers. Types of muscle contraction depending on the frequency of stimulation: single, tetanic. Types of muscle contraction depending on the change in their length and tension: isometric, isotonic. The relationship between the length of a muscle fiber and its tension. The relationship between the speed of muscle contraction and their load. Properties of muscles in the body. Motor units. Electromyography. Muscle strength and work. Dynamometry. Energetics of muscle contraction.

Membrane potentials of smooth muscles.

Types of smooth muscles. Processes of coupling excitation and contraction. Contractile proteins. Molecular basis of muscle contraction and relaxation. Features of contraction and relaxation of smooth muscles. Myogenic regulation of the force of contraction of smooth muscles. The role of calcium ions and calmodulin in the regulation of the force of contraction, sources of calcium ions. Regulation of the force of contraction of visceral muscles of hollow organs, digestive canal. Morpho -functional features of muscles in antenatal ontogenesis. Morpho -functional features of muscles in postnatal ontogenesis.

Features of the physiology of excitable tissues in children. Morpho -functional characteristics of nerve fibers in ontogenesis. Morpho -functional features of myoneural synapses in ontogenesis.

Clinical aspects of changes in the transport function of cell membranes and their regulatory mechanisms. Clinical aspects of changes in the parameters of membrane potentials, the speed of their conduction in ensuring the physiological functions of nerve and muscle fibers. Mechanisms of contraction and relaxation of skeletal, cardiac and smooth muscle fibers and the role of regulatory mechanisms in their provision. Clinical aspects of changes in the force and speed of contraction of muscle fibers and the mechanisms of their regulation.

Topic 2. Age-related features of the endocrine system

The state of physiological functions of the body, its systems and organs when the concentration of hormones in the human body changes. Production and transport of hormones in the fetus.

Thyroid changes during pregnancy and the influence of maternal TG on fetal development. Development, age-related features of the parathyroid glands.

Embryological development of the pancreas. Age-related features of the pancreas.

Adrenal gland development.

Age-related features of body functions related to the activity of endocrine glands, clinical aspects of their disorders.

Clinical aspects of changes in humoral regulation of the functions of the child's body.

Content module 2. Age-related physiology of visceral systems

Specific objectives:

- *Analyze age-related changes in blood composition, functions and regulatory mechanisms, and clinical aspects of their changes*
- *Analyze age-related changes in blood circulation parameters and draw conclusions about the physiological properties of the heart as a pump, the functions of blood vessels, the mechanisms of blood circulation regulation, and the clinical aspects of their changes*
- *Explain the age-related features of the respiratory process, their regulation, and the clinical aspects of their changes*
- *Analyze age-related features of the functions of the digestive system, their regulation and clinical aspects of their changes*
- *Analyze age-related changes in the body's energy expenditure and their regulation, clinical aspects of their changes*
- *Explain the age-related features of thermoregulation in a child and its regulation, clinical aspects of their changes*
- *To analyze the age-related features of the functions of the excretory system and the mechanisms of their regulation, the clinical aspects of their changes*

Topic 3. Age-related features of the blood system

Blood functions, physicochemical properties. Composition of fetal blood.

Physiology of erythrocytes, age-related features. Protective functions of blood. Types and physiological mechanisms of hemostasis in case of damage to the vessel wall. Physiology of platelets. Physiology of leukocytes. Immunity. Blood groups. Genetics of blood groups. Blood aggregation regulation system (RAS).

Age-related changes in blood composition, functions and regulatory mechanisms and clinical aspects of their changes.

Topic 4. Age-related features of the cardiovascular system

General characteristics of the circulatory system, its role in the body. Physiological properties of the heart as a pump, its role in hemodynamics, physiological foundations of research methods. Physiological foundations of electrocardiography. Regulation of cardiac activity: myogenic , nervous, humoral.

Systemic blood circulation, laws of hemodynamics, the role of vessels in blood circulation.

Microcirculation. Morpho -functional characteristics of the vessels of the microcirculatory bed. Blood movement in capillaries, its features. Blood pressure in capillaries. Mechanisms of exchange of fluid and other substances between blood and tissues.

