MINISTRY OF HEALTH PROTECTION OF UKRAINE

ODESSA NATIONAL MEDICAL UNIVERSITY

Department of Physiology and Biophysics

I APPROVE

Vice-rector for scientific and pedagogical work

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METHODOLOGICAL DEVELOPMENT FOR THE SEMINARS WORKS FROM EDUCATIONAL DISCIPLINE "PHYSIOLOGY"

Physiological bases of interpretation of clinical and laboratory studies of a healthy person

(selective discipline)

Faculty - medical, 2nd year

Educational discipline - physiology

Approved:

Meeting of the Department of Physiology Odesa National medical university

Protocol No. 1 from "07" september 2023

Head of the department

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Developers:

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Notes: In the case of publication of Methodological Developments as an independent printed publication, the Academic Council of the Faculty provides a recommendation for publication in the presence of two reviews, one of which is external - from a reviewer of another institution of higher education.
The department has the right to combine the topics of practical/seminar/laboratory classes in the form of methodical development according to: (1) content modules; or (2) by year of study; or (3) by the entire discipline in general.

SEMINAR CLASS

Seminar lesson No. 1

Topic: Introduction to the course "Physiological bases of interpretation of clinical and laboratory studies of a healthy person".

Purpose: to form a clear idea of the basic concepts of physiology and clinical and laboratory research, basic approaches to laboratory research in clinical practice; to form the ability to apply methods of researching the physiological functions of human systems and organs and to be able to analyze the obtained data.

Basic concepts:

Among the various functions of cell membranes, one of the main ones is the generation and conduct of bioelectric activity, which is determined by the difference in electric potentials between two points of living tissue. The main types of bioelectric potentials are: membrane potential (resting potential) - MPS and action potential (AP). All living cells have a different electric charge on the outer and inner surfaces of the membrane. Thus, the membrane is polarized. At rest, the outer surface has a positive charge, and the inner one has a negative charge. This potential difference determines the presence of a resting membrane potential in living tissue. The presence of MPS can be recorded by inserting a thin glass microelectrode filled with KCl into the nerve fiber or cell. Another indifferent electrode is contained in the extracellular environment. When the membrane is not yet pierced, the oscilloscope does not record the current, but as soon as the tip of the microelectrode passes through the membrane, the device will witness the appearance of an electric current. MPS is characterized by such parameters as magnitude (expressed in millivolts), polarity and constancy. The resting membrane potential of, for example, a nerve fiber is -90 mV.

The resting membrane potential can be recorded in all living cells. The value of the MPS does not change at an unchanged state of the cell. Depending on the location of the electrodes on the object, two methods of recording biopotentials are distinguished - bipolar (bipolar) - electrodes on the surface and unipolar (unipolar) - one lead electrode is placed on the surface of the cell, and the second (passive) - inside the cell.

The occurrence of PD is associated with a short-term increase in the permeability of the membrane for Na+ ions, followed by an increase in the diffusion of these ions along the concentration gradient inside the cell. So, if PS or MP is caused by K+ ions, then PD is caused by Na+ ions, therefore MP is called potassium, and PD is called sodium. Diffusion of sodium ions inside the cell leads to a decrease in MP. A decrease in MP to a certain critical value (usually by 10–30 mV) causes a positive feedback, that is, a decrease in MP below the critical level leads to a further increase in membrane permeability for Na+ ions, which is accompanied

by an avalanche-like increase in sodium diffusion into the cell. A phase of depolarization occurs, which leads to the emergence of a short-term upward current directed inside the cell, which graphically corresponds in time to the upward phase of PD. With a lack of extracellular Na+, the incoming current of Na+ cannot increase, regardless of the extent to which K+ (gradient of Na+) increases, and therefore the depolarization phase of PD cannot occur.

The second stage of the occurrence of PD is associated with a longer period of increased permeability of the membrane for K+ ions and increased diffusion of these ions from the cell to the outside. An increase in the ion flow of K+ leads to a decrease in the permeability of the membrane for Na+ ions and a decrease in their flow. As a result, the flow of Na+ into the cell decreases sharply, and for K+ it increases. This leads to the appearance of a longer output current, which corresponds to the repolarization phase, that is, the restoration of membrane polarity, and in time corresponds to the descending phase of PD. Therefore, the repolarization of the membrane does not occur as a result of the reverse movement of Na+ ions, but as a result of the exit of an equivalent number of K+ ions from the cell. If the increase in conductivity for K+ is prevented by some substances, for example tetraethylammonium, the membrane repolarizes much more slowly after PD. This indicates that the increase in conductivity for K+ is an important factor in membrane repolarization. Therefore, PD is caused by the cyclic process of entry of Na+ into the cell and subsequent exit of K+.

In addition to PS and PD, living tissues contain:

1. Postsynaptic potentials — arise in synapses.

2. Receptor potentials are registered in receptors.

3. Secretory potentials — arise on the membranes of secretory cells.

Laws of irritation of excitable tissues

I. Law of force gradient.

II. All or nothing law.

III. Dependence of the corresponding reaction on the rapidity of the increase in the force of irritation.

IV. Dependence of the corresponding reaction on the time of the stimulus.

Equipment: bioamplifier, skin electrodes, isotonic sodium chloride solution; disinfectant solution, pieces of gauze fabric; fixing rubber band. tables, slides, videos, notebooks, pens.

Plan:

1. Organizational measures:

- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,

- motivation of students of higher education regarding the study of the topic.

2. Control of the reference level of knowledge:

- written test,

- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes:

Know:

- basic concepts of the physiology of excitable tissues

- basic approaches to the use of biopotential registration in clinical practice

Be able:

- to study the physiological functions of human systems and organs and to be able to analyze the obtained data

- master the skills of using physiological research methods in clinical practice

List of didactic units: textbooks, manuals, methodological recommendations on the topic of practical training, instructional materials for practical work.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

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

2. Modern ideas about the structure and functions of cell membranes.

3. Membrane ion channels, their types, functions. Ion gradients of the cell — ion asymmetry.

4. Transport of ions through membranes. Membrane ion pumps, their functions.

5. Membrane receptors, their functions.

6. Resting membrane potential, mechanisms of origin, recording methods. MPS parameters and its physiological role.

7. PD, origin mechanisms, registration methods.

8. PD phases and its parameters. Physiological role of PD.

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

10. MP changes during the action of an electric current as a stimulus. Local response (LV), or local potential (LP).

11. Level of critical depolarization. Depolarization threshold as a measure of excitability.

1. Which of the following is not included in the general scientific approaches on which physiology as a science is based?

A. complexity

B. systematicity

C. humanism

D. individual approach

E. mechanical approach

2. For what purpose are research methods used in physiology?

A. for the study of the functional state of the organism and the evaluation of the reactions of systems to the action of load factors

B. for the study of biochemical processes of energy generation and transformation of substances in the body during sports activities

C. to assess the morphological state of the examined tissues, for example, as a result of a puncture biopsy of muscles

D. to assess the dynamics of mental processes and analyze their level of development in an individual under the conditions of sports activity

E. for mathematical processing and analysis of the results of observation under the conditions of sports activities

3. What levels of research of physiological processes are used in physiology?

A. Organismal

B. Systemic and organ

C. Fabric

D. Cellular and subcellular

E. All of the above

4. For what purpose is the ergometry method used?

A. to measure the amount and intensity of physical work with electromyogram registration

B. to register involuntary vibrations of individual parts of the body using tremometers

C. to determine the strength and endurance of individual muscle groups using dynamometers

D. to register involuntary deviations from a certain point or line that a person must follow during the performance of work using a coordinate meter

E. for biochemical assessment of lactate content in muscles under sports conditions

5. For what purpose is the reflexometry method used?

A. to determine the time of reflex reactions using a chronoreflexometer

B. to study the bioelectrical activity of the brain using an electroencephalograph

C. to study blood circulation in the brain using a Doppler

D. to study the psychological state of a person

E. to study the level of brain performance

6. Thanks to which research method is it possible to record the electrical activity of the heart muscle?

A. Electromyography

B. Electrocardiography

C. Electroencephalography

D. Computed tomography

E. Doppler

7. What method allows you to study blood pressure in human vessels?

A. Pulsometry

B. Tonometry

C. Sphygmography

D. Phlebography

E. Duplex scanning

8. What are the methods of tonometry?

A. Non-invasive

B. Invasive

C. Korotkova

D. Riva-Rocci

E. All of the above

Answers: 1.E, 2.A, 3.E, 4.A, 5.A, 6.B, 7.B, 8.E

Situational tasks to test basic knowledge:

1. Calculate how the excitability of the tissue will change if the MPS increased by 20% and the CRD by 30%? Output values: Eo = –90 mV, Ek = –60 mV.

Answer: In this case, the new MPS became equal to -108 mV, and the CRD was -78 mV. The initial values of these indicators are -90 mV and -60 mV. Therefore, the initial difference between MPS and CRD did not change and remained equal to 30 mV. This means that the excitability of this membrane has not changed.

2. Calculate how the MPS level will change if the concentration of K+ ions inside the nerve fiber is artificially reduced by 30%?

Answer: MPS will decrease because the K+ concentration gradient will be smaller. The degree of reduction is about 30%.

3. Explain the mechanism of action of tetrodotoxin on the level of MPS, if it is known that tetrodotoxin is a poison that blocks Na+ channels. Draw a graph of the change in MPS value.

Answer: Since in this case the Na+ current will not reduce the K+ current, the value of MPS will increase.

3. Formation of professional abilities and skills (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

- Investigate the mechanisms of occurrence and methods of recording electrical potentials of excitable tissues.

- To solve situational tasks on the topic of practical training.

Instructional materials on the performance of tasks:

Methodology of recording electrical potentials of human muscles

For work, you need: bio-amplifier; oscillograph; skin electrodes; a set of loads of 1, 3, 5 kg; isotonic solution of sodium chloride; disinfectant solution, pieces of gauze fabric; fixing rubber band.

The object of research is a person.

Conducting work. Research is recommended to be conducted on several subjects, as in this case there will be a noticeable difference in individual reactions. The experimenter registers each indicator on both hands, determining their expressiveness and symmetry.

Recording of the electrical activity of muscles — electromyography (EMG) of a person is used for diagnostic purposes in the clinic during functional studies and under the conditions of muscle dysfunctional states. Depending on the purpose, EMG is performed during voluntary movements of the muscles under study, under the influence of a load and under the influence of stimulation. Shoulder skin above m. biceps are treated with a disinfectant solution, then with an isotonic solution of sodium chloride. Check the interelectrode resistance, which normally does not exceed 40–50 kΩ. After that, the appropriate amplification factor is selected during the test bending of the arm in the elbow joint with a weight of 5 kg. The calibration signal is registered. According to this, the subject is offered to lift a weight of 1 or 3 kg. During this, emerging biopotentials are recorded on the oscilloscope monitor. Biopotentials are recorded at the beginning of work, after 2–3 min and during muscle fatigue. After 5–10 min of rest, the potentials are re-registered during work with a heavy load (3 or 5 kg). Observe the nature of changes in muscle potentials. Then they perform the same work on the other hand and compare the results.

Requirements for registration of results and their assessment. Record the obtained indicators in the protocol. Compare the results of several subjects. Draw conclusions.

Control materials for the final stage of the lesson:

Tests for the final stage of the lesson:

1. After the effect on the excitable cell of the poison that inhibits ATP synthesis, the action of the electrical stimulus will lead to the fact that the incoming current of Na+ during the development of MPD ... as a result of ...

A. It will decrease ... a decrease in the Na+ concentration gradient

B. The decrease in the Na+ concentration gradient will increase

C. The increase in the concentration gradient of Na+ will increase

D. The increase in the concentration gradient of Na+ will decrease

E. It will not change ... the decrease in the Na+ concentration gradient

2. Under conditions of an increased number of inactivated Na+ channels under the action of a local anesthetic, the

depolarization threshold of the cell membrane ... and its excitability ...

A. Will increase ... will increase

B. Will decrease ... will decrease

C. Will increase ... will not change

D. Will increase ... decrease

E. Will not change ... will decrease

3. During the MPD peak, the depolarization threshold of an excitable cell ..., and its excitability ...

A. 2–5 times … 2–5 times

B. to infinity ... tends to 0

C. 3–5 times ... 3–5 times

D. Does not change ... tends to 0

E. Tends to 0 ... does not change

4. The ionic current during the MPD repolarization phase is mainly provided by:

A. Movement of K+ along the concentration gradient

B. Movement of Na+ along the concentration gradient

C. Movement of Na+ against the concentration gradient

D. Movement of K+ against the concentration gradient

E. By the operation of the Na+/K+ pump

5. Under the conditions of an increase in the number of inactivated Na+ channels under the action of a local anesthetic, the absolute value of the CRD of the membrane ... and its excitability ...

A. Will decrease ... increase

B. Will increase ... decrease

C. Will decrease ... will decrease

D. Will decrease ... will not change

E. Will not change ... will increase

6. After exposure to an excitable cell by a poison that inhibits ATP synthesis, a series of stimuli will lead to the fact that the K+ current during MPD:

A. It will increase

B. Will decrease

C. Will not change

D. Will disappear

E. Change direction

7. Na+/K+ pump:

A. Introduces Na+ ions into the cell

B. Introduces K+ ions into the cell

C. Removes Na+ ions from the cell

D. Removes K+ ions from the cell

E. Removes Cl- ions from the cell

8. How will the membrane depolarization threshold change when the strength of the suprathreshold electrical stimulus increases?

A. Aspires to 0

B. Will increase

C. Will decrease

D. Will disappear

E. Will not change

9. In the experiment, it is necessary to assess the level of tissue excitability. What indicator should be determined for this?

A. MPD amplitude

B. MPS level

C. Duration of MPD

D. Depolarization threshold

E. CRD

10. How will the excitability of the nerve cell membrane change during the MP peak?

A. Will disappear

B. Will increase by 1.5–3 times

C. Will not change

D. It will decrease by 2-3 times

E. It will decrease by 1.5–3 times

Answers

1.A, 2.D, 3.B, 4.A, 5.C, 6.B, 7.C, 8.E, 9.D, 10.A.

Situational tasks for the final stage of the lesson:

1. Calculate whether a propagating excitation will occur in the nerve, if it is known that the MPS = –90 mV, the CRD is 30% lower than it, and the stimulating current changes the MP in one case by 10 mV, in the other - by 30 mV ?

Answer: Excitation will occur under the conditions, if MPS is less than or equal to KRD. Therefore, in this case, the spreading excitation will occur only if the MP decreases by a value greater than 27 mV (by 30%).

2. The nerve is stimulated with a frequency of 10, 100 and 1000 Hz. Calculate how much MPD will occur in each case?

Answer: A nerve cannot be excited with any high frequency. This is prevented by the ARP, which lasts approximately 2 ms after the start of MPD. At a frequency of 10 Hz, the interval between stimuli is 0.1 s, at 100 Hz — 0.01 s. In both cases, it is large enough for the refractory period to end and the nerve to reproduce the stimulation with the given frequency. At a frequency of 1000 Hz, the interval between stimuli is too small (0.001 s), and therefore every second pulse will fall into the refractory period after the previous excitation. The total number of MPDs will not exceed 500.

3. Explain whether the mechanisms involved in MPD generation in a cell will be affected if it is treated with proteolytic enzymes. Draw a diagram of the MPD change.

Answer: Proteolytic enzymes split protein molecules that are part of the walls of ion channels and "gates" that open and close these channels. Consequently, the permeability of the membrane for ions will be disturbed.

4. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated.

5. List of recommended literature (main, additional, electronic information resources):

Basic literature:

1. Physiology [textbook] /V. M. Moroz, O.A. Shandra.– 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728p.

4. *Further reading:*

1. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier. - 6th ed.,2017.- 528 p

2. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, J. Yuan, H. L. Brooks. - McGraw Hill Professional. – 26th edition,2019.–752 p.

3. Guyton A. Textbook of Medical Physiology / A. Guyton, J. E. Hall. - Elsevier. - 14th Edition, 2021. – 1820 p.

4. Koeppen B. M.«Berne and Levy Physiology / B. M. Koeppen, B. A. Stanton. - Elsevier. - 7th edition, 2018. – 880 p.

5. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 8th ed., 2019.–1186 p.

Electronic information resources:

1. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

2. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

3. National Scientific Medical Library of Ukraine http://library.gov.ua

4. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua

Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua

Seminar session No. 2

Topic: Interpretation of clinical and laboratory studies of the central nervous system

Purpose: to form a clear idea of the main mechanisms of excitation propagation in the central nervous system; to form the ability to apply research methods and their interpretation.

Basic concepts:

Transmission of excitation in the central nervous system is ensured by synapses. A synapse is a place of contact between two heterogeneous tissues with the participation of glial cells. Neuromuscular synapse is classified as peripheral chemical cholinergic.

- Presynaptic membrane – the unmyelinated end of a myelinated axon 1 mm long, which contains synaptic vesicles with the mediator acetylcholine, mitochondria, endoplasmic reticulum. Each vesicle contains 1-10 thousand acetylcholine molecules. They accumulate in the active zones, which also contain calmodulin protein and Ca2+ ions.

- The synaptic cleft is filled with synaptic fluid (similar in composition to blood plasma), glycocalyx, and acetylcholinesterase.

- Postsynaptic membrane - forms numerous folds, on the combs of which there is a maximum number of H-cholinergic receptors and mediators - purines, calcium ions, ATP

Under resting conditions, one of the vesicles spontaneously opens and releases a quantum of mediator into the synaptic cleft with an interval of 1s. This causes a short-term weak depolarization of the postsynaptic membrane of the muscle fiber - a miniature postsynaptic potential with an amplitude of 0.5 mV.

When the presynaptic terminal is excited, its membrane is depolarized, potential-dependent Ca2+ channels open, and Ca2+ enters the presynaptic terminal according to the concentration gradient from the surrounding tissue fluid. There, through calmodulin, Ca2+ activates vesicles, which begin to move to the active centers of the presynaptic membrane, where they exit into the synaptic cleft through exocytosis (300 vesicles per 1 PD).

The mediator diffuses to the postsynaptic membrane, where it interacts with chemoreceptors and forms a receptor-mediator complex that activates G-protein. At the same time, there is an increase in sodium permeability in excitatory synapses, which causes depolarization of the postsynaptic membrane and the emergence of the potential of the end plate, which is called the excitatory postsynaptic potential. In inhibitory synapses, the permeability to potassium and chlorine increases, hyperpolarization of the postsynaptic membrane occurs, and the end plate potential, called the inhibitory postsynaptic potential, occurs.

Due to the fact that the postsynaptic membrane contains only chemo-dependent and no potential-dependent channels, its depolarization cannot become regenerative, that is, it cannot lead to the formation of an action potential. The simultaneous formation and summation of several potentials of the end plate on the surface of the postsynaptic membrane contributes to the achievement of CUD and the generation of PD. 1-2 ms after release, ACh is split by AChE into choline and acetic acid, which are returned to the presynaptic terminal for ACh resynthesis.

Features of neuromuscular synapses:

- the presynaptic ending is the axon of a motor neuron.

- PSP - have a large amplitude, always reaches the CUD, unlike neuronal synapses, in which summation of potentials is necessary for the occurrence of PD.

- leads to activation of myofibrils and muscle contraction.

General properties of chemical synapses:

- unilateral conduct

- synaptic delay, which is formed due to the time it takes for the release of the mediator, its diffusion, the occurrence of PKP, achievement.