Physiological features of regional blood circulation: pulmonary, coronary, cerebral, abdominal.

Fetal blood circulation. Features of fetal heart functioning. Regulation of fetal blood circulation._Changes in blood circulation after birth, features of blood circulation in a newborn child. Regulation of blood circulation in a newborn child. Features of the ECG of the fetus and people of different ages. Features of the FCG of healthy children and adults.

Lymph, its composition, quantity, functions. Mechanisms of formation and movement of lymph through lymphatic vessels.

Age-related changes in blood circulation parameters, blood vessel functions, mechanisms of blood circulation regulation and clinical aspects of their changes.

Topic 5. Age-related features of the respiratory system

Structure and functions of the respiratory system. The importance of breathing for the body. The main stages of the respiratory process.

Mechanisms of gas exchange between inhaled air and the alveolar gas mixture, between the alveoli and blood in the pulmonary capillaries. Relationship between pulmonary circulation and lung ventilation. Transport of gases by the blood.

Development of the external respiratory apparatus in the prenatal period. Postnatal development of the external respiratory apparatus. Stages of development of the respiratory function of the lungs, pulmonary gas exchange, features of respiratory regulation.

Regulation of breathing. Protective respiratory reflexes. Breathing during physical work, at increased and decreased barometric pressure. Regulation of the first breath of a newborn child. Features of adaptation to hypoxia in children of different ages.

Age-related features of the respiratory process, their regulation and clinical aspects of their changes.

Topic 6. Age-related features of the digestive system

Digestion: its types (cavity, membrane, intracellular), main stages. Basic principles and mechanisms of digestion regulation. Gastrointestinal hormones. Phases of secretion of the main digestive glands. Periodic activity of the digestive organs.

The role of the liver in digestion. Formation of bile, its composition and properties. Research methods. Anatomical and physiological features of the liver in children.

Age-related features of the functions of the digestive system, their regulation and clinical aspects of their changes.

Topic 7. Age-related features of energy metabolism and thermoregulation

Forms and sources of energy in the body. Age-related dynamics of basal metabolism. Age-related changes in the body's energy expenditure and their regulation, clinical aspects of their changes.

Thermoregulation. Development of thermogenesis mechanisms . Features of heat loss processes in children. Thermoregulatory processes in the postpubertal period. Features of thermoregulation in premature children.

Age-related features of thermoregulation and its regulation, clinical aspects, their changes.

Adaptation to periodic changes in environmental temperature. Hardening.

Topic 8. Age-related features of the urinary system

Excretory system, its structure, functions. General characteristics of the excretory system. The role of the kidneys in the processes of excretion, mechanisms of urine formation.

The main processes of urine formation: filtration, reabsorption, secretion. Mechanisms of filtration, composition of primary urine. Regulation of filtration rate. Reabsorption in the tubules, its mechanisms.

Regulation of urine formation. Urination and its regulation.

The role of the kidneys in maintaining homeostasis.

Embryonic development of the excretory system. Development of the kidney in the postnatal period.

Age-related changes in urine formation and urination, mechanisms of their regulation, clinical aspects of their changes.

Content module 3. Age-related physiology of higher integrative functions

Specific objectives:

- *To analyze the age-related features of higher nervous activity (behavioral reactions) of the human body and the clinical features of their changes.*
- *Interpret indicators of a person's muscular and mental performance, analyze the factors on which their value depends*
- *Explain the localization and mechanisms of human fatigue development during work*
- *Explain the physiological foundations of methods for studying the state of human physical performance (endurance, strength, speed).*
- *Analyze age-related features of the formation and functions of the visual and auditory sensory systems*
- *Explain the physiological foundations of methods for studying the visual and auditory sensory systems.*

Topic 9. Age-related features of the physiology of the CNS, visual and auditory sensory systems.

Morpho -functional features of CNS development in the antenatal period. Morpho - functional features of CNS development in the postnatal period.