- transformation of the rhythm: facilitation of the conduction of the impulse (in the basis - the accumulation of Ca2+) - in the basis of training; inhibition (based on persistent depolarization) - Vvedensky's pessimum

- plasticity

- fatigue (especially central synapses)

- high selective sensitivity to chemicals

- is the most important part of the central nervous system

Blockade of neuromuscular transmission. Some chemicals can partially block neuromuscular transmission. There are reversible and irreversible blockades.

The mechanism of their action can be different, which is determined by the place of adding the substance. The following main ways of blocking can be identified:

- Blockade of nerve fiber conduction - novocaine.

- Blockade of mediator release – botulism toxin.

- Violation of mediator synthesis in presynaptic endings.

- Inhibition of cholinesterase - nerve-paralytic poisons, FOS (sarin, soman), ezerin, proserin.

- Receptor blockade – curare poison, muscle relaxants.

In addition, the spread and transmission of excitation has its own characteristics depending on the type of nerve fibers through which it is spread. Yes, they can be myelinated and unmyelinated.

Equipment: bioamplifier, skin electrodes, isotonic sodium chloride solution; disinfectant solution, pieces of gauze fabric; fixing rubber band. tables, slides, videos, notebooks, pens.

Plan:

1. Organizational measures:

- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,
- motivation of students of higher education regarding the study of the topic.

2. Control of the reference level of knowledge:

- written test,
- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes:

Know:

- basic concepts of the physiology of processes of excitation of excitable tissues
- basic approaches to the use of biopotential registration in clinical practice

Be able:

- to study the physiological functions of human systems and organs and to be able to analyze the obtained data
- master the skills of using physiological research methods in clinical practice

List of didactic units: textbooks, manuals, methodological recommendations on the topic of practical training, instructional materials for practical work.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

1. Define the laws of irritation and conduction of excitation by nervous tissues.

2. Provide diagrams for each law and mark their components.

3. Define the term "synapse". Classification of synapses.

4. Concepts of "mediator", "receptor". Types of mediators and types of receptors for them.

5. General properties of chemical synapses and features of neuromuscular synapses.

6. Structure and functions of the neuromuscular synapse.

7. Mechanisms of chemical transmission of excitation through the neuromuscular synapse.

8. The mechanism of emergence of the potential of the end plate (PKP).

9. Excitatory postsynaptic potential (PSP), its properties.

10. Inhibitory postsynaptic potential (GPSP), its properties.

11. Physiological mechanisms of blockade of neuromuscular transmission.

Test tasks:

1. Stale products (meat, fish, canned goods) may contain the microbial botulinum toxin. Its effect on myoneural synapses is similar to the removal of Ca2+ ions from them. Why can poisoning be fatal?

A. As a result of respiratory arrest due to relaxation of the respiratory muscles

B. Due to contraction of respiratory muscles in the mode of tetanus due to increased release of mediator

C. Due to ↓ excitability of the respiratory center and inhibition of its work

D. Due to the speed of conduction of excitation by myelinated fibers

E. Due to cardiac arrest

2. In the experiment, a substance that reduces metabolic processes is introduced into the axon. What phenomena will be observed under these conditions?

A. ↑ MPD amplitudes

B. ↑ speed of irritation

C. Enhancement of axon contraction

D. ↑ amount of mediator

E. ↓ amount of mediator

3. In the solution in which the nervous

a muscle preparation of the calf muscle of a frog, a curare-like substance is introduced. After some time, the motor nerve of the calf muscle was irritated. How will muscle contractions change?

A. Muscle contractions will not change

B. There will be no muscle contractions

C. Cuts will increase

D. Complete (smooth) tetanus will occur

E. Incomplete (dentate) tetanus will occur

4. In the solution in which the nervous

frog calf muscle preparation, administered curare. Why then did stimulation of the motor nerve not cause the muscle to contract?

A. ↑permeability of the presynaptic membrane for Ca2+

B. Blocking of cholinergic receptors of the postsynaptic membrane occurred

C. Cholinergic receptors of the presynaptic membrane were blocked

D.↑release of acetylcholine (ACH) into the synaptic cleft

E. ↓ release of AH into the synaptic cleft

5. In the solution in which the nervous

muscle preparation of frog calf muscle, administered eserine, which inhibits cholinesterase activity. Why did the irritation of the motor nerve not cause the muscle to contract?

A. ↓ AH release into the synaptic cleft

B. ↓ K+ permeability of the postsynaptic membrane

C. There was a persistent depolarization of the postsynaptic membrane

D. ↑Na+ conductance of the postsynaptic membrane

E. ↑Ca2+ permeability of the postsynaptic membrane

6. In excitatory synapses, the main role of the mediator is as follows:

A. ↓permeability of the postsynaptic membrane for Na+ and Ca2+ ions

B. Depolarization of the postsynaptic membrane

C. ↑permeability of the postsynaptic membrane for K+ and Cl- ions

D. ↑permeability of the postsynaptic membrane for Ca2+ and H+ ions

E. None of the answers are correct

7. The nerve of the neuromuscular preparation of the calf muscle of a frog was stimulated with electrical stimuli and MPD was recorded in the muscle. Why did MPDs not occur in the nerve during muscle stimulation?

A. Inhibition develops in the motor nerve

B. AH production is blocked at the neuromuscular synapse

C. The MPD amplitude of the muscle is insufficient to irritate the nerve

D. A neuromuscular synapse has unidirectional conduction

E. There is no correct answer

8. In animals, the posterior roots of the spinal cord were stimulated with single electrical stimuli and MPD was recorded in the anterior roots. Why were MPDs not registered in the back roots when the front roots were irritated?

A. Inhibition develops in neurons of the spinal cord

B. Synapses of the spinal cord have a unilateral conduction of irritation

C. The fibers of the posterior roots are less excitable than the fibers of the anterior roots

D. The fibers of the anterior roots do not conduct irritation to the spinal cord

E. Mediator formation is disrupted in spinal cord neurons

9. What causes the intense release of AH from the synaptic plaque into the synaptic cleft:

A. Depolarization of the subsynaptic membrane

B. Depolarization of the presynaptic membrane

C. Depolarization of the postsynaptic membrane

D. Hyperpolarization of the presynaptic membrane

E. Repolarization of the presynaptic membrane

10. What transmembrane redistribution of K+ and Na+ ions is characteristic of the initial moment of the development of ZPSP:

A. Penetration of K+ ions into the cell

B. Penetration of Na+ ions inside the cell

C. Exit of Na+ ions from the cell

D. Exit of K+ ions from the cell

E. Entry of Cl- ions into the cell.

Answers

1.A, 2.E, 3.B, 4.C, 5.C, 6.B, 7.D, 8.D, 9.D, 10.D

Situational tasks to test basic knowledge:

1. Indicate which of the listed excitable structures is characterized by the greatest excitability: nerve, synapse or muscle. Which structure has the least lability? Explain the mechanism of this phenomenon.

Answer: To test this assumption, we need to proceed to direct stimulation of the muscle. If the amplitude of contractions increases under these conditions, fatigue did not occur in the muscle, but in the synapses.

3. Which of the listed structures of the neuromuscular synapse has increased chemical sensitivity: neuron body (soma), axon, postsynaptic membrane, muscle fiber membrane? Explain the reason.

Answer: The postsynaptic membrane has increased chemical sensitivity.

4. It is known that fatigue is one of the main properties of excitable tissue. In an experiment on a neuromuscular preparation of frogs, rhythmic indirect stimulation of the muscle was performed. Explain: 1) How will the amplitude of muscle contraction change after long-term nerve stimulation? 2) How will the amplitude and frequency of MPD in nerve fibers change under the conditions of the development of fatigue in the muscle?

Answer: 1) Under conditions of long-term irritation, the amplitude of muscle contractions decreases due to the process of muscle fatigue. 2) The amplitude and frequency of PD of nerve fibers will not change, because nerves are subject to the law of relative non-fatigue.

3. Formation of professional abilities and skills (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

- Investigate the parameters of direct electric current necessary for the occurrence of propagating excitation (PD) in excitable tissues.

- To solve situational tasks on the topic of practical training.

Instructional materials on the performance of tasks:

The method of researching the excitability of motor nerves according to the electrical threshold strength

irritation of their movement points

The parameters of direct electric current that are important for the occurrence of MPD in excitable tissues are the following: the polarity of the pulses, their strength, duration and growth rate. In clinical practice, the excitability of nerve and muscle tissues is determined by the threshold force (voltage) of the electrical stimulus of the corresponding movement points. The motor point of a nerve is the part of the skin of the body under which this nerve is located most superficially. Movement points of muscles are areas of the skin of the body that correspond to the places where nerve fibers enter these muscles. The threshold strength of irritation for a whole nerve or muscle is determined by the level of the threshold of excitation of their most excitable fibers.

For work, you need: an electric stimulator that outputs rectangular electric pulses of dosed voltage, irritating electrodes, an isotonic solution of sodium chloride, pieces of gauze fabric, a fixing rubber band.

The object of research is a person.

Conducting work. Research is recommended to be conducted on several subjects, as in this case there will be a noticeable difference in individual reactions. The experimenter registers each indicator on both hands, noting their expressiveness and symmetry.

A passive irritating electrode (anode) is placed on the surface of the subject's shoulder using a rubber band, under which is a piece of gauze moistened with an isotonic solution of sodium chloride. An active stimulating electrode (cathode) is placed on the surface of the forearm above the motor point of the nerve — the superficial flexor of the fingers. They are convinced of the correct placement of the active electrode by conducting a test irritation of the nerve with pulses of sufficient strength (20–25 V) and duration (5–10 ms) at a frequency of 1 pulse/s in the “rhythmic series” stimulator mode. After that, the voltage is reduced to the zero point and the stimulator is switched to the "single pulses" mode. The strength of the stimulating pulse is gradually increased from 0 to 30 V, and after each increase in voltage, a test stimulation of the nerve under study is performed. Research continues until the moment of appearance in response to another irritation of barely noticeable bending of the fingers. The voltage at which the fingers were bent is recorded. Then the polarity is changed without changing the voltage, and it is noted whether bending of the fingers occurs. After that, restore the previous polarity and begin to gradually reduce the duration of the irritating stimulus, noting whether for any duration of the irritation, bending of the fingers of the subject's hand will occur.

Requirements for registration of results and their assessment. Record the voltage, duration, and polarity indicators at which excitation occurred and the fingers of the subject's hand began to bend. Compare the results of several subjects. Draw conclusions.

Control materials for the final stage of the lesson:

Tests for the final stage of the lesson

1. Accumulation of an excess amount of AH in the neuromuscular synapse of skeletal muscle leads to:

A. To increase muscle contraction

B. To weaken muscle contraction

C. To relax the muscle

D. Muscle contraction will not change

E. Does not affect muscle contraction

2. During the arrival of a nerve impulse to the synapse, the following occurs in the presynaptic membrane:

A. Depolarization of the presynaptic membrane

B. Hyperpolarization of the presynaptic membrane

C. Increase in Cl- permeability

D. Decreased Ca2+ permeability

E. Increase in Ca2+ permeability

3. When Ca2+ ions enter the synaptic plaque:

A. Interaction of Ca2+ with calmodulin

B. Interaction of Ca2+ with active centers of actin

C. Interaction of Ca2+ with myosin

D. Interaction of Ca2+ with AH

E. Interaction of Ca2+ with receptors

4. What will lead to the inactivation of acetylcholinesterase in the neuromuscular synapse of skeletal muscle:

A. To hyperpolarization of the postsynaptic membrane

B. To persistent depolarization of the postsynaptic membrane

C. To improve the transmission of excitation through the synapse

D. To the deterioration of the transmission of excitation through the synapse

E. To depolarization of the presynaptic membrane

5. The synaptic cleft of the neuromuscular synapse contains an enzyme ... that acts on the mediator ...

A. Cholinesterase ... AH

B. Monoamine oxidase (MAO) ... norepinephrine (NA)

C. Transaminase ... AH

D. Peptidase ... ON

E. ATPase ... ATP

6. The neuromuscular synapse in skeletal muscle acts on the mediator:

A. Ah

B. ON

C. Gamma-aminobutyric acid (GABA)

D. Glutamate

E. Glycine

7. PKP develops as a result of interaction with receptors of the postsynaptic membrane:

A. Cholinesterases

B. Ah

C. ON

D. K+

E. Ca2+

8. PKP is one of the types:

A. Local excitation

B. Excitation spreading

C. Local inhibition

D. Passive potentials

E. Central braking

9. Nerve endings of ... skeletal muscle:

A. 70% of the fibers are present

B. 20% fibers present

C. 50% fibers present

D. Present on all fibers

E. Absent on fibers

10. The release of a mediator in the neuromuscular synapse of skeletal muscle is the result of:

A. Ca2+ entry through the presynaptic membrane

B. Ca2+ entry through the postsynaptic membrane

C. Entry of K+ through the presynaptic membrane

D. Depolarization of the presynaptic membrane

E. Depolarization of the postsynaptic membrane

Answers 1.A, 2.A, 3.A, 4.B, 5.A, 6.A, 7.B, 8.A, 9.D, 10.A.

Situational tasks for the final stage of the lesson:

1. During the irritation of the nerve of the neuromuscular drug, the muscle is brought to fatigue. Explain what will happen if you irritate the muscle at this time?

Answer. The muscle will begin to contract again, because when the neuromuscular drug is irritated, fatigue first occurs in the synapse. It is known that AH is one of the main mediators of the nervous system.

2. During the examination of the subject, it was established that the blocker of acetylcholinergic transmission of excitation in synapses — atropine — caused dilation of the pupil, an increase in the force and frequency of heart contractions (HR), and a decrease in peristalsis of the gastrointestinal tract (GI). At the same time, the contractile function of the skeletal muscles did not change. Explain: 1) What postsynaptic receptors does AX act on under the conditions of its release into the synaptic cleft? 2) Possible reasons for the different effects of atropine in the neuromuscular synapses of the somatic nervous system and in the synapses of the ANS on internal organs.

Answer: 1) The AX mediator acts on two types of postsynaptic receptors: M- and H-cholinerceptors. M-cholinoceptors are located in neuron-organ synapses of the parasympathetic nervous system (PSNS). H-cholinergic receptors are located in neuromuscular synapses and autonomic ganglia. 2) Atropine blocks only M-cholinergic receptors, therefore the action of the PSNS is blocked, and the somatic regulation of skeletal muscles is not disturbed.

3. The muscle of the neuromuscular preparation is subjected to indirect irritation. After some time, the amplitude of contractions decreases. Explain whether this means that the muscle

has developed fatigue. How to test this assumption? Answer 3. To test this assumption, we need to proceed to direct stimulation of the muscle. If the amplitude of contractions increases under these conditions, fatigue did not occur in the muscle, but in the synapses.

4. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated.

5. List of recommended literature (main, additional, electronic information resources):

Basic literature:

1. Physiology [textbook] /V. M. Moroz, O.A. Shandra.– 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728p.

4. *Further reading:*

6. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier. - 6th ed.,2017.- 528 p

7. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, J. Yuan, H. L. Brooks. - McGraw Hill Professional. – 26th edition,2019.–752 p.

8. Guyton A. Textbook of Medical Physiology / A. Guyton, J. E. Hall. - Elsevier. - 14th Edition, 2021. – 1820 p.

9. Koeppen B. M.«Berne and Levy Physiology / B. M. Koeppen, B. A. Stanton. - Elsevier. - 7th edition, 2018. – 880 p.

10. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 8th ed., 2019.–1186 p.

Electronic information resources:

5. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

6. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

7. National Scientific Medical Library of Ukraine http://library.gov.ua

8. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua

Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua

SEMINAR CLASS

Session No. 3

Topic: Interpretation of clinical and laboratory studies of the endocrine system

Purpose: to form knowledge of the role of humoral factors in the regulation of body functions under conditions of normal physiology and to be able to analyze clinical and laboratory research methods.

Basic concepts:

Humoral regulation is one of the basic steps in the regulation of body functions, it is a means of transmitting information to effectors through the liquid internal environment of the body (blood, lymph and tissue fluid) with the help of molecules of chemical substances that are secreted by cells or specialized tissues and organs.

Hormonal regulation is ensured by the endocrine system, which includes: 1) endocrine organs or glands, 2) endocrine tissue in the organ, 3) cells of organs that have, in addition to the main, endocrine function at the same time

The differences between humoral regulation and nervous regulation are as follows: a) for humoral regulation, the carrier of information is a chemical substance, for nervous regulation, action potential; b) the nature of information transmission in the humoral - blood and lymphatic vessels and intercellular spaces, in the nervous - nerve fibers; c) the humoral way of transmitting information is the flow of blood, lymph and diffusion; in nerve - this is the propagation of the action potential by nerve fibers.

The humoral way of transmitting information has the following features: a) the humoral signal in the body spreads at a low speed, b) the humoral signal can be dosed less precisely in terms of strength and duration than excitement, c) humoral regulation is used in the body to ensure reactions that do not require urgency and accuracy.

Factors of humoral regulation (primary messengers or mediators) are:

a) hormones;

b) hormones (tissue or local hormones);

c) some metabolites and ions (actual metabolites and damage factors are released).

Hormones are chemical substances that are formed and secreted by specialized endocrine cells into the internal environment of the body for the regulation of metabolism and vegetative functions of the body, humoral support for the coordination and integration of life processes. As carriers of information, hormones participate in the regulation of body functions, adapt it to constantly changing conditions of the external environment, ensure its growth, development and reproduction.

There are five types of hormone action:

1) metabolic (effect on metabolism);

2) morphogenetic (stimulation of formation, differentiation of organs and tissues, growth);

3) kinetic (inclusion of certain activities);

4) corrective (change in intensity of functions of organs and tissues);

5) reactogenic (ability to change tissue reactivity). In addition, hormones affect immunogenesis, hemostasis, have sensitizing and desensitizing effects.

The destruction of hormones occurs by the enzymatic systems of the liver, lungs, brain, and kidneys. Sometimes hormones are hydrolyzed in the target cell itself, being bound to the receptor or free in the lysosome.

Based on functional criteria, three groups of hormones are distinguished: 1) hormones that directly affect the target organ; these hormones are called effector hormones, 2) hormones whose main function is the regulation of the synthesis and release of effector hormones, they are called tropic; 3) hormones synthesized by nerve cells in the hypothalamus, they regulate the synthesis and release of hormones by the adenohypophysis, they are called releasing hormones.

General properties of hormones:

1. Specificity of action. Each hormone acts on specific physiological systems, organs or tissues, that is, on those structures that contain specialized receptors for it.

2. Remote action. Many hormones act through the internal environment on organs that are located far from the place of their formation. However, tissue hormones that are secreted without the participation of specialized endocrine cells, most often have a local effect at a short distance from the place of their formation.

3. They do not have species specificity, with the exception of growth hormone and p-lipotropin.

4. The action is due to the effect on target cells of plasma membranes.

5. High biological activity - influence on the functions of organs and tissues in very small concentrations.

Hormones are released to ensure one or another regulatory act, that is, one or another functional state of the body. And they, like the autonomic nervous system, exhibit trophotropic and ergotropic effects. Trophotropic regulation is the participation of hormones in the regulation of the processes of growth and development of the organism in order to ensure its linear growth and processes of differentiation. Ergotrophic is participation in the regulation of metabolic processes in the body.

Mechanism of action of hormones on body cells.