Mechanisms of reflex regulation of functions and the role of the links of the reflex arc as components of the biological regulation circuit in ensuring the adaptive response of the organism. Age-related features of unconditioned reflexes.

Principles of reflex coordination with the participation of relevant neural circuits in ensuring the adaptive response of the organism. Development of the motor sphere of children. The influence of nutrition on the development and functioning of the CNS.

The role of different levels of the central nervous system in ensuring the systemic activity of the body.

Age-related features of nervous regulation of functions and clinical aspects of their changes.

The state of the functions of the sensory system, its structural elements and auxiliary structures.

Age-related features of the formation of the functions of the visual and auditory sensory systems and clinical aspects of their changes.

Topic 10. Age-related characteristics of higher integrative functions and labor activity.

Neurophysiological foundations of behavior. Internal needs of the organism. Biological motivation. Motivational arousal. Innate (unconditioned-reflex) forms of behavior. Instincts, their significance for the adaptive activity of the organism.

Types of higher nervous activity, their classification, physiological foundations, research methods. First and second signaling systems. Language. Functions of language. Modern mechanisms of language formation. Functional asymmetry of the cerebral cortex, the concept of the dominant hemisphere, functions of the non-dominant hemisphere, interaction of the hemispheres. Thinking, consciousness and self-awareness.

Physiology of sleep, its types and phases, electrical activity of the brain. Modern mechanisms of sleep development, its biological role and disorders. Biological rhythms, their physiological role.

Age-related aspects of higher nervous activity in a child.

Labor activity. Physiological foundations of labor. Features of physical and mental labor. Strength, endurance, working capacity. Muscular working capacity, its periods. Indicators of human working capacity and their energy supply, factors on which their quantitative value depends, and methods of its measurement.

Range and level of functional activity.

Neuroendocrine regulation of functions in the process of activity.

Features of the functional range in children. Mental activity and educational load. Indicators of muscular and mental performance of a child, factors on which their value depends.

Human fatigue during labor activity. Factors that determine the rate of fatigue development during muscular work. Mechanisms of fatigue and recovery: general patterns of fatigue development and recovery (G.V. Folbort's rules); the concept of active recreation and its mechanisms (I.M. Sechenov). The significance of these patterns for applied physiology, occupational hygiene and clinical medicine. Methods for assessing fatigue and recovery during muscular work. Features of fatigue in children. Localization and mechanisms of fatigue development in a child during labor activity. Mental performance and its periods. Modern mechanisms of mental fatigue. The relationship between physical and mental work.

Age-related features of working capacity. Physiological foundations of methods for studying the state of a person's physical working capacity (endurance, strength, speed).

Names of content modules and topics	Number of hours					
	day uniform					
	total	including				
		l	n	seven	ind	s.r.
1	2	3	4	5	6	7
Module 1. “Age Physiology”						
Content module 1. Age-related physiology of excitable tissues						
Topic 1. Subject and tasks of age physiology. Periods of ontogenetic development of the organism. Age-related features of the physiology of excitable tissues.	7	1	2	-	-	4
Topic 2. Age-related features of the endocrine system	7	1	2	-	-	4
Together by content module 1	17	2	4	-	-	8
Content module 2. Age-related physiology of visceral systems						
Topic 3. Age-related features of the blood system	7	1	2	-	-	4
Topic 4. Age-related features of the cardiovascular system	7	1	2	-	-	4
Topic 5. Age-related features of the respiratory system	8	-	2	-	-	4
Topic 6. Age-related features of the digestive system	8	2	2	-	-	4
Topic 7. Age-related features of energy metabolism and thermoregulation	9	-	2	-	-	4

Topic 8. Age-related features of the urinary system	7	-	2	-	-	5
Together by content module 2	48	4	12	-	-	25
Content module 3. Age-related physiology of higher integrative functions						
Topic 9. Age-related features of the physiology of the CNS, visual and auditory sensory systems.	11	-	2	-	-	8
Topic 10. Age-related characteristics of higher integrative functions and labor activity.	11	-	2	-	-	8
Together by content module 3	25	0	4	-	-	16
Total hours	90	6	20	-	-	56
TOGETHER	90	6	20	-	-	56

4. Lecture topics

No.	Topic name	Number of hours
Module 1. Age-related physiology		
1.	Age-related features of the physiology of excitable tissues and the endocrine system	2
2.	Age-related features of the blood and circulatory system	2
3.	Age-related features of the digestive system	2
	Total hours	***6***
	TOGETHER	***6***

5. Seminar topics

Seminar classes are not included in the curriculum.