According to their chemical structure, hormones are divided into: Protein-peptide (insulin, glucagon, all hormones of the hypothalamus and pituitary gland). They are water-soluble, but poorly soluble in lipids. Steroids – hormones of the cortical substance of the adrenal glands, sex hormones. They are fat-soluble, but poorly soluble in water. Derivatives of amino acids: thyroid hormones (fat-soluble); catecholamines (water soluble). Solubility in water or fat determines the mechanism of action of hormones on target cells: - fat-soluble hormones easily penetrate the cell through its membrane and act through interaction with cytoplasmic cytoreceptors; - water-soluble hormones cannot penetrate into the cell through its membrane, which is built mainly of lipids, so their effect on the cell is associated with interaction with membrane cytoreceptors→switching on membrane mechanisms→formation of secondary mediators (messengers, messengers). A change in the concentration inside the cell of secondary mediators changes its function and metabolism.

The mechanism of action of fat-soluble hormones on cells: The hormone enters the cell through the membrane and interacts with cytoplasmic cytoreceptors → the hormone-receptor complex is transported to the cell nucleus → binding of the hormone to DNA → increasing the rate of I-RNA synthesis → increasing the biosynthesis of certain proteins (enzymes) in the cell , channels, etc.)→change in metabolism, function, cell structure. The mechanism of action of fat-soluble hormones determines their following features: - a long latent period (the time interval from the release of the hormone to the appearance of a biological effect→effect through the exchange of nuclear nucleic acids); - duration of action.

Mechanism of action of water-soluble hormones on cells When water-soluble hormones act on target cells, intracellular mediators are formed: cAMP; cGMP; diacylglycerol; inositol-3-phosphate; Ca2+ ions, calmodulin. The effect of hormones through membrane cytoreceptors is characterized by a relatively short latent period and a relatively short-term effect.

Regulation of functions of synthesis and secretion of hormones by endocrine glands is carried out in several ways:

1. Neurogenic regulation is carried out in two directions: a) direct influence of the nervous system on the synthesis and secretion of hormones (neurohypophysis, medulla of the adrenal glands); b) the nervous system regulates hormonal activity indirectly, changing the intensity of blood supply to the gland.

2. Humoral regulation consists in the direct influence on the cells of the gland of the concentration of the substrate, the level of which is regulated by the hormone (feedback). Yes, the level calcium in the blood affects the secretory activity of the parathyroid and thyroid glands, where parathyroid hormone and thyrocalcitonin are produced, and the concentration of glucose in the blood determines the activity of insulin release from the pancreas, etc.

3. Neurohumoral regulation is carried out with the help of the hypothalamic-pituitary system. The function of the thyroid and gonads, the adrenal cortex is regulated by the hormones of the anterior lobe of the pituitary gland (adenohypophysis) - tropic hormones: adrenocorticotropic, thyroidotropic, follicle-stimulating and luteinizing. Somewhat tentatively, tropic hormones also include pituitary somatotropic hormone, which exerts its influence on growth indirectly through the hormone somatomedin, which is produced in the liver. The adenohypophysis also produces intermedin (melanocyte-stimulating hormone, MSG) and prolactin, which have a direct effect on peripheral organs. In turn, the release of all these hormones of the adenohypophysis depends on the hormonal activity of the neurons of the medial part of the hypothalamus. Hormones are produced here that have a stimulating or inhibitory effect on the secretion of adenohypophysis hormones: releasing factors (liberins) and static inhibitors. Liberins and statins, affecting the production of tropic hormones of the adenohypophysis, regulate the activity of some glands of internal secretion.

Plan:

6. Organizational measures:

- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,
- motivation of students of higher education regarding the study of the topic.

7. Control of the reference level of knowledge:

- written test,
- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes:

Know:

- general characteristics of hormones, mechanism of their action.
- physiological bases of methods for researching the functions of endocrine glands.

Be able:

- draw a diagram of the interaction of the hypothalamic-pituitary system.
- master the skills of researching the effect of pituitrin on the melanophore cells of a frog using the materials of the educational video

List of didactic units: textbooks, manuals, methodical recommendations on the topic of practical training, video film.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

1. Humoral regulation and its main differences from nervous regulation.

2. Basic methods of researching the activity of endocrine glands.

3. Physiological significance of humoral regulation factors.

4. General characteristics of hormones, their classification, properties, chemical nature.

5. Mechanisms of hormone action on target cells of the body.

6. Types of action of hormones on the body

7. Regulation of biosynthesis and secretion of hormones.

8. Basic mechanisms of regulation of endocrine gland activity

9. Physiological significance of hormones of the hypothalamic-pituitary system

Test tasks:

1. What is the average amount of hormones in a free state in blood plasma?

A. 10%

B. 30%

C. 40%

D. 60%

E. 80%

2. Hormone receptors are contained in:

A. Blood hemoglobin

B. Blood transport protein

C. Cells of target organs

D. Vascular endothelium

E. In ribosomes

3. Which hormone practically does not have special target organs?

A. Oxytocin

B. Somatotropin

C. Thyrotropin

D. Antidiuretic hormone

E. Vasopressin

4. A secondary messenger is a factor that:

A. Acts on cell receptors in target organs

B. Activates the hormone-receptor complex

C. Causes dissociation of the molecular inhibitor

D. Provides signal transmission from the receptor to specific intracellular structures

E. All answers are incorrect

5. Where, apart from the central nervous system, is a significant amount of regulatory peptides produced?

A. Spleen

B. Liver

C. GASTROINTESTINAL

D. Lungs

E. Kidneys

6. Under conditions of increased estrogen content in

in the blood plasma, there is an increase in the secretion of oxytocin by the neurohypophysis, which is an example of:

A. Positive feedback

B. Reactogenic effect

C. Permissive effect

D. Morphogenetic effect

E. Negative feedback

7. Hormones circulate in the blood:

A. In free form

B. In the form of non-specific complexes with erythrocytes (Er)

C. In the form of a complex with specific proteins

D. The correct answers are A, B, C

E. In free form and in a complex with specific proteins

8. The intracellular type of reception is characteristic of:

A. Peptides

B. Steroid and thyroid hormones

C. Catecholamines

D. Insulin

E. All answers are correct

9. Which of the following interactions characterizes a long feedback loop?

A. Hypothalamus–hypothalamus

B. Pituitary–hypothalamus

C. Pituitary-hypophysis

D. Peripheral endocrine gland–hypothalamus

E. Pituitary–peripheral gland of internal secretion

10. What are opiate receptors?

A. Receptors interacting with endorphins

and enkephalins

B. Receptors interacting with vasopressin

and oxytocin

C. Receptors that only the addict has

D. Pain receptors

E. There is no correct answer

Answers: 1.A, 2.C, 3.B, 4.B, 5.C, 6.A, 7.D, 8.B, 9.D, 10.A

Situational tasks to test basic knowledge:

1 The patient turned to the endocrinologist for a conclusion on the state of thyroid gland function. In the blood test, the content of thyroid hormones is reduced. Thyroliberin was administered to the patient for diagnostic purposes. Research results: 20 minutes after the introduction of thyroliberin, the content of thyrotropin in the blood increased 5 times, and after 4 hours, the content of thyroid hormones (T4 and T3) increased by 70%. Explain:

1) In which chain is the hypothalamic-pituitary-thyroid hormonal mechanism broken?

2) Does the patient have pituitary insufficiency?

3) Does the patient have thyroid dysfunction?

Answer 1: 1) Insufficient content of thyroid hormones in the body can be the result of damage to the hypothalamus, pituitary gland, and thyroid gland.

2–3) In this case, under the conditions of the introduction of thyroliberin, the level of thyrotropin and thyroid hormones increases, that is, the patient does not have damage to the pituitary gland and thyroid gland, but there is stimulation of thyroliberin production in the hypothalamus.

2. Consider the following stages and results of the experiment: 1. Two groups of male rats were placed in cages separated by a mesh partition. 2. Females in the state of estrus were planted in the free half of the cages. 3. One of the groups was injected with a drug — a luliberin receptor blocker — before mating the females, the second group was a control group. 4. We studied the dynamics of testosterone and lutropin in the blood of males of both groups after the mating of the female. In the control group, the dynamics of testosterone level increase were detected 20–40 min after the appearance of the female. The increase in testosterone levels was facilitated by the lutropin peak. In the second group, after the introduction of the drug, an 8-fold decrease in the initial level of testosterone was found. Against the background of the blockade of luliberin receptors in males, in the presence of a female, there was no increase in the level of testosterone in the blood. Explain:

1) What is the mechanism of inhibition of testosterone production with the introduction of luliberin receptor antagonist?

2) How is testosterone secretion regulated?

Answer 2: 1) Regulation is carried out by the hypothalamic-pituitary system using a feedback mechanism.

2) Blockade of luliberin receptors of the pituitary gland leads to inhibition of the secretion of lutro-

foam and subsequent decrease in testosterone secretion. A decrease in the level of testosterone causes

inhibition of sexual motivation

Formation of professional abilities and skills (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

- Investigate the effect of pituitrin on frog melanophore cells
- To solve situational tasks on the topic of practical training.

Instructional materials on the performance of tasks:

Study of the effect of pituitrin on frog melanophore cells

For work, you need: materials of an educational video film

Requirements for registration of results and their assessment. Draw a conclusion, enter it in the research protocol, solve the relevant situational and test tasks.

Control materials for the final stage of the lesson:

Tests for the final stage of the lesson

1. What hormones are derivatives of amino acids?

A. Thyroxine, triiodothyronine

B. Adrenaline, norepinephrine

C. Dopamine

D. Melatonin

E. All of the above

2. What is the average amount of hormones bound to specific carrier proteins in blood plasma?

A. 20%

B. 40%

C. 80%

D. 60%

E. 100%

3. Which of the interactions listed below characterizes an ultrashort feedback loop?

A. Hypothalamus–hypothalamus

B. Pituitary–hypothalamus

C. Pituitary-hypophysis

D. Peripheral gland of internal secretion - hypothalamus

E. Pituitary–peripheral internal gland secretions

4. Which hormones are mostly characteristic

species specificity?

A. Steroids

B. Protein-peptide

C. A derivative of amino acids

D. Hormones are not species-specific fecundity

E. Species specificity does not depend on

chemical nature of hormones

5. Which of the methods of quantitative determination

hormone level is the most accurate and widely used in clinical practice?

A. Radioimmunological

B. Chromatographic

C. Gel electrophoresis

D. Photoelectrocalorimetric

E. Magnetic resonance

6. Which of the substances listed below belongs to secondary mediators (messengers)?

A. Cyclic adenosine monophosphate

B. Cyclic guanosine monophosphate

C. Inositol triphosphate

D. Ionized Ca2+ and calmodulin

E. All the listed substances

7. When the content of glucocorticoids in the bloodstream increases, there is a decrease in the secretion of adenocorticotropic hormone (ACTH) by the adenohypophysis, which is an example of:

A. Positive feedback

B. Negative feedback

C. Kinetic action

D. Starting action

E. Reactogenic action

8. The membrane type of reception is characteristic of:

A. Peptides and catecholamines

B. Steroid hormones

C. Thyroid hormones

D. Glucocorticoids

E. All answers are correct

9. The primary messenger is a factor that:

A. Provides signal transmission from the receptor to specific intracellular structures

B. Activates the hormone-receptor complex

C. Acts on cell receptors in target organs

D. Causes dissociation of the molecular inhibitor

E. All answers are correct

10. A person has a daily urine output of 6 liters, the glucose content in the blood plasma is normal. Violation of the secretion of which hormone is the cause of this phenomenon?

A. Vasopressin

B. Insulin

C. Glucagon

D. Cortisol

E. Oxytocin

Answers: 1.E, 2.C, 3.A, 4.B, 5.A, 6.E, 7.B, 8.A, 9. C, 10.A

Situational tasks for the final stage of the lesson:

1. Explain what is the feedback principle of endocrine gland activity? Give an example. Draw a circuit diagram of biological regulation on the example of the chosen hormone.

Answer 1: The principle of feedback in the regulation of the activity of the endocrine system is that the tropic hormones of the pituitary gland stimulate the release of hormones by the endocrine gland, and the gland, in turn, through the release of its hormones, inhibits the secretion of tropic hormones (the so-called "plus-minus interaction"). For example, ACTH stimulates the formation of glucocorticoids, and cortisone inhibits the release of ACTH.

2. Explain how many times the speed of propagation of humoral influence is lower than the speed of propagation of a nerve impulse.

Answer 2: As many times as the speed of blood movement is less than the speed of propagation of nerve excitation.

3. Explain what will happen to the function of the endocrine gland if larger doses of its hormones are injected into the body. Give an example. Draw an outline of the biological regulation of the functioning of this gland.

Answer 3: The activity of the corresponding gland is inhibited by a negative feedback mechanism and atrophy from inactivity may occur.

4. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated.

5. List of recommended literature (main, additional, electronic information resources):

Basic literature:

1. Physiology [textbook] /V. M. Moroz, O.A. Shandra.– 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728p.

4. *Further reading:*

11. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier. - 6th ed.,2017.- 528 p

12. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, J. Yuan, H. L. Brooks. - McGraw Hill Professional. – 26th edition,2019.–752 p.

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14. Koeppen B. M.«Berne and Levy Physiology / B. M. Koeppen, B. A. Stanton. - Elsevier. - 7th edition, 2018. – 880 p.

15. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 8th ed., 2019.–1186 p.

Electronic information resources:

9. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

10. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

11. National Scientific Medical Library of Ukraine http://library.gov.ua

12. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua

Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua

SEMINAR CLASS

Semina lesson No. 4

Topic: Interpretation of clinical and laboratory studies of the higher nervous system

Purpose: an important criterion for the successful introduction of patients is knowledge of the role of innate and acquired forms of behavior, typological properties of VND. Analysis and knowledge of basic research methods with their subsequent use in practice.

Basic concepts:

Conditioned reflexes are complex adaptive reactions produced in the course of life on the basis of unconditional ones. Unlike unconditioned, conditioned reflexes are not characterized by constancy. They can form and disappear depending on specific conditions. Therefore, they are called conditional, that is, conditions are required for their formation. These reflexes are formed with the participation of the cortex of the large hemispheres. This is evidenced by experiments on animals in which the bark was removed. They almost lost the ability to form conditioned reflexes, but retained unconditioned and previously developed conditioned ones.

The stages of formation of a conditioned reflex distinguish two main stages:

1.-stage of generalization of the conditioned reflex

2. – the stage of specialization of the conditioned reflex

Inhibition of conditioned reflexes. Produced conditioned reflexes under various conditions can be extinguished due to inhibition. There is a distinction between external and internal braking. External inhibition occurs when excitations of various strengths appear in the central nervous system. Then a stronger excitation inhibits a weaker one. Internal inhibition occurs when the conditioned stimulus is not reinforced. It arises inside the arc of a conditioned reflex, that is why it is called internal. For example, if you develop a conditioned reflex - a food response to a call, and then give a call and do not reinforce it with food, then the food response to it is inhibited and may even disappear.

Memory. Mechanism of short-term memory. The mechanism of short-term memory is associated with the release of the serotonin mediator at the interneuron terminals. By binding to specific receptors on the membrane of a sensory neuron, serotonin leads to the activation of adenylate cyclase and an increase in the concentration of cAMP in the neuron. cAMP activates protein kinase, which increases the release of the neurotransmitter into the synaptic cleft of the sensory-motor synapse. As a result, weak stimuli are accompanied after their repetition by a long-lasting response. This phenomenon is called increased sensitivity (sensitization).

The mechanism of long-term memory is related to the phenomenon of long-term post-tetanic potentiation. The essence of the phenomenon of long-term posttetanic potentiation is that presynaptic stimulation unchanged in strength is transformed into increased postsynaptic return.

Figuratively speaking, where one PD arose, three or more arise. The secret of this phenomenon lies in specific receptors (so-called NMDA receptors: N-methyl-D-aspartate - sensitive), located on postsynaptic plates. The mediator in such synapses is glutamine. Having been released from the presynaptic ending, glutamine interacts with NMDA receptors, activates them, which leads to a massive influx of calcium and sodium ions into the cell. Along with these receptors, glutamine also activates AMPA (a-omino-3-hydroxy-5-methyl-propionate)-sensitive receptors through which only sodium enters. Thus, the postsynaptic membrane becomes more depolarized. Calcium entering the cell binds to calmodulin and activates adenylate cyclase. The level of cAMP in the cell increases. cAMP activates protein kinase A, which moves to the nucleus and activates a specific protein responsible for gene expression in the nucleus. That is, the genetic apparatus of the cell is connected to the mechanisms of long-term memory formation. As a result, RNA is synthesized, on the matrix of which a new one is synthesized in ribosomes
protein - memory protein. To date, the participation of protein in the mechanisms of long-term memory formation has been indisputably proven - when using certain compounds (for example, antibiotics - puromycin, anisomycin), which inhibit protein biosynthesis, long-term memory is not formed. The new proteins synthesized in the dendritic spines go to the neuron membrane, are embedded in it and thus cause a change in the shape and size of the synapse. Plasticity of synapses, according to modern concepts, is an integral component of long-term memory formation. However, this plasticity is not only structural, but also functional: part of the proteins formed goes to the synthesis of membrane AMPA receptors, which also change the functional features of this synapse.

Functional asymmetry of the brain hemispheres

Left hemisphere - provides speech and consciousness, as both hemispheres together. An isolated right hemisphere cannot provide spoken or written language. But she has a memory, the ability to visually and tactilely recognize objects. Depending on which of the hemispheres a person dominates, some features of psycho-nervous activity are manifested. If the left hemisphere dominates, the person is talkative, cheerful, in a good mood, prone to generalizations, abstract thinking, thinking directed to the future; the details of the picture are not captured. Such people mostly use verbs, the intonation is unclear. Language at the level of a 10-year-old child. Weak orientation in space, disinhibition, liveliness, positive emotionality. A "right-hemisphere" person is sad, few words (the right hemisphere is speechless, but artistic). Orientation in the space of good, subtle perception of musical works, painting. They mostly operate with nouns. Skillful manipulation of objects. Thinking in the present and past tense, figurative, objective, concrete. The emotional mood is mostly negative. The left hemisphere is more often dominant. In 95% of right-handed people and 70% of left-handed people, the left hemisphere ensures the development

of abstract logical thinking (perception, processing, analysis and synthesis of signals of the second signaling system). Only 15% of left-handed people have speech centers on the right, and 15% have them in both hemispheres. The right hemisphere is responsible for the perception, processing, analysis and synthesis of signals of the first signal system, that is, direct signals from the environment.

Temperament is an individual characteristic of a person, manifested in the strength of emotional reactions, as well as in excitability, balance, speed, rhythm and intensity of mental processes.

I.P. Pavlov, on the basis of many years of studying the peculiarities of the formation and course of conditioned reflexes in animals, singled out the main types of higher nervous activity. He based the division into types on three main indicators:

1. the strength of excitation and inhibition processes;
2. mutual balance, that is, the ratio of the strength of the excitation and inhibition processes;
3. mobility of excitation and inhibition processes, i.e. speed,

Plan:

8. Organizational measures:
- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,
- motivation of students of higher education regarding the study of the topic.

9. Control of the reference level of knowledge:
- written test,
- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes

Know:
- classification of conditioned reflexes, conditions for development of conditioned reflexes
- memory classification, mechanisms, mediators.
- physiological bases of research methods of the functions of higher nervous activity.

Be able:
- name the phases of sleep and know their characteristics on the electroencephalogram.

master the skills of electroencephalogram research.

List of didactic units: textbooks, manuals, methodical recommendations on the topic of practical training, video film.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

1. Stages of emergence of conditioned reflexes.
2. Classification of inhibition of conditioned reflexes.
3. Types of higher nervous activity
4. Asymmetry of the cerebral cortex.
5. Mechanisms of short-term and long-term memory.
6. Neurochemical mechanisms of sleep.
7. Violation of sleep phases.

Test tasks

1. How long is information stored in primary memory?

A. A few milliseconds
B. Seconds-minutes
C. Hours–days
D. Up to one year
E. A few years

2. How long is information stored in secondary memory?

A. Minutes–hours
B. Hours–days
C. Days–months–years
D. Tens of years
E. All life

3. Which of the structures listed below is the most important in the processes of memory formation?

A. Quadrituberous body of the midbrain
B. Amygdala
C. Hypothalamus
D. Corpus callosum
E. Hippocampus

4. What is the approximate percentage of perceived information stored in long-term memory during a person's life?

A. 10%
B. 20%
C. 50%
D. 100%
E. 1%

5. Consolidation is:

A. Consolidation of information in sensory memory
B. Transfer of information from short-term memory to long-term memory
C. Consolidation of information in primary memory
D. Transfer of information from conscious memory to unconscious memory
E. Consolidation of information in the secondary
memory

6. During the study of memory, a person was shown a bright object for a fraction of a second. She kept it in memory for another 150 ms. What process in the central nervous system ensured the preservation of information?

A. Excitation reverberation
B. Excitation irradiation
C. Divergence of excitement
D. Convergence of excitement
E. Multiplication of excitation

7. During the memory study, the examinee was shown a certain number of geometric shapes for a few seconds, after which he had to display them by heart. What type of memory was studied under these conditions?

A. Sensory

B. Secondary

C. Primary

D. Tertiary

E. Short-term

8. A person complained of poor memory to a neurologist: she remembers the past well, but cannot learn new information at all. What memory process is impaired?

A. Conservation

B. Cognition

C. Consolidation

D. Reproduction

E. Conservation

9. A right-handed person after a stroke can barely speak words, but language comprehension, reading and the ability to write are not impaired. What parts of the brain are possibly affected under these conditions?

A. Temporal lobe of the left hemisphere

B. Frontal lobe of the left hemisphere

C. Temporal lobe of the right hemisphere

D. Frontal lobe of the right hemisphere

E. Occipital lobe of the left hemisphere

10. What mechanism underlies the formation of long-term memory?

A. Emergence of a dominant focus in the cortex

B. Activation of synthesis of macromolecules (protein, DNA, RNA)

C. Circulation of impulses by closed circuits of neurons

D. Reciprocal braking

E. Irradiation processes

Answers

1.B, 2.C, 3.E, 4.E, 5.B, 6.A, 7.C, 8.C, 9.B, 10.B.

Situational tasks to test basic knowledge:

Situational task 1. Some people prefer to speak the text aloud when preparing for a report, lecture, or public performance. Others pronounce the text about themselves, but at the same time walk around the room. How can such differences in behavior be explained from a physiological point of view? Answer:. Types of memory are classified according to various characteristics, in particular, according to the modality of action: visual, auditory, kinetic. Some people remember better what they saw, others - what they heard, and still others - what was associated with some body movements. This explains their different behavior. According to this, it is best to show one student, tell another, and let the third do something with his hands.

Situational task 2. Electroconvulsive shock causes retrograde amnesia in an animal. She forgets a previously developed skill. Some drugs have a similar effect. How to determine the duration of short-term memory using any of these tools? Answer:. Based on the essence of short-term

memory, it is necessary to determine the time required for the perceived traces left after any actions to be transferred to long-term memory. Figuratively speaking, this is the time required for the book in our hands to be put on the shelf, where it will be stored for a long time and reread as needed. To determine this time, we will cause a shock or inject the drug after short intervals of time — 2, 5, 10, 20, 30 s after the first realization of the skill (for example, the rat's avoidance of pain). Next, you should find the maximum time after which the action still leads to forgetting the skill. This is the duration of short-term memory. For a time longer than this, amnesia does not occur, because the relevant information has already been transferred to long-term memory.

Situational task 3. A right-handed person does not remember the names of objects, but correctly describes their purpose. Explain which part of the brain is affected in this person. Answer: The left temporal area is affected, in which the sensory center of speech is located (field 38–39 according to Brodmann).

Formation of professional abilities and skills (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

- examine the electroencephalogram, phases of sleep.

Solve situational tasks on the topic of practical training

Instructional materials on the performance of tasks:

Study of the role of electroencephalogram

For work, you need: materials of an educational video film

Requirements for registration of results and their assessment. Draw a conclusion, enter it in the research protocol, solve the relevant situational and test tasks.

Control materials for the final stage of the lesson:

Tests for the final stage of the lesson

1. Types of higher nervous activity are formed as a combination of characteristic qualities, with the exception of:

A. Forces

B. Mobility

C. Excitability

D. Equilibrium

E. All the listed qualities

2. The expelled student hid it from his parents for a long time. Later, he developed a nervous breakdown. Which type of temperament according to Hippocrates could this student belong to?

A. Melancholic and choleric

B. Melancholic and sanguine

C. Melancholic and phlegmatic

D. Choleric and sanguine

E. Choleric and phlegmatic

3. What is the name of the type of thinking that mainly processes information from the second signaling system?

A. Emotional thinking

B. Verbal and logical thinking
C. Visual-active thinking
D. Figurative thinking
E. Artistic thinking

4. During the examination of the person, it was determined that the right hemisphere is the leading one. The level of functioning of which signaling system is higher in this person and to which type of higher nervous activity does he belong?
A. Mental, 2nd signaling system
B. Artist, 2nd signaling system
C. Middle, 1st and 2nd signal systems
D. Mental, 1st signaling system
E. Khudozhnyi, 1st signaling system

5. Which department of the central nervous system dominates during the analysis and synthesis of abstract (verbal) signals?
A. Limbic system
B. Thalamus
C. Hypothalamus
D. Left hemisphere
E. Right hemisphere

6. Language formation in a child takes place in several phases. The word acts in a complex with a direct stimulus and does not cause an adequate reaction. At what age does this happen?
A. The first six months after birth
B. The second half of the year after birth
C. In the second year of life
D. From two to three years
E. From three to five years

7. The formation of a child's language occurs in several phases. In one of the periods, the child understands, but does not speak. At this time, the beginning of the activity of social signal systems is laid - a direct vegetative or somatic reaction occurs to the word. At what age does this happen?
A. The first six months after birth
B. The second half of the year after birth
C. In the second year of life
D. From two to three years
E. From three to five years

8. Which method can be used to form an idea about the type of higher nervous activity?
A. Method of conditioned reflexes
B. Method of observations
C. Psychological observation
D. Self-assessments
E. All answers are correct

9. A five-year-old child lost the ability to speak for a while after a brain injury, but after a long time this ability was restored. Which hemisphere was injured, and due to which feature of the central nervous system in children, the restoration of speech became possible?
A. Left hemisphere, plasticity
B. Right hemisphere, plasticity
C. Left hemisphere, mobility
D. Right hemisphere, mobility

E. Both hemispheres, plasticity

10. In a tropical forest, a scientific expedition took a child from a tribe of monkeys who had lost the ability to speak. All methods to restore the child's speech have not been successful. At what age was the child found?

A. From 2 years
B. From 2 to 3 years
C. From 3 to 4 years
D. From 4 to 5 years
E. Older than 5 years

Answers

1.C, 2.A, 3.B, 4.E, 5.D, 6.A, 7.B, 8.E, 9.A, 10.E

Situational tasks for the final stage of the lesson:

Situational task.1 As a result of a car accident, the driver received a head injury and lost the ability to recreate his past (retrograde amnesia). Explain the function of which hemisphere is impaired. Answer: Most likely, the right, because it is believed that the traces of past events are stored mainly in the right hemisphere.

Situational task. 2 After anesthesia, a person does not remember the information that was offered to him before anesthesia. Explain which theory of short-term memory is supported by this fact. Answer: This fact testifies in favor of the theory of reverberation (circulation) of pulses in closed neural networks.

Situational task 3. Explain in which cases dreams can have diagnostic value. Answer: In this case, the most likely possibility is a pathological process that has started in the knee joint. So far, this process is still weakly expressed, the impulse from the lesion in the waking state is suppressed by other stimuli. But during sleep, these inhibitory effects are removed and the hearth reminds of itself.

Situational task 4. Serotonergic neurons of the blue spot in the hindbrain can have an inhibitory effect on the reticular formation of the brainstem. Explain how this interaction changes as a person transitions from sleep to wakefulness.

Answer: During the transition to wakefulness, the cortex becomes active. The most important role under these conditions is played by ascending activating influences from the reticular formation of the brain stem. In order for them to appear, the inhibitory effect of neurons of the blue spot on the reticular formation of the brain stem must be significantly reduced. Under the conditions of the transition to sleep, the picture will be reversed.

4. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the

topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated.

5. List of recommended literature (main, additional, electronic information resources):

Basic literature:

1. Physiology [textbook] /V. M. Moroz, O.A. Shandra.– 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728p.

4. *Further reading:*

16. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier. - 6th ed.,2017.- 528 p

17. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, J. Yuan, H. L. Brooks. - McGraw Hill Professional. – 26th edition,2019.–752 p.

18. Guyton A. Textbook of Medical Physiology / A. Guyton, J. E. Hall. - Elsevier. - 14th Edition, 2021. – 1820 p.

19. Koeppen B. M.«Berne and Levy Physiology / B. M. Koeppen, B. A. Stanton. - Elsevier. - 7th edition, 2018. – 880 p.

20. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 8th ed., 2019.–1186 p.

Electronic information resources:

13. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

14. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

15. National Scientific Medical Library of Ukraine http://library.gov.ua

16. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua

Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua

SEMINAR CLASS

Seminar session No. 5

Topic: Interpretation of clinical and laboratory studies of the sensory system

Purpose: an important criterion for the successful introduction of patients is the knowledge of the operation of the sensory system, the mechanisms of information encoding and its implementation, all this helps in case of malfunctions of one of the analyzers.

Basic concepts:

The existence of a living organism is impossible without information, which must come both from the outside world and from the internal environment. Both streams of information interact and are carried out thanks to the functioning of special systems - sensor systems. They transform adequate stimuli into nerve impulses that go to the central nervous system. At different levels of the brain, this information is filtered, analyzed, recognized and transformed into sensory sensations that are perceived and an image of the stimulus is created.

Each analyzer structurally consists of three parts: 1. Peripheral or receptor department. 2. Conductor department. 3. Brain department. The receptor part of the analyzer is the "window" of the nervous system. They are specialized cells or free nerve endings located on open areas of the skin and mucous membrane and respond primarily to adequate irritation. However, the brain must know not only about changes in the environment, but also about what is happening inside the body. Therefore, receptors are located in every internal organ and even in the brain itself (hypothalamus, 5 medulla oblongata). Depending on the location, the receptors are contact and remote. Contact are excited by direct contact with the source of irritation (tactile receptors). Distant receptors receive information at some distance from the source of irritation (visual, sound, olfactory). By localization, the receptors are: exteroreceptors - receptors located in the skin; proprioceptors - receptors located in muscles, joints and tendons; interoreceptors are receptors located in internal organs. According to the adequacy of irritation receptors are: chemoreceptors, mechanoreceptors, photoreceptors, nociceptors. According to the mechanism of excitation, primary and secondary receptors are distinguished. Primary sensory receptors are free nerve endings. They perceive irritation, turn it into excitation, and a receptor potential known as a type of local potential arises. The receptor potential, having reached a critical level of depolarization, turns into an action potential. Primary sensory receptors include skin, smell, and taste receptors. Secondary sensing receptors are functionally and structurally different. In their composition there is a receptor cell, around which there are sensitive nerve endings of the nerve cell. They always have their own background activity. Under the action of a stimulus, the stimulus is perceived by the receptor cell, a receptor potential (RP) arises in it, which leads to the release of a mediator. The latter causes depolarization of the postsynaptic membrane, which

generates a generator potential (similar to the excitatory postsynaptic potential), when it reaches a critical level of depolarization, an action potential arises. Secondary sensory receptors include visual, auditory, and vestibular receptors. Receptors have the following purpose: 1. Detection and recognition of signals. 2. Perception of irritation. 3. Transformation of signals into action potential and coding of the stimulus: a) primary coding is the coding of the type of stimulus, its frequency and intensity in the form of bundles of pulses of a certain frequency, duration, certain intervals between the bundles, which creates a certain drawing or pattern; b) secondary coding is the coding of the quality of the stimulus, features of the stimulus, compression of information in time (temporal coding) and compression of information in space (spatial coding). The intensity of the stimuli is coded by the pulse frequency, the nature of the irritation is indicated by the grouping of pulses, i.e. the pulses come in bundles at certain intervals - a time pattern (pattern) is created. It contains a certain number of pulses in a pack, it is different for each stimulus, and the intervals between them are also different pulses in a bundle and between bundles. During primary coding, the number of excited neurons changes, which are localized both in the central nervous system and in the cortex of the large hemispheres. 4. Primary analysis of the received information. 5. Selection of useful information. The conducting part of each analyzer includes, as a rule, 3 neurons. The first neuron is located in the spinal ganglion or in the ganglion of the cranial nerve, the second neuron is located in the structures of the CNS, the third neuron 6 is located only in the switching nuclei of the thalamus. The conductor department detects and recognizes signals on the basis of which useful information is extracted. Part of the received information is completely excluded, the other part is delayed for a while due to inhibition, the rest reaches the cortex. Out of 10 million bits of information sent to the cortex, only 1 million is received. Reticular nuclei and non-specific pathways take part in information filtering. Structurally, this process is determined by numerous branches, collaterals to various departments of the central nervous system and the cortex of the large hemispheres. The brain section of each analyzer is located in the cortex. It has nuclear and diffuse parts. The nuclear part of the analyzer is located in a specific projection field of the cortex, and the diffuse part is located in the corresponding associative area. The brain department is responsible for decoding, detecting, recognizing signals, building an image of a stimulus and forming a sensory sensation. Detection is a selective analysis of individual signs of a stimulus. This work is performed by detector neurons of various levels, which are excited only by certain features of the stimulus. Next, recognition of the stimulus or signal occurs due to the parallel analysis of all signs of the stimulus. After that, higher detectors create an image of the stimulus and at the same time a certain sensation is formed. The formation of the feeling occurs in all departments of the analyzer and ends in the brain department. Depending on the modality of the stimulus,

independent sensations of touch, sight, hearing, smell, taste, cold, heat, pain, vibration, position of the body and limbs in relation to the body are formed. Sensual perception of information, its awareness, subjective relation to it in the form of emotions is formed on the basis of the totality of all sensations. As a result of everything, a sensory experience arises, that is, a memory of the action of the stimulus is created. Perception of information - perception - is a reflection in the human mind of objects and phenomena of reality with their direct effect on analyzers as a whole.

Plan:

1. Organizational measures:

- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,
- motivation of students of higher education regarding the study of the topic.

2. Control of the reference level of knowledge:

- written test,
- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes:

Know:

- Structure of the visual analyzer
- The structure of the auditory analyzer
- The structure of the vestibular analyzer
- The structure of the somato-sensory analyzer

Be able:

- examine visual acuity
- examine hearing acuity
- explore tactile sensitivity

List of didactic units: textbooks, manuals, methodological recommendations on the topic of practical training, instructional materials for practical work.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

1. Structural and functional organization of sensory systems.
2. Sensory system receptors. Adaptation of receptors.
3. Behavioral department of the sensory system.
4. Mechanism of receptor excitation.
5. Nociceptive system and its structural and functional organization
6. Antinociceptive system. Opiate and non-opiate.

7. Structure and function of individual layers of the retina

Test tasks:

1. When a person injured his skin, he felt pain, this feeling was formed in a certain part of the cerebral cortex, namely:

A. In the postcentral gyrus

B. In the precentral gyrus

C. In the frontal lobes

D. In the temporal gyrus

E. In the orbitofrontal cortex

2. A person got skin burns on a sunny day and is in pain. Indicate which of the substances listed below was involved in the formation of the pain sensation?

A. Serotonin

B. Histamine

C. Adrenaline

D. Acetylcholine

E. GABA

3. A person constantly wears a wedding ring and does not feel it on his hand. Indicate what processes occurred in the membrane of the afferent nerve fiber

given skin irritation conditions:

A. An increase in the depolarization threshold

B. Increasing excitability

C. No change in excitability

D. Without changing the depolarization threshold

E. Reduction of the depolarization threshold

4. During the study of mechanoreception in humans, Meissner's corpuscles were activated under touch conditions. Specify which process ensures their activation:

A. Increasing pressure intensity

B. Increasing the speed of movement

C. Impact of vibration

D. Reduction of movement speed

E. Reducing the intensity of pressure and vibration

5. In a chronic experiment on an animal recorded evoked potentials in the somatosensory cortex under the conditions of stimulation of low-threshold receptors. Under these conditions, they were not fixed, because endo was synthesized in the brain gene peptides that relieved pain sensations. Specify these substances from the following:

A. Statins

B. Liberines

C. Vasopressin

D. ACTH

E. Endorphins

6. Under the conditions of traumatic damage to the posterior sensitive root of the spinal cord, there is a loss of all types of skin sensitivity, which has a certain character on the human body. Specify which one:

A. Half

B. Segmental

C. Longitudinal

D. Cross

E. Ribbon-like

7. Damage to the postcentral gyrus cerebral cortex in a person causes the loss of all types of sensitivity of certain areas of the body, namely:

A. of the same name
B. Opposite
C. The upper half of the body
D. Scalp
E. The lower half of the body

8. It has been established that when a person gets dressed, he gradually loses the feeling of clothes on his body due to the adaptation of tactile receptors as a result of a change in the permeability of the membrane afferent nerve fiber for ions, namely:
A. Decrease for calcium ions
B. Increase for sodium ions
C. Reduction for potassium ions
D. Increase for calcium ions
E. Reduction for sodium ions

9. It was established that the nature of human behavior changes under the conditions of significant temperature fluctuations of the air — from minus to plus values. This corresponds to the amount of cold and thermal receptors, which are in a certain ratio:
A. 5:1
B. 3:1
C. 8:1
D. 2:1
E. 6:1

10. A person suffering from chronic pain turned to a neurosurgical clinic, where by the method of stereotaxic surgery got rid of the unbearable feeling. Indicate which of the following brain structures were disabled:
A. Ventromedial nuclei of the thalamus
B. Supraoptic nuclei of the thalamus
C. Ventropostlateral nuclei of the thalamus
D. Thalamus (thalamectomy)
E. Nerve fibers connecting the frontal lobes with the thalamus (frontal leukotomy)

Answers
1.A, 2.B, 3.A, 4.B, 5.E, 6.B, 7.B, 8.E, 9.E, 10.C.

Situational tasks to test basic knowledge:

Situational task.1 When transmitting information in sensor systems, the principle of frequency modulation is used, among others. In the same group of receptors in the experiment, bundles of pulses were registered twice, the total number of which per unit of time in each bundle is the same. Can it be argued that the same information was transmitted in both cases?

Answer: 1. No, you cannot. The transmitted information is coded not only by the total number of pulses per unit of time, but also by the nature of their distribution in the packet. For example, the same number of cartridges per minute can be spent by firing both long and short bursts, and alternately.

Situational task.2. Explain why the most diverse stimuli and, moreover, of different modalities cause a uniform response in receptor cells - the emergence of a receptor potential.