6. Topics of practical classes

No.	Topic name	Number of hours
Module 1. Age-related physiology		
1.	Subject and tasks of age physiology. Periods of ontogenetic development of the organism. Age-related features of the physiology of excitable tissues.	2
2.	Age-related features of the endocrine system	2
3.	Age- related features of the blood system	2
4.	Age-related features of the cardiovascular system	2
5.	Age-related features of the respiratory system	2
6.	Age-related features of the digestive system	2
7.	Age-related features of energy metabolism and thermoregulation	2
8.	Age-related features of the urinary system	2

9.	Age-related features of the physiology of the CNS, visual and auditory sensory systems.	2
10.	Age-related characteristics of higher integrative functions and labor activity.	2
	Total hours	***20***
	TOGETHER	***20***

7. Topics of laboratory classes

According to the curriculum, laboratory classes are not provided.

8. Independent work (IW)

No.	Topic name	Number of hours	Type of control
Module 1. Age-related physiology			
1.	**Preparation for practical classes –** *theoretical training and development of practical skills*	64	Current control in practical classes
	Total hours	***64***	
	TOGETHER	***64***	

9. Individual tasks

Individual independent work is performed by students at their request to receive additional points and is assessed during the ongoing control process at relevant (to the topic of the work) practical classes and during the final control (exam). The maximum number of points assigned to students as "credited" for individual work is 10 points. Points for individual work can be received by students who wrote and presented essays (reports using multimedia technology) on recommended topics using additional educational and scientific literature or took prizes in the discipline Olympiad among students of their university and higher educational institutions of Ukraine.

Tasks for individual work

No.	Topic name
1.	Literature analysis and discussion on the topic: “Age-related characteristics of the vestibular sensory system ”
2.	Literature analysis and discussion on the topic: “Age-related features of energy metabolism and thermoregulation in children”
3.	Literature analysis and discussion on the topic: “Physiological features of sexual development of a child ”
4.	Literature analysis and discussion on the topic: “Age-related characteristics of the musculoskeletal system in ontogenesis.”

11.Teaching methods

I. Methods of organizing and implementing educational and cognitive activities in the study of the discipline:

- verbal: lectures with the use of presentations. The lectures reveal problematic issues of the relevant sections of physiology with the peculiarities of childhood, clinical cases. Explanation of the contours of the regulation of physiological functions.

- visual: observations, illustrations, demonstrations.

- practical classes include:

1) research by students of physiological functions in experiments on animals, isolated organs, cells, models or based on virtual research presented in computer programs and other educational technologies;

2) research into the functions of a practically healthy person;

3) solving situational problems (assessment of function indicators, homeostasis parameters, regulation mechanisms, etc.) that have practical significance in the future doctor's further professional activities.

II. Methods differ in the logic of transmitting and perceiving educational information: inductive, deductive, analytical, synthetic.

III. Methods of different levels of independent thinking: reproductive, search, research.

Independent work of students: with a book; completion of individual educational projects .

11. Methods and forms of control, distribution of points received by students, assessment of discipline

Evaluation of current learning activities

Lecture material and independent work of students are assessed during the ongoing control in the relevant practical classes and during the final control.

Indicative criteria for evaluating current educational activities

Practical classes in physiology are structured and involve a comprehensive assessment of all types of learning activities (learning tasks) that students perform during the practical class:

1) At the initial stage of practical training, a test control is carried out: the tests contain at least 10 test tasks of a selective type with one correct answer. Its results are evaluated positively if the student gave at least 60% of correct answers; the student does not receive points if the number of correct answers is less than 60%. In the overall assessment of the current educational activity, this stage is 20%.

2) At the main stage of the practical session, the following are assessed **:**

2.1) performing practical work (research), writing a research protocol in accordance with the requirements, the ability to analyze and interpret research results and correctly draw substantiated conclusions;

2.2) solving situational problems, drawing graphs, diagrams, and regulation contours.

In the overall assessment of the current educational activity, this stage is 50%. **,** if the student correctly completed the practical work (research), wrote down the research protocol in accordance with the requirements, was able to analyze and interpret the research results, draw substantiated conclusions, and also correctly solved all the proposed situational tasks and other tasks.

A student scores 40% of points if he/she correctly completed the practical work (research), wrote a research protocol in accordance with the requirements, was able to analyze and interpret the research results, draw substantiated conclusions, and solved at least half of the proposed problems.

A student scores 30% of points if he/she correctly completed the practical work (research), wrote a research protocol in accordance with the requirements, was able to analyze and interpret the research results, draw reasonable conclusions, and did not solve any of the proposed tasks.

A student does not earn points at the main stage of educational activity if he or she fails to correctly complete practical work (research), write a research protocol in accordance with the requirements, analyze and interpret the research results, and draw substantiated conclusions.

3) At the final stage of the practical session, the control of theoretical and practical training is carried out using test tasks (at least 10) or solving complex situational tasks, creating regulation contours and other tasks that allow assessing the degree of achievement of the educational goal. It is assessed positively provided that the student correctly solved at least 60% of the test tasks or solved all situational tasks and other tasks. Provided that the student correctly solved less than 60% of the test tasks or did not solve the proposed situational tasks, the student does not receive any points. In the overall assessment of the current educational activity, this stage is 30%.

Comprehensive assessment of educational activities is carried out by assigning a traditional grade (on a 4-point scale), which is converted into points on a 200-point scale (the grade is determined by the number of topics in the discipline - *see the points distribution tables*). The student receives during the practical session:

grade “5” – if he completed at least 90% of the learning tasks correctly;

grade “4” – if he completed at least 75% of the learning tasks correctly;

grade “3” – if he completed at least 60% of the learning tasks correctly;

grade “2” – if he completed less than 60% of the learning tasks correctly.

At the final stage of the lesson, the teacher gives a traditional grade on a 4-point (traditional) scale ("5", "4", "3", "2") according to the criteria for evaluating the student's current activity in the student's progress journal and notebook for practical classes, where

all tasks must be completed and research protocols recorded, and puts his signature and date.

Assessment of current learning activities is carried out at each practical lesson on the relevant topic. The student is given grades on a 4-point (traditional) scale ("5", "4", "3", "2"). Grades given on a traditional scale are converted into points.

The maximum number of points that a student can score for current academic activity when studying the discipline **is 190** points (***additionally, from*** **1** to **10** points can be obtained for individual independent work).

possible **approaches** to conversion.

Approach 1. *Conversion into points before the final control :*

The calculation of the number of points is carried out on the basis of **the positive grades** received by the student on the traditional scale during the study of the discipline, by calculating the arithmetic average (**SA**), rounded to two decimal places, divided by the maximum traditional grade, namely " **5** ", and multiplied by the maximum score for the current educational activity, namely **190.** The resulting value is converted into points on a multi-point scale as follows:

$$x = CA \times 190 / 5$$

For convenience, here is a conversion table based on a 200-point scale:

Conversion of the average grade for current activities into a multi-point scale for the discipline, which ends with a final test (differential assessment)