Answer: 2. Because they all change the permeability of the receptor cell membrane for certain ions, which leads to the emergence of a receptor potential.

Situational task.3. A person looks at a group of people and at the same time takes a picture of it. The reflection of this group occurs both in the brain and on photographic film. In what case does information processing take place and how is it expressed?

Answer: 3. Information processing is the selection from the general flow of some part that is most important for the system that perceives information. Obviously, the brain processes information because we only see and hear what interests us. On the photographic film, everything is fixed without exception, therefore, information processing does not take place.

Situational task.4. If you close your eyes and roll a pea with two adjacent uncrossed fingers, you get the feeling of one pea. If you do the same thing with crossed fingers, there is a sensation of two peas (Aristotle's experiment). Explain the physiological mechanisms underlying this phenomenon.

Answer: 4. In the first case, the inner surfaces of the fingers that touch each other are irritated. In the second, there are external ones that do not touch each other. Under natural conditions, the outer surfaces of neighboring fingers can be irritated by only two objects at the same time, which is why the corresponding sensation arises in the brain.

Situational task.5. Explain why a person does not feel a ring that he constantly wears on his finger, but clearly feels when a fly has landed on this finger.

Answer: 5. During the constant action of a tactile stimulus, the receptors adapt and the irritation ceases to be felt, so the ring on the finger ceases to have an irritating effect.

Formation of professional abilities and skills (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

- Tactile sensitivity research methodology
- Methods of determining visual acuity
- Methodology for determining hearing acuity

Solve situational tasks on the topic of practical training

Instructional materials on the performance of tasks:

- Study of the role of visual acuity determination, hearing acuity determination

For work, you need: materials of an educational video film

Requirements for registration of results and their assessment. Draw a conclusion, enter it in the research protocol, solve the relevant situational and test tasks.

Control materials for the final stage of the lesson:

Tests for the final stage of the lesson	A. Somatoreceptors
1. What are pain receptors called?	B. Nociceptors

C. Proprioceptors
D. Distant receptors
E. Contacts

2. Objective signs of pain include changes in:
A. Blood pressure
B. All answers are correct
C. Rhythm of heart activity
D. Breathing rhythm
E. Leukocyte formula and hormonal spectrum of blood plasma

3. What kind of pain occurs when connective tissue, bones, joints, and muscles are damaged?
A. Visceral
B. Somatic superficial, delayed
C. Somatic superficial
D. Somatic superficial, initial
E. Somatic deep

4. Where is the largest number of nociceptors per unit area?
A. In the tendons
B. In the skin
C. In internal organs
D. In the muscles
E. In bone tissue

5. What is the name of pain sensitivity, which is phylogenetically more ancient, without clear localization, diffuse?
A. Somatic
B. Protopathic
C. Epicritic
D. Visceral
E. Caudal

6. How does pain sensitivity change under conditions of excitation of the structures of the antinociceptive system of the brain?
A. It is increasing
B. Sharply rises
C. Decreases
D. Does not change
E. Sharply decreases

7. What is a complete loss of pain sensitivity called?
A. Hyperalgesia
B. Analgesia
C. Normalgesia
D. Causalgia
E. Hypoalgesia

8. How does pain sensitivity change under the conditions of blocking the structures of the antinociceptive system of the brain, for example, with naloxone?
A. Sharply decreases
B. Does not change
C. Increases sharply
D. This system has nothing to do with pain sensitivity
E. All answers are incorrect

9. What substances released by the antinociceptive system of the brain suppress pain sensitivity?
A. Bradykinin, substance R

B. Adrenaline, norepinephrine

C. Acetylcholine, histamine

D. Prostaglandins, potassium ions

E. Endorphins, enkephalins

A. Decreases

B. Increases

C. Does not change significantly

D. First increases and then decreases

E. It first decreases and then increases

10. How does pain sensitivity change under conditions of long-term pain stimulus-reaction?

Answers

1.B, 2.B, 3.E, 4.B, 5.B, 6.C, 7.B, 8.C, 9.E, 10.C.

Situational tasks for the final stage of the lesson:

Situational task 1. During the transmission of information in sensor systems, the principle of frequency modulation is used, among others. In the same group of receptors in the experiment, bundles of pulses were registered twice, the total number of which per unit of time in each bundle is the same. Can it be argued that the same information was transmitted in both cases?

Answer: 1. No, you cannot. The transmitted information is coded not only by the total number of pulses per unit of time, but also by the nature of their distribution in the packet. For example, the same number of cartridges per minute can be spent by firing both long and short bursts, and alternately.

Situational task 2. Explain why the most diverse stimuli and, moreover, of different modalities cause a uniform response in receptor cells - the emergence of a receptor potential.

Answer: 2. Because they all change the permeability of the receptor cell membrane for certain ions, which leads to the emergence of a receptor potential.

Situational task 3. A person looks at a group of people and at the same time takes a picture of it. The reflection of this group occurs both in the brain and on photographic film. In what case does information processing take place and how is it expressed? Answer: 3. Information processing is the selection from the general flow of some part that is most important for the system that perceives information. Obviously, the brain processes information because we only see and hear what interests us. On the photographic film, everything is fixed without exception, therefore, information processing does not take place.

Situational task 4. If you close your eyes and roll a pea with two adjacent, uncrossed fingers, you get the feeling of one pea. If you do the same thing with crossed fingers, there is a sensation of two peas (Aristotle's experiment). Explain the physiological mechanisms underlying this phenomenon.

Answer: 4 In the first case, the inner surfaces of the fingers that touch each other are irritated. In the second, there are external ones that do not touch each other. Under natural conditions, the outer surfaces of neighboring fingers can be irritated by only two objects at the same time, which is why the corresponding sensation arises in the brain.

4. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated

5. List of recommended literature (main, additional, electronic information resources):

Basic literature:

1. Physiology [textbook] /V. M. Moroz, O.A. Shandra.– 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728p.

4. *Further reading:*

21. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier. - 6th ed.,2017.- 528 p

22. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, J. Yuan, H. L. Brooks. - McGraw Hill Professional. – 26th edition,2019.–752 p.

23. Guyton A. Textbook of Medical Physiology / A. Guyton, J. E. Hall. - Elsevier. - 14th Edition, 2021. – 1820 p.

24. Koeppen B. M.«Berne and Levy Physiology / B. M. Koeppen, B. A. Stanton. - Elsevier. - 7th edition, 2018. – 880 p.

25. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 8th ed., 2019.–1186 p.

Electronic information resources:

17. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

18. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

19. National Scientific Medical Library of Ukraine http://library.gov.ua

20. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua

Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua

SEMINAR CLASS

Seminar lesson No. 6

Topic: Interpretation of clinical and laboratory studies from the side of the cardiovascular system

Purpose: an important criterion for the successful introduction of patients is the study of the functions, mechanisms and regularities of the activity of the cardiac system and the circulatory system, the processes of control and regulation of these systems for adaptation and maintenance of homeostasis. It is necessary for applicants to get acquainted with the basics of the structure and functioning of the cardiovascular system, with indicators of its activity, methods of determining blood pressure, pulsometry, mastering new modern methods of diagnosing diseases

Basic concepts:

The heart muscle has properties that ensure its continuous rhythmic activity: excitability, automaticity, conduction, contractility, refractoriness. Automaticity is the ability of an organ, tissue or cell to be excited under the influence of impulses arising in themselves, without external stimuli. An isolated heart of a frog in cold-blooded Ringer's solution can contract at a constant rate for a long time - from several hours to several days. The process of heart excitation occurs in the area of the mouth of the vena cava. Here is the sinoatrial node (SA) - the center of the first order of automation, which is the driver of the rhythm, that is, the source in which the excitation that causes the heart contraction first occurs. From the sinoatrial node, the excitation passes to the muscle fibers of the right and then the left atrium and reaches the atrioventricular node (AV) - the center of second-order automation, which is the beginning of the conduction system of the ventricles. It is located in the thickness of the heart membrane, at the border of the atria and ventricles. The bundles of His originate from the atrioventricular node, which conduct excitation from the atria to the ventricles. The final branches of the conduction system are represented by a network of Purkinje fibers located under the endocardium. Together with the bundle of His, the Purkinje fibers form the center of third-order automatism, which is in direct contact with the working cells of the myocardium. As a result of the work of the three centers, the contraction of the heart generally occurs in the following sequence: the atria, the tops of the ventricles, the bases of the ventricles. At rest, the heart rate (HR) is determined by the CA node (discharge rate 60–80 beats/min). It subordinates all other nodes to itself and imposes its rhythm on them. Excitability is the ability to respond with excitement to stimuli. Under the influence of electrical, chemical and other stimuli, the heart goes into a state of excitement. Contractility is the property of muscles to contract in response to stimulation, i.e. an increase in the tension of muscle fibers or a reduction in their length. 22 Conductivity is the ability to conduct excitation. In the muscle cells of the SA node, it is 0.9–1.0 m/s; in AB – 0.05 m/s, in the bundle of His –

1.0–1.5 m/s; in Purkinje fibers - 3 m/s (such fast conduction of excitation in the fibers ensures simultaneous excitation of the ventricles). During excitation, the heart muscle loses its ability to respond with a second burst of excitation to an artificial stimulus or to an impulse that comes to it from a source of automation. This state of immobility is absolute refractoriness, its duration is 0.27 seconds at a heart rate of 70 beats per minute. The refractory period of the heart muscle lasts as long as its contraction in response to a single stimulus. Due to the significant duration of the refractory period, the heart muscle is not able to respond to repeated frequent stimuli with a fused contraction, the so-called tetanus. At a high frequency of stimulation, the heart muscle does not respond to every successive stimulation, but only to every second, third or fourth one that will arrive after the end of the refractoriness of the heart muscle. At the same time, single reductions, separated from each other, will be observed. Confused tetanic contraction of the heart muscle is present only in artificial conditions of the experiment, when by means of certain influences on the heart muscle, the duration of the action potential and the period of refractoriness can be sharply shortened. At the end of absolute refractoriness, the excitability is gradually restored to the initial level. This is the period of relative refractoriness, which lasts 0.03 s. At this time, the heart muscle is able to respond excitation only to very strong stimuli that exceed the initial stimulus threshold. After a period of relative refractoriness, there is a short interval when excitability is increased, a period of supernormal excitability. At this time, the heart muscle responds to subthreshold stimuli with a burst of excitement.

Plan:

1. Organizational measures:

- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,
- motivation of students of higher education regarding the study of the topic.

2. Control of the reference level of knowledge:

- written test,
- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes:

Know:

- the conducting system of the heart
- functions of typical and atypical cardiomyocytes
- atrioventricular delay
- Cardiac cycle

Be able:

- examine the pulse
- examine blood pressure
- examine the sphygmogram

List of didactic units: textbooks, manuals, methodological recommendations on the topic of practical training, instructional materials for practical work.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

1. Structure of the heart
2. Conductive system of the heart
3. Graph of atypical cardiomyocytes
4. Graph of typical cardiomyocytes
5. Phases of the cardiac cycle
6. Large and small circle of blood circulation
7. The effect of ANS on the work of the heart

Test tasks:

1. The speed of conduction of excitation through different parts of the animal was studied on an isolated heart. Where was the lowest speed determined?

A. In the atrioventricular node
B. At the tip of the bundle of His
C. In Purkinje fibers
D. In the atrial myocardium
E. In the myocardium of the ventricles

2. During heart transplantation, the viability of myocardial cells is determined. Determining which of these myocardial parameters is most important?

A. Heart temperatures
B. MPS of cardiomyocytes
C. O2 content in heart vessels
D. Concentrations of Ca2+ ions in myofibrils
E. Concentrations of Ca2+ ions in heart vessels

3. Under the conditions of the experiment, under the influence of a chemical substance, the reaction of the Ca2+ pump in the muscles weakened. What phenomena will be observed under these conditions?

A. Prolonged relaxation
B. Long-term MPA
C. Resting potential
D. Activation of the K+/Na+ pump
E. Change in the rate of spread of MPD

4. A 20-year-old athlete developed functional hypertrophy of the left ventricle of the heart as a result of constant physical exertion. What morphofunctional process is the reason for this?

A. Change in the number of conducting cardiomyocytes
A. Change in the amount of adipose tissue
B. Change in the number of fibroblasts
C. Change in cell size and number of contractile organelles

D. Change in the amount of connective tissue

5. The heart gives single contractions thanks to:
A. Existence of the exaltation phase
B. The shrinking phase of relative refractoriness
C. Long phase of absolute refractoriness
D. Contractive phase of absolute refractoriness
E. All answers are correct

6. Under the conditions of the examination, the patient needed to study the contractile function of the myocardium. What method can be used?
A. Ballistocardiography
B. Electrocardiography
C. Vector electrocardiography
D. Plethysmography
E. Sphygmography

7. Ca2+ channels of cardiomyocytes were blocked on an isolated rabbit heart. What changes in cardiac activity occur as a result?
A. Power of abbreviations
B. Frequency of contractions
C. Frequency and strength of contractions
D. Cardiac arrest during diastole
E. Cardiac arrest during systole

8. In what phase of the cardiac cycle are all the heart valves closed?
A. Isometric reduction
B. Asynchronous reduction
C. Quick expulsion
D. Slow expulsion
E. Active filling

9. A person takes drugs that block Ca2+ channels. What processes in the myocardium do they affect?
A. Excitability
B. Electromechanical coupling
C. Conductivity
D. Automatism
E. Perception of rhythm

10. During recording of MPD of cardiomyocytes, the duration of the plateau phase increases. This is due to:
A. Inactivation of slow Ca2+ channels
B. Activation of fast Ca2+ channels
C. Activation of Na+ channels
D. Activation of K+ channels
E. Activation of slow Ca2+ channels

Answers
1.A, 2.B, 3.A, 4.D, 5.C, 6.A, 7.C, 8.A, 9.B, 10.E.
Situational tasks to test basic knowledge:

Situational task: 1 Explain the physiological meaning of the fact that the walls of the left ventricle are much thicker than the right. Answer: In a large circle, the resistance is much greater, so the left ventricle does more work than the right, and its myocardium is more powerful

Situational task: 2. In mammals, the weight of the heart is on average 0.58% of the body weight. The deviation from this value in different species is relatively small. However, shrews, the smallest mammals (body weight 2.5–4.0 g), have a disproportionately large heart — 1.7% of body weight (almost three times more than expected). Explain this feature. Answer: It is known that with a decrease in body size, the intensity of metabolism per unit of mass increases significantly, therefore the heart rate increases sharply, since the work of the heart is aimed at ensuring the necessary amount of HOC and meeting the body's need for oxygen. In shrews, the heart rate reaches its physiological limit at 1200–1300 beats/min, therefore, they can obtain the required amount of IOC only by increasing the size of the myocardium.

3. Calculate why the weight of the heart of a newborn child weighing 3200 g should be equal. Answer The weight of the heart of a newborn is 0.8% of the body weight, so in this case it weighs 0.8 • 3200 : 100 = 25.6 g.

4. A six-month-old baby weighs 7.5 kg. Calculate what the mass of her heart should be. Answer The child is 5–6 months old. the mass of the heart is

0.4% of body weight. In this case, it weighs 0.4 • 7500 : 100 = 30 g.

5. Explain whether the boundaries of the heart correspond to those indicated in the table. 8.1, the age of the child? Specify the correct age limits. Answer The child is 5–6 months old. the mass of the heart is

0.4% of body weight. In this case, it weighs 0.4 • 7500 : 100 = 30 g.

Formation of professional abilities and skills (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

- Heart rate research methodology
- Pulse research methodology
- Methodology of research of AT

Solve situational tasks on the topic of practical training

Instructional materials on the performance of tasks:

- Study of the role of heart rate determination, blood pressure determination

For work, you need: materials of an educational video film

Requirements for registration of results and their assessment. Draw a conclusion, enter it in the research protocol, solve the relevant situational and test tasks.

Control materials for the final stage of the lesson:

Tests for the final stage of the lesson

1. During emotional excitement, the heart rate of a 30-year-old person reaches 112 bpm. Which part of the conduction system of the heart is responsible for these changes?
A. Purkinje fibers
B. His bundle
C. Atrioventricular node
D. Sinoatrial node
E. Legs of the bundle of His

2. After an illness, an adult has a heart rate of 40 bpm. What part of the conduction system of the heart provides this frequency?
A. His bundle
B. Bachmann bundle
C. Purkinje fibers
D. Kis node — Fleck
E. Aschoff's node — Tavara

3. As a result of the injury, the patient's right vagus nerve is damaged. In this case, what is the possible disturbance of cardiac activity?
A. Violation of automaticity of the atrioventricular node
B. Violation of the automatism of the sinoatrial node
C. Violation of conduction in the right atrium
D. Blockade of conduction in the atrioventricular node
E. Occurrence of arrhythmia

4. A feature of cardiomyocyte excitation is:
A. Spontaneous depolarization of membrane diastole
B. The presence of a repolarization plateau
C. Depolarization of the interventricular septum
D. Ventricular refractoriness
E. Compensatory pause

5. The average duration of the phase of absolute refractoriness in cardiomyocytes is:
A. 1–3 ms
B. 4–8 ms
C. 14–20 ms
D. 50–100 ms
E. 250–270 ms

6. The long duration of MPD of myocardiocytes depends on the plateau phase caused by:
A. By extending the activation time of Na+
B. Opening of Ca2+ channels of the cell membrane and Ca2+ current into the cell
C. Delay in the Na+ activation process
D. Delayed opening of membrane K+ channels
E. Delayed repolarization

7. A person fainted during a heart attack, convulsions appeared. It was found on the ECG that the frequency of contractions of the atria and ventricles is not the same. What can be the cause of this condition?
A. Complete transverse blockade of conduction of excitation
B. Violation of automaticity of the CA-node
C. Violation of automaticity of the AV node

D. Emergence of heterotropic foci of excitation

E. Violation of conduction between the atria

8. Cardiomyocyte and skeletal muscle fiber have in common:

A. Cell automation

B. The presence of intercellular contacts-nexuses

C. Dependence of biopotentials on concentration gradients of K+ and Na+

D. Presence of a "plateau" phase of the action potential

E. All answers are incorrect

9. What is the name of the phase of myocardial excitability, which corresponds to the "plateau" period of the action potential?

A. Phase of relative refractoriness

B. Phase of supernormal excitability

C. Phase of absolute refractoriness

D. Phase of subnormal excitability

E. Latent period

10. How will the work of the heart change after applying the first ligature of Stanius?

A. The atria and ventricles are contracting with the previous frequency

B. Atria and ventricles do not contract

C. The atria contract, the ventricles do not

D. The atria and ventricles contract simultaneously

E. Atria do not contract, ventricles contract

Answers

1.D, 2.E, 3.B, 4.B, 5.E, 6.B, 7.A, 8.C, 9.C, 10.B.

Situational tasks for the final stage of the lesson:

Situational task 1 The poison contained in some types of mushrooms sharply reduces the ARP of the myocardium. Explain whether poisoning by these mushrooms can lead to death. What is the mechanism of this phenomenon? Answer The peculiarity of myocardial ARP is that its duration is much longer than in skeletal muscle. Therefore, ARP continues throughout almost the entire systole. This prevents tetanic contraction of the myocardium. If the ARP shortens, the myocardium will be able to respond to irritation even before the end of systole. As a result, tetanus may occur, which is incompatible with the pumping function of the myocardium and leads to its stopping during systole.