4-point scale	200-scoring scale	4-scoring scale	200-scoring scale	4-scoring scale	200-scoring scale	4-point scale	200-point scale
5	190	4.21	160	3.42	130	2.63	100
4.92	187	4.13	157	3.37	128	2.58	98
4.87	185	4.08	155	3.29	125	2.5	95
4.79	182	4	152	3.21	122	2.42	92
4.71	179	3.92	149	3.13	119	2.36	90
4.63	176	3.87	147	3.08	117	2.29	87
4.55	173	3.79	144	3.03	114	2.21	84
4.5	171	3.71	141	3	111	2.13	81
4.42	168	3.63	138	2.87	109	2.08	79
4.34	165	3.55	135	2.79	106	2.03	77
4.29	163	3.5	133	2.71	103	2	0

Or the sum (**C**) **of positive** grades on the traditional scale is calculated, divided by the maximum traditional grade, namely " **5** " multiplied by the number of classes in the discipline, the resulting number is multiplied by the maximum score for the current

educational activity, namely **19 0** . The resulting value is converted into points on the multi-point scale as follows:

x = C×190 / 5×N classes

Approach 2. *Conversion into points for each lesson :*

The number of points corresponding to the grade "5" is calculated by dividing the maximum number of points for the current educational activity, namely **190** , by the number of practical classes. To calculate the grade "3", the number of points is calculated, which is 60% of the maximum number of points for the current educational activity, i.e. 111 points, divided by the number of practical classes.

Form of final control of learning success (differential credit)

The final final control (differential assessment) is carried out upon completion of the study of the discipline based on the results of current training, implementation of individual and control measures . When setting a grade for the discipline, the number of points accumulated by the student for current training is taken into account **(maximum number of points 200)** . The student is credited for the discipline differentially according to the total number of points accumulated by him, which must be no less than the minimum required, and corresponds to the minimum value of the grade E, and therefore is **111 points .**

When a student is given a failing grade in a discipline, he/she is given the right to retake unsatisfactory grades no later than ***three days*** *before the final examination in order to accumulate the minimum number of points for passing the discipline.*

The department does not conduct differential credit in the form of a separate lesson.

Scheme of calculation and distribution of points received by students

“ ***Age physiology*** **”.** *Number of study hours* / ECTS credits : 90/3.0. Number of content modules: No. 1-3	Number of practical training topics	Conversion to traditional grades					Minimum number of points	Maximum number of points
		Traditional assessments				Points for completing individual tasks as a type		
		“5”	**“4”**	**“3”**	**“2”**			
For current educational activities	10	19	15.5	11.1	0	10	111	200
For mastering discipline							111	200

Discipline assessment.

The results of studying the discipline are assessed using the 200-point knowledge control system adopted at the university and the national scale, and are reflected in the relevant information.

The grade for the discipline “Age Physiology”, which is completed with a differential credit, is determined as the sum of the points accumulated by the student for

the current educational activity **(maximum number of points 200)** . At the same time, to be credited with a credit for the studied discipline, the total number of points received by the student must be no less than the minimum, which is determined by the curriculum for the discipline and corresponds to the minimum value of the grade E, and therefore is **111 points** .

Discipline scores for students who have successfully completed the program are independently converted to both the ECTS scale and the national (four-point) scale. ECTS scale scores are not converted to the 4-point scale and vice versa, since the ECTS scale and the four-point scale are independent .

Assessment of knowledge in the discipline is carried out according to the appropriate scale:

Score	National scale assessment	ECTS score	
		Rating	Explanation
170 – 200	perfectly	A	Excellent (excellent performance with only a few errors)
155 – 169	good	D	Very good (above average with a few errors)
140 – 154		C	Good (generally correct execution with a certain number of significant errors)
125 – 139	satisfactorily	D	Satisfactory (not bad, but with a significant number of shortcomings)
111 – 124		E	Sufficient (performance meets minimum criteria)
60 – 110	unsatisfactorily	FX	Unsatisfactory (with the possibility of reassembly)
0 – 59		F	Unsatisfactory (with mandatory re-study of the discipline)

If a student receives an unsatisfactory grade in a discipline within the range of 60-110 points (FX), he/she has the right to retake it 2 times: once by the departmental commission with the participation of the head of the department, and the last time by the commission with the participation of the head of the department and the dean.