Situational task 2. The patient is assumed to have a slowing of atrioventricular conduction. Explain how this can be objectively established. Answer The spread of excitation in the myocardium is most objectively recorded on the ECG. In this case, there will be an increase in the duration of the PQ interval by more than 0.1 s, which reflects the conduction of excitation from the atria to the ventricles through the atrioventricular node. A complete heart block will

occur, during which the atria contract in the rhythm of the sinoatrial node, the ventricles in the rhythm of the automaticity of the bundle of His.

Situational task 3. Explain how the work of the myocardium will change if the conduction of excitation by the bundle of His is completely blocked. Answer Complete heart block will occur, during which the atria contract in the rhythm of the sinoatrial node, the ventricles in the rhythm of the own automation of the bundle of His Situational task. In the patient, the excitation time from the atria to the ventricles is 2.5 times longer than normal. Calculate the conduction time of the atrioventricular node in this case.

Answer Normally, the conduction time of excitation through the atrioventricular node is 0.1 s. In this case, 0.1 • 2.5 = 0.25 s, which is typical for first-degree heart block.

4. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated.

5. List of recommended literature (main, additional, electronic information resources):

Basic literature:

1. Physiology [textbook] /V. M. Moroz, O.A. Shandra.– 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728p.

4. *Further reading:*

26. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier. - 6th ed.,2017.- 528 p

27. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, J. Yuan, H. L. Brooks. - McGraw Hill Professional. – 26th edition,2019.–752 p.

28. Guyton A. Textbook of Medical Physiology / A. Guyton, J. E. Hall. - Elsevier. - 14th Edition, 2021. – 1820 p.

29. Koeppen B. M.«Berne and Levy Physiology / B. M. Koeppen, B. A. Stanton. - Elsevier. - 7th edition, 2018. – 880 p.

30. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 8th ed., 2019.–1186 p.

Electronic information resources:

21. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

22. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

23. National Scientific Medical Library of Ukraine http://library.gov.ua

24. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua
Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua

SEMINAR CLASS

Seminar lesson No. 7

Topic: Interpretation of clinical and laboratory studies from the digestive and respiratory organs

Purpose: to form a clear idea of the basic concepts of the physiology of breathing, the main approaches to registering the functions of the respiratory system in clinical practice; to form the ability to apply methods of research of the physiological functions of the respiratory system and to be able to analyze the obtained data.

Basic concepts:

to form a clear idea of the basic concepts of the physiology of breathing and digestion, the main approaches to registering the functions of the respiratory and digestive systems in clinical practice; to form the ability to apply methods of research of the physiological functions of the respiratory and digestive systems, to be able to analyze the obtained data.

Basic concepts:

Central regulation of breathing is carried out by the respiratory center. The respiratory center is a group of nerve formations located at different levels of the central nervous system. The main nuclei of the respiratory center are located at the bottom of the IV ventricle (inspiratory and expiratory centers) and in the varoli bridge (center of respiratory rate regulation).

Afferent effects on the respiratory center are carried out by the ascending fibers of the vagus nerves. Efferent impulses of the respiratory center are transmitted to the respiratory muscles and the diaphragm through the motoneurons of the spinal cord.

The stretching of the walls of the pulmonary alveoli during inhalation is accompanied by the sending of a volley of nerve impulses by the vagus nerves to the center of exhalation.

Scheme of nervous regulation of breathing:

a - nerve impulses coming from the inhalation center; b - impulses to the pneumo-taxic center and to the exhalation center; c - impulses from the exhalation center; d, d - impulses to the inhalation and exhalation centers from lung receptors; / - pneumotaxic center; 2-exhalation center; 3 - sensitive fibers of the vagus nerve from the stretch receptors of the lungs; 4, 5 - motor nerve fibers to the intercostal muscles and diaphragm; 6 - center of inhalation

Humoral regulation of breathing is carried out by changing the excitability of the respiratory center under the action of chemical irritants or biologically active substances entering the blood. An increase in the partial pressure of carbon dioxide in the blood increases the excitability of the respiratory center. So, if the content of CO2 in the blood increases by 0.2%, then pulmonary ventilation increases by 20%.

The excitability of the respiratory center and pulmonary ventilation increases with the accumulation of H + ions in the blood. The resulting increase in pulmonary ventilation restores the disturbed acid-base balance: excess C02 is removed with exhaled air.

Increased sensitivity of the respiratory center to C02 is the result of a violation of its chemoreceptors located on the ventrolateral surface of the medulla oblongata.

The lack of oxygen in the blood causes increased breathing reflexively, through the chemoreceptors of the sinocarotid zone, aorta and other vessels. The respiratory center itself is practically immune to oxygen deficiency. As a result of the limited impact of oxygen deficiency on the respiratory center in a person, it is possible to underestimate its dangerous consequences.

The respiratory function ensures gas exchange between atmospheric (breathed) air and the body. Tissues and organs of the human body absorb atmospheric oxygen, used by them in oxidation. With the exhaled air, carbon dioxide is released from the body - the end product of biological oxidation.

In the respiratory function, external and internal breathing and the intermediate link between them - the transport of gases through the blood - are clearly visible. Adaptation of the respiratory system to physical exertion is manifested in the search for more perfect forms of regulation, increase functional reserves of external and tissue respiration. An objective indicator of adaptation is an increase in the functional levels of oxygen consumption, pulmonary ventilation, and the coefficient of oxygen utilization by tissues.

Respiratory function in children and adolescents is less pronounced than in adults, economical. They reach the appropriate values of oxygen consumption faster, but the achieved maximum is maintained for a shorter time.

Local, humoral and central nervous mechanisms can be conventionally distinguished in the regulation of breathing. The stretching of the walls of the pulmonary alveoli by air is accompanied by a volley of nerve impulses to the outlet center. Via the efferent branches of the vagus and spinal nerves, impulses reach the muscles of the chest and diaphragm, which provide exhalation. Humoral regulation is carried out through the respiratory center, to which impulses from chemoreceptors converge. The respiratory center itself has a selectively high sensitivity to the accumulation of C02 in the blood. Breathing is controlled by the higher departments of the central nervous system (voluntary delay, increased breathing rate. The assessment of the mechanisms of regulation of breathing processes is carried out during the determination of the time of the maximum breath delay on inhalation (Stange test) or on exhalation (Sabraze test). In the first case, the subject in a sitting position takes a deep breath and holds his breath as much as possible. The time of the maximum breath hold is determined. The test is repeated several times and is performed before and after physical exertion. During the determination of the time of the

maximum breath hold on exhalation (Sabraze test), the subject performs forced breathing for 1 minute. Then he makes a maximum exhalation, the time is determined The test is repeated several times.

Equipment: stopwatch, tables, slides, videos, notebooks, pens.

Plan:

1. Organizational measures:

- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,
- motivation of students of higher education regarding the study of the topic.

2. Control of the reference level of knowledge:

- written test,
- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes:

Know:

- basic concepts of respiratory physiology
- basic approaches to registration of functions of the respiratory system in clinical practice

Be able:

- to study the physiological functions of the human respiratory system and to be able to analyze the obtained data
- master the skills of using physiological research methods in clinical practice

List of didactic units: textbooks, manuals, methodological recommendations on the topic of practical training, instructional materials for practical work.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

1. Gas exchange in the lungs, its mechanism. Gas exchange in tissues, its mechanisms.

2. Diffusion capacity of the lungs, factors affecting its value. Arteriovenous oxygen difference. Anatomical and physiological dead space. Coefficient of oxygen utilization, method of determination.

3. Transport of gases by blood, importance for the body. The role of hemoglobin and myoglobin in respiration. Oxyhemoglobin dissociation curve. Factors affecting the formation and dissociation of HbO2. Blood oxygen capacity (BOC), determination methods. 4. Transport of carbon dioxide by blood, forms of transport. Oxygen and carbon dioxide tension in tissue fluid and cells.

5. Formation and dissociation of bicarbonates and carb-hemoglobin. The value of carbonic hydrase.

6. Gas exchange between blood and tissues, direction and mechanisms. Blood oxygenation level, method of determination.

7. Structures of the central nervous system that ensure the periodicity of breathing. Structures of the hindbrain, their role in the generation of the basic rhythm of breathing and regulation of inhalation. The role of the pneumotaxic center in the inhibition of inhalation, regulation of the volume and frequency of breathing. Apnea center. His role.

8. Lung stretch receptors, their significance in breathing regulation, Hering's - Breuer's reflex. The role of irritant, J-receptors and proprioceptors in the regulation of breathing.

9. Protective respiratory reflexes. The role of airway resistance in breathing.

10. Voluntary regulation of breathing. Influence of the gas composition and pH of arterial blood on the frequency and depth of breathing.

11. Central and peripheral chemoreceptors, their importance in ensuring gas homeostasis. Changes in lung ventilation under conditions of hypercapnia and hypoxia.

12. Breathing during physical exertion, increased and decreased barometric pressure.

13. The mechanism of the first breath of a newborn. Age-specific features of breathing regulation

Test tasks

1. What is the content of dissolved oxygen in normal arterial blood?

A. 0.9–1.4 vol%

B. 1.5–1.6 vol%

C. 18–22 vol%

D. 0.25–0.3 vol%

E. 8–14 vol%

2. Under normal conditions, the saturation of venous blood with oxygen is about:

A. 92-97%

B. 95–100%

C. 60-70%

D. 25–30%

E. 15–25%

3. Normally, the oxygen content in 1 liter of arterial blood is approximately:

A. 180–220 ml

B. 300–320 ml

C. 90–120 ml

D. 120–130 ml

E. 70–80 ml

4. The oxygen utilization rate in the human body during moderate physical activity increases to:

A. 20–40%

B. 50–60%

C. 90–100%

D. 75–85%

E. 40–60%

5. What is the name of the state in which the tension of carbon dioxide in the arterial blood is 60 mm Hg. Art. and more?

A. Normocapnia
B. Hypocapnia
C. Hypoxemia
D. Asphyxia
E. Hypercapnia

6. What is the name of the state in which the oxygen tension in the arterial blood is 60 mm Hg Art. and less?
A. Hypercapnia
B. Asphyxia
C. Hypoxemia
D. Hyperoxia
E. Normocapnia

7. In which of the following answers does the tension of oxygen and carbon dioxide in arterial blood correspond to normal values (in mm Hg)?
A. pO2 = 120, pCO2 = 60
B. pO2 = 90, pCO2 = 25
C. pO2 = 98, pCO2 = 40
D. pO2 = 55, pCO2 = 30
E. There is no correct answer

8. Gas exchange in the alveoli takes place:
A. Continuously during inhalation and exhalation
B. Only at the height of inhalation
C. Only during exhalation
D. Only at the beginning of the exhalation phase
E. During the exhalation phase

9. What composition is characteristic of exhaled air?
A. O2 18.3%, CO2 0.03%, N2 79.0%, H2O vapor 2.67%
B. O2 10.0%, CO2 5.5%, N2 78.0%, H2O vapor 6.5%
C. O2 13.5%, CO2 5.3%, N2 74.9%, H2O vapor 6.3%
D. O2 16.1%, CO2 3.9%, N2 75.1%, H2O vapor 6.0%
E. O2 20.85%, CO2 0.03%, N2 78.62%, H2O vapors 0.5%

10. The condition in which hypercapnia and hypoxia occur in the body at the same time is called:
A. Hyperoxia
B. Asphyxia
C. Hypocapnia
D. Hypoxemia
E. There is no correct answer

Answers: 1.D, 2.C, 3.A, 4.B, 5.E, 6.C, 7.C, 8.A, 9.D, 10.B.

Situational tasks to test basic knowledge:

1. Three people of the same age and physique take part in a 1000-meter race. At the end of the distance, the first and second had 120,000 ml each, and the third had 60,000 ml; BH equals 40, 80 and 40 in 1 min, respectively. Calculate which runner you think is the most trained and why.

Answer: In a trained person, the largest HOD is achieved with the smallest BH due to deepening of breathing. The first person is better trained, the third person is the worst.

2. In some people with bronchial asthma, in its early stage, there is an increase in VLDL. During treatment, the size of the VLDL returns to the initial level. Explain this phenomenon.

Answer: Under the conditions of bronchial asthma, a spasm of small bronchioles occurs, which greatly complicates breathing, especially exhalation. Under these conditions, the increase in VLDL is a compensatory adaptive reaction of the body, which provides a significant stretching of the lungs during inhalation, which, due to the increase in the elastic tension of the alveolar tissue, contributes to a more vigorous exhalation. During recovery, reverse phenomena occur and the VL decreases, as the need for more vigorous exhalation decreases.

3. A person needs to walk along the bottom of the reservoir. In such a situation, if there are no special devices, they breathe through a tube, the end of which comes out of the water. There are three tubes. The length of each is 1 m, and the inner diameter is 68, respectively; 30; 5 mm. Explain which tube to use. Justify your answer with an appropriate calculation. What main element of the tube can affect the efficiency of breathing?

Answer: Each tube, according to its volume, increases the anatomical dead space differently. The volume of the first tube is about 3.6 liters. Such a dead space is practically irresistible. Choosing this tube dooms a person to death from suffocation. The volume of the second tube is about 600 ml. This dead space can be overcome by breathing deeply and infrequently, using reserve inspiratory volume. Finally, the volume of the third tube is quite small. But due to its very small diameter, the air during breathing will move very quickly in the tube and its friction against the walls will increase sharply, which can significantly complicate breathing. Therefore, the dimensions of the second tube are optimal.

3. Formation of professional skills and abilities (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

- Investigate the maximum breath hold time.
- To solve situational tasks on the topic of practical training.

Instructional materials on the performance of tasks:

Determination of the time of the maximum breath delay during inhalation (Stange test)

A stopwatch is required for operation. The object of research is a person.

Conducting work. The subject in a sitting position takes a deep breath and holds his breath as much as possible. The time of maximum breath retention is determined. The test is repeated several times and is performed before and after physical exertion.

The method of determining the time of the maximum breath delay on exhalation (Sabraze test)

A stopwatch is required for work. The object of research is a person.

Conducting work. The subject performs forced breathing for 1 minute. Then he makes a maximum exhalation, the time of the maximum delay is determined. The test is repeated several times.

Requirements for registration of results and their assessment. Enter the obtained data in the research protocol, compare the time of breath retention on exhalation in several subjects. Draw conclusions.

Control materials for the final stage of the lesson:

Tests for the final stage of the lesson:

1. What condition occurs in the subject if he breathes atmospheric air frequently and deeply for 1 minute?

A. Asphyxia

B. Hypercapnia

C. Hypoxemia

D. Apnea

E. Hypocapnia

2. Peripheral chemoreceptors involved in breathing regulation are mainly localized:

A. In the pleura

B. In the carotid sinus and aortic arch

C. In the trachea

D. In respiratory muscles

E. In the medulla oblongata

3. The reason for the occurrence of hypoxia under the conditions of moving a resident of the plains to the conditions of the highlands is:

A. An increase in pO2 in the air due to an increase in atmospheric pressure

B. A decrease in the concentration of O2 in the air below 20.93%

C. Reduction of pO2 in the air due to a decrease in atmospheric pressure

D. Increased erythropoiesis

E. Reduction of erythropoiesis

4. What is the approximate percentage of O2 in a rarefied atmosphere at an altitude of 6000 m above sea level?

A. 15.42%

B. 18.75%

C. 8.34%

D. 16.80%

E. 20.93%

5. What is the immediate and main cause of altitude sickness?

A. A decrease in O2 tension in the blood that supplies the brain

B. Hypocapnia, central alkalosis and cerebral vasospasm

C. Acidification of arterial blood by products of anaerobic metabolism

D. Hypoxia and paralysis of the respiratory center

E. Increasing BH

6. The main effect of hyperbarotherapy is to improve the delivery of O2 to tissues by increasing:

A. Alveolar ventilation

B. Its connection with hemoglobin

C. Its solubility in blood plasma

D. All answers are incorrect

E. All answers are correct

7. Caisson disease develops under the conditions of a sharp transition from the zone:

A. High barometric pressure to a lower zone

B. Low barometric pressure in the zone of higher

C. With an atmospheric pressure of 760 mm Hg. Art. to a zone with the same pressure

D. With an atmospheric pressure of 760 mm Hg. Art. in the zone with a pressure of 800 mm Hg. Art.

E. All answers are incorrect

8. How will CHOD change and what will be the stimulus-response in regulation under these conditions, if the tension of carbon dioxide in arterial blood has increased to 60 mm Hg. Art.?

A. It will decrease (hypercapnic stimulus-response)

B. It will decrease (stimulus-response of hypoxia)

C. Will increase (stimulus-reaction of hypoxia)

D. Will increase (hypercapnic stimulus-response)

E. Will not change

9. What humoral factor plays the main role in breathing regulation?

A. Adrenaline

B. H+

C. CO2

D. O2

E. Products of metabolism

10. How will the minute volume of breathing change and what stimulus-reaction in regulation will appear in this case, if the oxygen tension in the arterial blood has decreased to 50 mm Hg. Art.?

A. Will increase (hypercapnic stimulus-response)

B. It will decrease (stimulus-response of hypoxia)

C. Will increase (stimulus-reaction of hypoxia)

D. Decrease (hypercapnic stimulus-response)

E. Reactions will not change

Answers: 1.E, 2.B, 3.C, 4.E, 5.C, 6.C, 7.A, 8.D, 9.C, 10.C.

Situational tasks for the final stage of the lesson:

1: Changes in homeostasis parameters occur when a person is sick with influenza. One of the first to change is body temperature. Explain: 1) how the amount of HbO2 will change; 2) how the parameters of external breathing change; 3) whether the HbO2 dissociation curve will change and why. Answer: 1) The amount of HbO2 in the blood decreases, because the affinity of Hb to O2 under conditions of high temperature decreases; 2) Breathing becomes more frequent; 3) The HbO2 dissociation curve changes, as the affinity of Hb to O2 decreases, the rate of dissociation increases.

2: In humans, oxygen transport by hemoglobin is severely impaired. What therapeutic action can help in providing oxygen to tissues?

Answer: If Hb function is insufficient, it is necessary to increase the amount of free dissolved O2 in the blood by subjecting the patient to hyperbaric oxygenation with high O2 pressure.

3: The analysis of gases in arterial blood showed that in the first case O2 contains 15%, CO2 - 40%. In the second case, these numbers are 20 and 60%, respectively. Explain in which case the blood belongs to an adult, in which case it belongs to a child.

Answer: In the first case, the child is of preschool age, in the second case, it is an adult.

4. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated.

5. List of recommended literature (main, additional, electronic information resources):

Basic literature:

1. Physiology [textbook] /V. M. Moroz, O.A. Shandra.– 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728p.

4. *Further reading:*

31. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier. - 6th ed.,2017.- 528 p

32. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, J. Yuan, H. L. Brooks. - McGraw Hill Professional. – 26th edition,2019.–752 p.

33. Guyton A. Textbook of Medical Physiology / A. Guyton, J. E. Hall. - Elsevier. - 14th Edition, 2021. – 1820 p.

34. Koeppen B. M.«Berne and Levy Physiology / B. M. Koeppen, B. A. Stanton. - Elsevier. - 7th edition, 2018. – 880 p.

35. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 8th ed., 2019.–1186 p.

Electronic information resources:

25. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

26. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

27. National Scientific Medical Library of Ukraine http://library.gov.ua

28. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua

Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua

SEMINAR CLASS

Seminar session No. 8

Topic: The role of clinical and laboratory research in rehabilitation

Purpose: to form a clear idea of the main concepts and to effectively and timely use the means of physical rehabilitation in the complex restorative treatment of patients; to form the ability to apply rehabilitation methods and to be able to analyze the received data.

Basic concepts:

The term "rehabilitation" (derived from the Latin: "habilitatis" - fitness, ability, capacity; prefix "re" - reverse or repeated action) means restoration of fitness, ability, capacity. It is used in all spheres of human activity - political, legal, intellectual, sports, etc. In medicine, it is defined as the process of restoring the health and working capacity of patients and disabled people.

the health of any human population (public health) is determined by four fundamental processes: reproduction of health, its formation, consumption, recovery. They are determined by biological, socio-economic, socio-psychological factors and are the basis on which a health management system can be built: form, preserve, strengthen it. 16 Public health of the population is assessed by medical and statistical indicators: birth rate, physical development, average life expectancy, morbidity, mortality. A health regime is important in maintaining a high level of health: a certain way of life that contributes to the restoration, maintenance and development of the body's reserves. An individual's health reserves depend on his physical condition and lifestyle. Physical condition - a person's ability to perform physical work. Lifestyle is a social category that includes the quality, way and style of life. According to the definition of the WHO, lifestyle is a way of existence based on the interaction between living conditions and specific patterns of individual behavior. The main factor in the formation of reserves and maintenance of a high functional state of the physiological systems of the human body is muscle work. Physical exercises train almost all working support systems - the heart, blood vessels, lungs, liver, kidneys and at the same time regulatory systems, since any muscle tension is a physiological stress. Regular exercise is a vivid example of a person's extraordinary adaptive capabilities. At the same time, long-term adaptation is manifested in the reorganization of the organism at the central, intersystem, systemic, organ, tissue, cellular, and molecular levels and is a manifestation of the biological norm. Physical detraining associated with the mechanization of work and life, in combination with excessive and unbalanced nutrition, hypodynamism against the background of neuropsychological overload contributes to the reduction of homeostasis reserves. Therefore, in modern conditions, a person's relationship to his health is of great importance, because today he takes a passive position. Specialists in physical rehabilitation should be especially important in

health promotion and disease prevention in our time. They, together with medical workers, conduct long-term monitoring of people, have the opportunity to determine their health level, predict it, adjust their lifestyle and thus prevent the development of diseases, promote a healthy lifestyle and involve them in physical and recreational activities.

Plan:

1. Organizational measures:

- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,
- motivation of students of higher education regarding the study of the topic.

2. Control of the reference level of knowledge:

- written test,
- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes:

Know:

- basic concepts of respiratory physiology
- basic approaches to registration of functions of the respiratory system in clinical practice

Be able:

- to study the physiological functions of the human respiratory system and to be able to analyze the obtained data
- master the skills of using physiological research methods in clinical practice

List of didactic units: textbooks, manuals, methodological recommendations on the topic of practical training, instructional materials for practical work.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

1. Describe the term "rehabilitation"?
2. What are the types of rehabilitation?
3. What is the process of physical rehabilitation?
4. Who is subject to rehabilitation and where is it carried out?
5. What is the main goal and task of rehabilitation?
6. What contributed to the creation of rehabilitation and when did it gain worldwide recognition?
7. What contribution did ancient scientists make to the therapeutic use of physical exercises?

Test tasks

1. During sports competitions of the same intensity, the oxygen debt will be the largest after the end of physical exertion during:
A. 2 min
B. 4 min
C. 6 min
D. 8 min
E. 10 min

2. The optimal training regimen includes loads that have one of the following characteristics throughout the entire training period:
A. Low power
B. Equal in intensity
C. Equal in duration
D. Cause fatigue
E. Do not cause fatigue

3. The oxygen debt is eliminated during the period:
A. Production
B. Steady state
C. Fatigue
D. Warm-up
E. Rest

4. The maximum duration of physical activity for a person is determined by:
A. Power of work
B. Energy losses
C. Work productivity
D. Efficiency coefficient
E. Anaerobic processes

5. After physical training, the maximum strength of the biceps muscle of the shoulder almost doubled due to the increase in:
A. Calcium concentrations
B. Amounts of muscle fibers
C. Physiological cross-section of each fiber
D. Numbers of mitochondria
E. Adaptations of the circulatory system

6. Static work performed while maintaining a vertical posture is carried out due to the activation of:
A. Fast motor units
B. Slow motor units
C. Solid tetanus
D. Glycogenesis
E. Anaerobic processes

7. Regular physical training counteracts the development of risk factors and helps maintain health by reducing:
A. Adrenaline concentrations
B. Hematocrit index
C. Glucagon concentrations
D. Cortisol concentrations
E. Blood pressure

8. Physical endurance training leads to the development of muscle fibers:
A. Hypertrophy
B. Hyperplasia
C. Hyperkalemia
D. Hyperglycemia
E. Hypernatremia

9. When studying the development of fatigue, it was found that one of the factors contributing to its occurrence is:

A. Hyperhydration

B. Respiratory alkalosis

C. Metabolic acidosis

D. Lack of calcium

E. Gluconeogenesis

10. When measuring the hand dynamometer strength of the student's hand flexor muscles, it was found to be reduced compared to normal values. This can be explained by the decrease:

A. Adrenaline concentrations

B. CO2 tension

C. Lactate concentrations

D. MPD frequencies in muscle fibers

E. Concentrations of K+ ions

Answers

1.A, 2.D, 3.E, 4.B, 5.C, 6.B, 7.E, 8.A, 9.C, 10.D.

Situational tasks to test basic knowledge:

1. A worker with a long experience in the course of his production activity performs standard operations. After each hour of work, he takes a 10-minute break for rest. Operations are being timed. The following data were obtained (the time of the same operation is indicated in seconds a few minutes before rest and immediately after rest). Before rest: 16, 15, 15, 16, 14, 15, 16, 16, 16, 15, 15, 16, 17, 15, 16. After rest: 21, 19, 18, 18, 19, 20, 17, 18, 18, 17, 18, 17, 15, 17, 16. What can explain the paradoxical effect — in the first minutes after rest, the indicators are not better, but worse than before rest?. Answer: During rest, the spent energy is not only restored, but also the dynamic stereotype formed during operations is weakened. It allows you to automate the performed actions to a high degree. After rest, some time is needed each time for "production", i.e. restoration of a certain rhythm, which is fixed during work, movement and during their sequence.

2. The well-known phenomenon of active recreation, established by I. M. Sechenov in relation to muscle work. Explain whether this pattern is also valid for mental activity. Answer: In case of mental fatigue, for example, when solving mathematical problems, working on a computer, etc., it is better not to just rest, doing nothing, but to switch to another type of mental activity - play a light game of chess, solve a crossword and etc. For the same reason, there is an opinion that it will be more effective for students to listen to two separate lectures on different subjects than a two-hour lecture on the same subject.

3. In four groups of rats, a stressful state was induced many times by immobilization. In the first group, rats were in this state 70% of the time of the day, in the second - 40%, in the third - 15%, and in the fourth - 5%. After the end of the experiment, the resistance of the organism to other

loads was determined in each of the four groups of rats. Explain in which group the resistance was the highest. Answer:

Excessive loads lead to a weakening of the body, a decrease in its resistance, but minimal loads also cause a decrease in resistance, since the necessary training of the body's protective forces, the inclusion of compensatory, adaptive mechanisms does not take place. Therefore, the animals of the third group, which were exposed to moderate, but not minimal stressful actions, turned out to be the most resistant. So, negative emotions, although unpleasant, but being moderate for this organism, contribute to increasing its resistance.

3. Formation of professional skills and abilities (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

Methodology for determination of stability and switching of attention

Solve situational tasks on the topic of practical training.

Instructional materials on the performance of tasks:

To work, you need a table with an image of tangled broken lines, a stopwatch.

The object of research is a person.

Conducting work. Under the experimenter's command, the subject finds the end of each line and marks it with the corresponding number in the right column, without using a pointer or a pencil, but only with his eyes. After 3 minutes, the experimenter interrupts the subject's work and, after checking it, evaluates the degree of stability of voluntary attention by the number of correctly found line ends in 3 minutes.

Requirements for registration of results and their assessment. Enter the obtained data in the research protocol, compare the time of breath retention on exhalation in several subjects. Draw conclusions.

Control materials for the final stage of the lesson

Tests for the final stage of the lesson

1. During exercise on a bicycle ergometer, an increase in lactic acid compared to pyruvic acid was found in human blood. This indicates:

A. Hyperglycemia

B. Trainability

C. Adaptation

D. Hyperthermia

E. Oxygen debt

2. At rest, O2 absorption was 0.3 l/min, after 20 squats for 30 s — 0.1 l/min. When recovering after physical exertion in the first 2 minutes — 1.5 l/min, in the 3rd minute — 0.3 l/min. Oxygen debt under these conditions:

A. 0.2 l

B. 0.3 l

C. 0.75 l

D. 0.85 l

E. 1.6 l

3. At rest, a person's heart rate is 75 bpm. After physical exertion on
In the 1st minute of recovery — 100 bpm, in the 3rd — 95 bpm. This indicates:
A. Lack of training
B. Availability of adaptation
C. Submaximal loads
D. Maximum loads
E. Excessive loads

4. The absorption of O2 in the subject at rest was within the physiological norm, and during physical exertion it doubled, which indicates an increase in:
A. Intensities of work
B. Intensities of metabolism
C. Work productivity
D. Utilization of oxygen
E. Diffusion capacity of the lungs

5. The student's maximum breath retention after maximum inhalation was measured, it was 20 s. This indicates a decrease in:
A. Oxygen utilization coefficient
B. Respiratory adaptation
C. Resistance to hypoxia
D. Diffusion capacity of the lungs
E. Hematocrit index

6. In a boy, during physical exertion, arterial blood pO2 is 100 mm Hg. art.; pH — 7.4; pCO2 — 38 mm Hg. art.; the maximum duration of breath retention after a deep breath —
50 s; HbO2 saturation — 96%. This shows that under the conditions of this physical work, the following is observed:
A. Adaptation
B. Hypoxia
C. Hypercapnia
D. Acidosis
E. Alkalosis

7. The best indicator of the degree of training (adaptation) under the conditions of physical exertion is:
A. Heart rate
B. Respiratory rate
C. Blood pressure
D. HOK
E. Maximum oxygen absorption

8. The duration of the recovery period depends on:
A. Quantities of hemoglobin
B. Intensities of work
C. Efficiency coefficient
D. Type of work
E. Work productivity

9. What indicator indicates that under the conditions of constant physical training, a young athlete is adapted to physical exertion?
A. Reduction of pO2 of arterial blood
B. Increase in pO2 of arterial blood
C. Increase in lactate concentration

D. Increasing saturation of hemoglobin with oxygen

E. An increase in the number of erythrocytes

10. During physical exertion, the dissociation of oxyhemoglobin increases due to:

A. Hyperventilation

B. Hyperoxia

C. Hypercapnia

D. Adenosine

E. Respiratory reserve

Answers

1.E, 2.D, 3.A, 4.B, 5.C, 6.A, 7.E, 8.B, 9.E, 10.C.

6. Situational tasks for the final stage of the lesson:

1. As you know, prolonged hypokinesia leads to the appearance of a whole series of disorders in the body. Other things being equal, where is hypokinesia more dangerous — on Earth or on a spaceship? Explain why. Answer: Weightlessness significantly reduces the load on the musculoskeletal system. This leads to the release of Ca++ from the bones and other adverse disorders. That is why special sets of physical exercises are being developed for cosmonauts to counteract hypokinesia.

2. It is necessary to adapt a person to the effect of an environmental temperature of 50 °C. However, when she was placed in a chamber with such a temperature, exhaustion quickly set in, and the experiment had to be stopped. Therefore, in the future, a special training regimen was developed, which made it possible to quickly reach the required level of heat resistance. Explain the principle on which the applied regime was based. No additional measures, such as medication, were used. Answer: One of the important principles of adaptation of the body to the action of heavy loads is a gradual increase in the force of action. This reveals the regularity of the thermodynamic approach, namely: it is easy for the system to pass from one stationary state to another, if the difference between these states is not very large. Therefore, a mode with a gradual increase in temperature in the chamber was used. Not immediately 50 °C, but first 30, then 35, then 40, etc. If you compare the process of adaptation of the body to any actions with climbing a very steep mountain, then we can say that the best result will be achieved if you climb the stairs , and the height and width of the steps should be selected according to the individual characteristics of each given organism.

3. The more work a muscle does, the more intensively it consumes oxygen. Can it be said that the more complex the task the brain is solving, the more oxygen it consumes? Answer: No. A muscle can be likened to an engine, which consumes energy per unit of time in proportion to the

work done. The brain can be likened to a computer that consumes a lot of energy, but the necessary amount of it does not depend on the complexity of the tasks being solved.

4. The value of the coefficient of useful action of the heart is defined as the ratio of the value of the work performed by the heart and the amount of absorbed O2. In an experiment on a cardiopulmonary drug, it was established that the value of the coefficient of useful action increases when the heart is in a critical, close to death state. Explain this result. Answer: The coefficient of useful activity shows how much of the spent energy is converted into useful work. A situation in which a dying heart would begin to use energy more efficiently is physiologically impossible. Therefore, the increase in the efficiency is not real, but imaginary, which follows from the peculiarities of the formula used. In an agonizing heart, oxidative processes weaken sharply and the heart uses anaerobic reactions as the last energy resources. However, the formula does not take this into account, hence the unexpected result.

4. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated.

5. List of recommended literature (main, additional, electronic information resources):

Basic literature:

1. Physiology [textbook] /V. M. Moroz, O.A. Shandra.– 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728p.

4. *Further reading:*

36. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier. - 6th ed.,2017.- 528 p

37. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, J. Yuan, H. L. Brooks. - McGraw Hill Professional. – 26th edition,2019.–752 p.

38. Guyton A. Textbook of Medical Physiology / A. Guyton, J. E. Hall. - Elsevier. - 14th Edition, 2021. – 1820 p.

39. Koeppen B. M.«Berne and Levy Physiology / B. M. Koeppen, B. A. Stanton. - Elsevier. - 7th edition, 2018. – 880 p.

40. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 8th ed., 2019.–1186 p.

Electronic information resources:

29. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

30. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

31. National Scientific Medical Library of Ukraine http://library.gov.ua

32. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua

Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua

SEMINAR CLASS

Seminar session No. 9

Topic: Comparison of clinical and laboratory studies in a healthy person at rest and during physical stress on the part of the nervous system

Purpose: to form a clear idea of the basic concepts of the physiology of the nervous system at rest and under physical stress, to be able to apply registration methods and analyze the obtained data.

Basic concepts:

The brainstem consists of the medulla oblongata, pons, and midbrain, and contains motor and sensory nuclei that perform motor and sensory functions for the face and head in the same way that the spinal cord performs these functions for the neck, trunk, and limbs. At the same time, the brain stem performs many special functions (including control of some visceral functions, balance posture, eye movements) and serves as a nodal station for "command signals" from higher centers. The vestibular and reticular nuclei of the brain stem play an important role in controlling body movements and its balance.

Reticular nuclei. They are divided into reticular nuclei of the bridge and reticular nuclei of the medulla oblongata. These two systems of nuclei function antagonistically to each other: the pons nuclei activate motoneurons that innervate the antigravity muscles (extensors), the nuclei of the medulla oblongata inhibit them. The reticular nuclei of the bridge transmit excitatory signals to the spinal cord through the bridge reticulospinal tract, located in the anterior column of the spinal cord. The fibers of this tract activate the motoneurons of the spinal cord, which send excitatory impulses to the motoneurons of the spinal cord, which innervate the extensor muscles of the limbs. The reticular nuclei of the bridge have high excitability. In addition, they receive excitatory impulses both from the vestibular nuclei and from the deep nuclei of the cerebellum. In this way, the activating reticular system of the bridge causes the activation of the antigravity muscles of the whole body. The reticular nuclei of the medulla oblongata transmit inhibitory signals to the same antigravity neurons of the spinal cord, but through a different pathway, the reticulospinal tract of the medulla oblongata, located in the lateral columns of the spinal cord. The reticular nuclei of the medulla receive collaterals from the corticospinal tract, rubrospinal tract, and other motor pathways. The normal activity of the inhibitory reticular system of the medulla oblongata maintains a balance with the activity of the activating system of the reticular formation of the bridge, as a result, the muscles of the body do not have excessive tension. Commands from the upper brain can interrupt the inhibitory influence of the medulla oblongata when the brain needs stimulation of the pons system to control the body's vertical position.

Excitation of the reticular system of the medulla oblongata can inhibit the motoneurons of the antigravity muscles (extensors) in those cases when it is necessary to perform some movements.

Activating and inhibiting reticular nuclei are a mandatory part of the control system, which is controlled by signals from the motor cortex; in addition, these nuclei create a basic level of tonic contraction to resist the forces of gravity and can inhibit certain muscle groups to provide other functions.

The vestibular nuclei are functionally connected with the reticular nuclei of the bridge, they activate the motoneurons of the antigravity muscles. The lateral vestibular nuclei transmit strong excitatory signals through the lateral and medial vestibulospinal pathways to the motoneurons that innervate the extensor muscles. Without the participation of the vestibular nuclei, the reticular system of the bridge significantly weakens its excitatory effect on the gravitational muscles of the neck, back, upper and lower limbs. The specific role of the vestibular nuclei consists in the selective control of excitatory signals coming from the vestibular apparatus to various antigravity muscles to maintain balance. The red nucleus of the midbrain functions in interaction with the corticospinal tract, having close connections with the motor cortex (cortical-erythrocyte fibers), cerebellum, reticular formation, olive. The axons that form the rubrospinal tract depart from the giant cells of the red nucleus. The fibers of this path end mainly on the insertion neurons of the intermediate zone of the gray matter of the spinal cord, but part of the axons contact directly with the motoneurons of the spinal cord.

In the giant cell part of the red nucleus (as well as in the motor cortex), all the muscles of the body are represented, by stimulating this part, single and group muscle contractions can be obtained. The cortico-rubrospinal pathway serves as an additional route for transmission of discrete signals from the motor cortex to the spinal cord. If the corticospinal fibers are destroyed and the corticorubrospinal pathways are preserved, discrete movements are partially preserved, but fine movements of the fingers and hand are significantly impaired. Thus, the blockade of the corticorubrospinal pathways disrupts the motor activity of the muscles in the wrist region. The corticospinal and rubrospinal tracts are located in the lateral columns of the spinal cord, control the distal muscles of the limbs and together make up the lateral motor system of the spinal cord. The vestibuloreticulospinal system lies medially in the spinal cord and this system is called the medial motor system of the spinal cord.

Motor reflexes of the hindbrain, decerebrate rigidity.

The hindbrain is the medulla oblongata and the pons. They retain signs of a segmental structure, but also have suprasegmental formations. Among the most important motor suprasegmental formations are the parenchymal nuclei and the reticular substance. They are called

suprasegmental formations, as they affect the muscles not directly, but through the motoneurons of the segmental structures - motor nuclei of the spinal cord and cranial nerves.

The hindbrain receives and processes all afferent information coming from the spinal cord, since all specific ascending pathways from the spinal cord, entering the brain stem (hindbrain and midbrain), give collaterals (branches) to the reticular formation, where the processing of afferent information continues.

The hindbrain receives new afferent information that plays a role in the regulation of motor functions - this is information from vestibular receptors.