If a student receives an unsatisfactory grade in a discipline within the range of 1-59 points (F), he/she is required to re-study it during extracurricular hours on a paid basis.

The objectivity of the assessment of students' academic performance is verified by statistical methods (correlation coefficient between ECTS and assessment on the national scale).

12. Course Policy

Mandatory adherence to academic integrity by students, namely:

- independent performance of all types of work, tasks, and forms of control provided for in the work program of the discipline;
- references to sources of information when using ideas, developments, statements, information;
- compliance with the norms of legislation on copyright and related rights;
- providing reliable information about the results of one's own educational (scientific, creative) activities, research methods used and sources of information.

13. Methodological support

- online course on the LIKAR_NMU distance learning platform;
- didactic materials on the discipline;
- methodological recommendations for lectures and practical classes;
- methodological recommendations for independent work of students;
- tasks for the current control of knowledge, skills and practical skills in the discipline;
- test tasks for current control;
- electronic educational content of the discipline.

14. Recommended reading

Basic

1. **McDonald R.B.** *Biology of Aging*. 2nd ed. Boca Raton: CRC Press, 2019. 400 p.
2. **Arking R.** *Biology of Aging: Observations and Principles*. 5th ed. New York: Oxford University Press, 2019. 600 p.
3. **Musi N., Hornsby P.J. (eds.)** *Handbook of the Biology of Aging*. 9th ed. Amsterdam: Elsevier, 2024. 650 p.
4. **Carlberg C., Ulven S.M., Velleuer E.** *Aging: How Science Works*. Cham: Springer, 2024. 300 p.
5. **Yashin A.I., Jazwinski S.M.** *Aging and Health: A Systems Biology Perspective*. Basel: Karger, 2014. 250 p.

Auxiliary

1. **Bilder G.E.** *Human Biological Aging: From Macromolecules to Organ Systems*. New York: Routledge, 2016. 352 p.
2. **Taylor A.W., Johnson M.J.** *Physiology of Exercise and Healthy Aging*. 2nd ed. New York: Human Kinetics, 2021. 480 p.
3. **Schlaerth K.R.** *The Ways Our Bodies Age: The Physiology of Aging*. New York: Rowman & Littlefield, 2025. 280 p.

4. **Arking R.** *Biology of Longevity and Aging: Observations and Principles*. 2nd ed. New York: Oxford University Press, 2019. 520 p.
5. **Kenney R.A.** *Physiology of Aging: A Synopsis*. New York: Springer, 1989. 200 p.

1. **15. Information resources American Physiological Society (APS). URL: https://www.physiology.org**
2. **The Physiological Society (UK). URL: https://www.physoc.org**
3. **Gerontological Society of America (GSA). URL: https://www.geron.org**
4. **National Institute on Aging (NIA, NIH). URL: https://www.nia.nih.gov**
5. **Aging Cell (Wiley). URL: https://onlinelibrary.wiley.com/journal/14749726 (onlinelibrary.wiley.com in Bing)**
6. **The Journals of Gerontology: Series A (Oxford Academic). URL: https://academic.oup.com/biomedgerontology (academic.oup.com in Bing)**
7. **Mechanisms of Ageing and Development (Elsevier). URL: https://www.sciencedirect.com/journal/mechanisms-of-ageing-and-development (sciencedirect.com in Bing)**
8. **PubMed (NIH). URL: https://pubmed.ncbi.nlm.nih.gov (pubmed.ncbi.nlm.nih.gov in Bing)**
9. **OpenStax – Anatomy & Physiology. URL: https://openstax.org/details/books/anatomy-and-physiology (openstax.org in Bing)**
10. **Khan Academy – Health and Medicine. URL: https://www.khanacademy.org/science/health-and-medicine (khanacademy.org in Bing)**
11. **TeachMePhysiology. URL: https://teachmephysiology.com**
12. **Armando Hasudungan (YouTube). URL: https://www.youtube.com/user/armandohasudungan (youtube.com in Bing)**
13. **Osmosis (YouTube). URL: https://www.youtube.com/c/osmosis**