Otolith receptors are hair cells, the hairs of which are immersed in the otolith membrane - a jelly-like membrane with the inclusion of CaCO3 crystals - otoliths. Displacement of this membrane deforms hairs stimulation of the receptor (or its inhibition, depending on which way the hair bends). The otolith membrane shifts relative to the hair cells under two conditions:

1. Displacement of the head in space. 2. Motion with linear acceleration.

The vestibuloreceptors of the semicircular tubules are hair cells that are located in the ampullae of the semicircular tubules and are immersed in the endolymph of these tubules. Endolymph moves relative to hair cells and deforms them when moving with angular acceleration. At the same time, the hair cells of the channel are excited, which is located in the plane in which rotational movements take place (in accordance with the three-dimensional space in which we exist, there are 3 semicircular tubules).

From the vestibuloreceptors, information is transmitted to the hindbrain via the afferent fibers of the VIII pair of cranial nerves (hereinafter referred to as the cranial nerve) - the vestibulo-cochlear nerve (more precisely, via its vestibular part). There are 4 vestibular nuclei (medial, lateral, upper and lower) located in the hindbrain. In the regulation of motor functions in humans, the lateral vestibular nucleus of Deiters, from which the vestibulospinal pathway (part of the MNS) begins, is of greatest importance.

The role of the hindbrain in the regulation of motor functions can be studied in animals with decerebration - a section of the brain stem between the midbrain and hindbrain (more precisely, below the red nuclei of the midbrain). When comparing the possibilities of regulation of motor functions of such an animal and a spinal animal, it is possible to assess the role of the hindbrain in the regulation of these functions. After the decerebration operation, the animal develops decerebration rigidity, which in the cat is manifested in the following: the front and rear limbs are stretched; the head is thrown back due to the extension of the neck; the tail is raised; the body is stretched. This cat pose is associated with hypertonicity of the extensors. The posture of a decerebrate animal (decerebrate rigidity) can be characterized as an enhanced antigravity

posture. Let's recall that the spinal cord ensured the formation of muscle tone of a reflex nature, but did not ensure the formation of an antigravity posture due to the low strength of the tone.

Vestibulospinal influences form the basis of decerebration regularity. The parenchymal nuclei of Deiters are tonically active, as the vestibuloreceptors adapt very slowly. From these nuclei, along the paraspinal pathways, which do not cross, information flows to the motoneurons that innervate the muscles of the trunk and proximal parts of the limbs. At the same time, □- and □-motoneurons of extensors are activated, and □- and □-motoneurons of flexors, on the contrary, are inhibited.

Activation of □-motoneurons of extensors leads to direct activation of extrafusal fibers of these muscles, increasing their tone. Activation of □-motoneurons leads to shortening of the contractile segments of intrafusal fibers, shortening of these segments, stretching of the nuclear bag of intrafusal fibers, excitation of the receptor, transmission of information through the □-loop to □-motoneurons, increasing their activity, increasing the tone of extensor muscles. The opposite changes occur in the flexor group of muscles.

Therefore, we can briefly say that the development of decerebrate rigidity is based on vestibulospinal influences, thanks to which:

- □- and □-strengthening of myotatic tonic reflexes of extensors;
- □- and □-weakening of myotatic tonic flexor reflexes.

Cervical postural reflexes - arise in response to a change in the normal position of the head relative to the body. At the same time, proprioceptors of the neck are irritated, transmission of information to the cervical segments of the spinal cord via propriospinal descending pathways to the motoneurons of the spinal cord, redistribution of muscle tone, which changes the position of the trunk in accordance with the position of the head:

- if the head tilts or turns to the side, the tone of the extensors increases on the side of the tilt, and the tone of the flexors increases on the opposite side. This redistribution of tone prevents falling, i.e. loss of posture;
- if the head tilts forward, the tone of the flexors increases on the front limbs of the cat, the tone of the extensors - on the back (the cat drinks milk or eats Whiskas);
- if the head is thrown back, the tone of the extensors increases on the front limbs of the cat, the tone of the flexors - on the back (the cat looks at the parrot and prepares to jump).

Peripheral (vestibular) reflexes of position - arise when the position of the head in space changes. When tilting or turning the head, the otolith vestibuloreceptors are excited, information is transmitted to the vestibular nuclei of Deiters, to the motoneurons of the spinal cord and to the muscles. As a result, the tone of the extensors increases on the side of the tilt (turn), and on the opposite side - the tone of the flexors of maintaining the posture.

Redistribution of tone due to cervical reflexes cannot be obtained in a spinal frog due to the weakness of tone, although the level of their closure is the spinal cord. The hindbrain reinforces these reflexes.

Cervical and postural position reflexes in the form of redistribution of tone can be obtained in a decerebrated animal. But against the background of rigidity, the degree of this redistribution is insufficient to maintain an antigravity posture: a decerebrated animal can stand like a doll, but still cannot maintain balance under conditions that turn on the cervical and parietal static postural reflexes.

Thus, the hindbrain:

1. Ensures the creation of an enhanced anti-gravity posture - a posture of decerebration rigidity.

2. Ensures the implementation of static postural reflexes (cervical and postural), aimed at maintaining a balanced posture when the position of the head relative to the body changes (cervical) or when the position of the head changes in space (parietal), but the degree of expressiveness of these reflexes against the background of increased tone is insufficient for maintaining posture.

3. It does not ensure preservation of the posture during movement (there are no stato-kinetic reflexes), restoration of the disturbed posture (there are no straightening reflexes).

4. Phasic reflexes against the background of increased tone are not caused.

The reticular formation of the brain stem, the nature of its ascending and descending influences.

The reticular substance (reticular formation - RF) is a cluster of nerve cells that have a large number of branching dendrites and long axons that form the descending (reticulospinal) and ascending pathways of the reticular substance.

There are many afferent pathways of the Russian Federation, it receives information from:

- all specific ascending efferent pathways that give collaterals to the RF nuclei, entering the brain stem;
- from these formations of the central nervous system, namely:
- from the cerebral cortex;
- from the hypothalamus;
- from the cerebellum;
- from the basal nuclei;
- from other organizations.

RF efferent connections can be divided into ascending and descending.

Ascending connections of the Russian Federation and ascending influences:

- transmits information to all parts of the brain through non-specific nuclei of the thalamus and has a non-specific activating effect on cells. This effect ensures a vigorous state of the body and

determines the level of activity of cortical cells. The RF has separate structures (hypnogenic zones) that reduce the degree (level) of cortical cell activity and cause the state of sleep;

- transmits information from various receptors to the hypothalamus via reticulohypothalamic pathways.

Nature of descending reticulospinal influences:

- from the medial nucleus of the RF of the hindbrain, the reticulospinal nerve begins (it is part of the MNS) - it specifically activates the motoneurons of the flexors and inhibits the motoneurons of the extensors of the trunk and proximal parts of the limbs;
- pathways that nonspecifically activate or inhibit spinal motoneurons originate from other RF nuclei and thus determine the degree of their activity;
- information is transmitted from the vegetative centers of the Russian Federation (respiratory, hemodynamic) along the reticulospinal pathways to the sympathetic motor neurons of the spinal cord during the regulation of the corresponding functions of the body.

Motor reflexes of the middle brain, their physiological significance.

The midbrain (Cm) with the participation of the reticular substance processes afferent information that enters the spinal cord and hindbrain. New information enters the SrM from visual and auditory receptors. Its processing takes place in the nuclei of the front (from visual receptors) and lower (from auditory receptors) tubercles. Based on the processing of information from all these receptors, the SrM monitors the state of the external and internal environment of the body.

Important suprasegmental motor nuclei of SrM are:

1) red nuclei - from them, information from the neurons of the spinal cord is transmitted along intersecting paths (rubrospinal paths - an element of the LNS);
2) reticular formation;
3) substantia nigra - is located in the midbrain, but functions as a single unit with the basal nuclei.

Rubrospinal effects are characterized by activation of □- and □-motoneurons of flexors and inhibition of □- and □-motoneurons of extensors. These influences are opposite

vestibulospinal. Due to rubrospinal effects, the muscle tone of a mesencephalic animal is more uniform than that of a decerebrate animal (the tone of the flexors and extensors is more balanced). Therefore, the posture of a mesencephalic animal is normal. That is, the enhanced antigravity posture of a decerebrated animal turns into a normal one in a mesencephalic animal due to rubrospinal influences.

Poso-tonic reflexes of two types are carried out with the participation of the motor nuclei of the SrM:

1. Rectifiers - provide restoration of a broken posture. In animals with a neck, righting reflexes have 2 phases:

a) Head straightening reflex - it begins with irritation of otolith vestibuloreceptors in response to a violation of the normal position of the head in space (for example, when falling). The closing level of this reflex is SrM. For its implementation, the participation of the red nuclei and the Russian Federation of the Russian Federation is necessary. Through the descending pathways from these structures, information is transmitted to the motoneurons of the spinal cord, redistribution of the tone of the neck muscles, the head acquires a normal position in space (with the crown of the head up).

b) The trunk straightening reflex - begins with irritation of the neck proprioceptors, which is caused by the head straightening reflex, as in this case the normal position of the head in space is restored, but its normal position relative to the trunk is disturbed. The input of information from the proprioceptors of the neck is carried out at the level of the spinal cord, the rise to the suprasegmental structures of the SrM, the processing of this information, the transmission to the motoneurons of the spinal cord to the muscles, which ensure the restoration of the normal position of the trunk relative to the head in space.

2. Stato-kinetic - ensure the preservation of the equilibrium posture during movement with acceleration. When moving with linear acceleration, otolith receptors are excited, and when moving with angular acceleration, receptors of the semicircular tubules are excited. The entry of this information into the CNS is carried out at the level of the hindbrain, the ascent to the structures of the SrM, processing and transmission by descending pathways to the motoneurons of the spinal cord, the redistribution of muscle tone, which ensures the preservation of balance during movement with acceleration. An important component of stato-kinetic reflexes is oculomotor reflexes, nystagmus of the eyes, more prolonged fixation of objects in the field of vision during movement, better orientation in space, more reliable preservation of posture during movement.

Once again, we emphasize that the level of closure of the rectifier and stato-kinetic reflexes is SrM. Therefore, they can be obtained from a mesencephalic animal and impossible from a decerebrate or spinal animal.

Due to the processing of information from the visual and auditory receptors (with the participation of the nuclei of the four tubercles), the motor nuclei of the SrM ensure the implementation of orientation reflexes - in response to strong sound and light stimuli, the mesencephalic animal turns its head in the direction of the stimulus, alerts its ears, its flexor tone increases somewhat - the animal seems to be preparing to respond to this stimulus.

The role of SrM in the implementation of phasic reactions depends on the level of organization of the animal:

- mesencephalic amphibians (frog) are capable of locomotion - movement in space (jumping, swimming);
- cats and dogs are not capable of locomotion, but perform locomotor synergies - coordinated movements of the limbs, resembling the act of walking: they are integrated by the structures of the SrM together with the structures of the hind and spinal cord.

In humans, SrM does not ensure the formation of a normal antigravity posture at rest and its maintenance during movement. For the implementation of all these functions in humans, the participation of the cortex of the large hemispheres is necessary (the principle of corticalization of functions).

Equipment: swivel chair, stopwatch, tables, slides, videos, notebooks, pens

Plan:

1. Organizational measures:
- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,
- motivation of students of higher education regarding the study of the topic.
2. Control of the reference level of knowledge:
- written test,
- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes:

Know:

- basic concepts of brain stem physiology
- basic approaches to registration of brain stem functions in clinical practice

Be able:

- to study the physiological functions of the brain stem and to be able to analyze the obtained data
- master the skills of using physiological methods of CNS research in clinical practice

List of didactic units: textbooks, manuals, methodological recommendations on the topic of practical training, instructional materials for practical work.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

1. The structure and functions of the medulla oblongata and pons, their role in the processes of regulation of muscle tone, movements and functions of the vegetative systems.

2. Reflexes of the medulla oblongata (bulbar reflexes), their differences from spinal reflexes.

3. Descending pathways and their role in regulating the activity of alpha and gamma motoneurons.

4. Tonic labyrinthine reflexes and the role of the vestibular apparatus (receptors sacculus and utriculus) in the regulation of tone and posture.

5. Tonic neck reflexes.

6. The structure and functions of the midbrain: the value of the conductive function, the role of the reflex function, midbrain centers.

7. Reflexes of the hindbrain: a) static and statokinetic reflexes; b) righting reflexes (labyrinthine and cervical); c) head turns and the role of semicircular canal receptors in maintaining balance under conditions of changing speed or angle of movement.

8. The role of the midbrain in the regulation of stereotyped involuntary movements. Approximate midbrain reflexes, their characteristics and mechanisms.

9. Vestibular eyeball stabilization mechanisms.

10. Differences between mesencephalic reflexes and spinal and bulbar reflexes.

11. The role of the hindbrain and midbrain in maintaining posture: vestibular nuclei, red nuclei, reticular formation (RF).

12. Decerebral rigidity, mechanisms of its occurrence. The role of the brain stem in the regulation of muscle tone.

13. RF functions of the brain stem: ascending and descending influences, integrative role. The works of Megun and Moruta..

Test tasks:

1. What is the main function of the quadrituberous body of the midbrain?

A. Regulation of homeostasis of all vegetative
functions

B. Implementation of indicative reactions

C. Participation in memory mechanisms

D. Regulation of muscle tone

E. All answers are correct

2. The sensory function of the midbrain is manifested in:

A. Primary analysis of information coming from visual and auditory receptors

B. Primary central analysis of information coming from visual receptors and secondary central analysis of information from
auditory receptors

C. Primary analysis of information coming from proprioceptors of the trunk

Secondary analysis of information coming from visual and auditory receptors

E. All answers are incorrect

3. What is the name of the type of muscle tone that occurs when the midbrain is cut below the level of the red nucleus?

A. Normal

B. Plastic

C. Weakened

D. Contractile

E. Eased

4. What centers of the medulla are vital important?

A. Respiratory, cardiovascular

B. Muscle tone; protective reflexes

C. Protective reflexes, food

D. Motor reflexes, food

E. Food, muscle tone

5. A person was diagnosed with a hemorrhage in
brain stem The examination revealed an increase
of the tone of the flexor muscles against the background of a decrease in the tone of the extensor muscles. Changes in muscle tone can be explained by irritation of which brain structures?

A. Black substance

B. Hall nucleus

C. Nucleus Deiters

D. Burdach nucleus

E. Red nuclei

6. After a brain injury, the patient had impaired fine movements of the fingers, muscle stiffness and tremors. What is the reason for this phenomenon?

A. Damage to the cerebellum

B. Damage to the midbrain in the area
red nuclei

C. Damage to the midbrain in the area
black substance

D. Damage to Deiters' nuclei

E. Damage to the brain stem

7. In a person with a disorder of cerebral blood flow, the act of swallowing is disturbed. She may sneeze when taking liquid food. Indicate which part of the brain is affected:

A. Cervical part of the spinal cord

B. Thoracic section of the spinal cord

C. RF

D. Medulla oblongata

E. Midbrain

8. The motor nuclei of the thalamus include:

A. Ventral group

B. Lateral group

C. Back group

D. Media group

E. Front group

9. What nuclei of the thalamus are involved in the formation of the phenomenon of "reflected pain"?

A. Reticular

B. Associative

C. Intralaminar complex

D. Raleigh

E. Non-specific nuclei

10. The thalamus is:

A. A collector of afferent pathways, a higher center of pain sensitivity

B. Regulator of muscle tone

C. Regulator of all motor functions

D. Regulator of homeostasis

E. Body temperature regulator

Answers

1.D, 2.B, 3.D, 4.A, 5.E, 6.C, 7.D, 8.A, 9.D, 10.A.

Situational tasks to test basic knowledge:

1. Explain whether the animal will retain any reflexes, except for spinal reflexes, after cutting the spinal cord below the medulla oblongata? Is breathing supported artificially?

Answer. Those reflexes that are carried out thanks to the nuclei of the cranial nerves will be preserved.

2. Two complete transections of the spinal cord under the medulla oblongata at the level of C2 and C4 segments were performed in the animal. Explain how the blood pressure will change after the first and second cuts?

Answer. After the first cut, BP will decrease because the connection between the main vascular center in the medulla oblongata and the local centers in the lateral horns of the spinal cord will be interrupted. Cutting again will have no effect because the connection is already broken.

3. Two people had a cerebral hemorrhage, one in the cerebral cortex, the other in the medulla oblongata. Explain which person has a more unfavorable prognosis?

Answer. There are no vital centers in the cerebral cortex, but there are in the medulla oblongata (respiratory, vascular, etc.), so a hemorrhage in the medulla oblongata is more dangerous to life. As a rule, it ends with a fatal outcome.

3. Formation of professional skills and abilities (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

- To study tendon and skin reflexes of a person.
- To solve situational tasks on the topic of practical training.

Instructional materials on the performance of tasks:

Methodology for studying the role of vestibular nuclei in maintaining muscle tone and coordination of movements in humans (rotary test)

For work, you need: a Baranya chair or a rotating chair, a stopwatch. The object of research is a person. Conducting work. Tests are recommended to be conducted on several subjects, since in this case there will be a noticeable difference between the expressiveness of individual reflex reactions. The subject stands in a vertical position with closed eyes, slightly tilting his head forward. Before the start of the test, the pulse is measured. Then, on command, the subject makes 5 rotations around the vertical axis in any direction. After that, he needs to take a few steps without opening his eyes. Normally, a person deviates when walking in the direction opposite to the direction of rotation. In the case of a poorly developed vestibular apparatus, the subject will move in the direction of rotation. Immediately after the movements, it is necessary to open the eyes and measure the pulse. Having determined the percentage of the pulse, it is possible to assess the expressiveness of the labyrinthine-cardiac reflex. During the opening of the eyes,

nystagmus of the eyeballs and head is observed - a slow movement against the direction of rotation, which changes with the direction of movement. The main direction of propagation of impulses during coordination of movements: receptors of the semicircular canals of the inner ear — vestibular ganglion — vestibular nuclei of the medulla oblongata (Bechterev, Roller, Schwalbe, Deiters) — vestibulospinal, vestibuloocular, vestibulocerebellar and lemniscal pathways — redistribution of muscle tone that maintains balance .

Tests for the final stage of the lesson:

1. One of the structures of the midbrain was destroyed in a dog in an experiment. As a result, he lost the approximate reflex to sound signals. What structure was destroyed?

A. Vestibular nucleus of Deiters

B. Red core

C. Upper cusps

D. Lower tubercles

E. Black substance

2. Animals with decerebrate rigidity are characterized by:

A. Disappearance of righting reflexes

B. Disappearance of the elevator reflex

C. A sharp increase in the tone of the extensor muscles

D. All answers are correct

E. All answers are incorrect

3. The associative nuclei of the thalamus include:

A. Central and intralaminar

B. Ventrobasal complex

C. Anterior, medial and posterior groups

D. Nuclei of the medial and medial geniculate bodies

E. Ventral group

4. Reflex reactions of which department of the central nervous system are directly related to maintaining posture, chewing, swallowing, secretion of digestive glands, breathing, heart activity, regulation of vascular tone?

A. Midbrain

B. Thalamus

C. Hindbrain

D. Spinal cord

E. Forebrain

5. Reflex reactions of which department of the central nervous system are directly related to the implementation of the "guard" reflex?

A. Hindbrain

B. Thalamus

C. Spinal cord

D. Cerebellum

E. Midbrain

6. How to experimentally prove the conditioning of decerebration rigidity by a significant gamma-enhancement of spinal myostatic reflexes?

A. Cut the posterior roots of the spinal cord

B. Cut the spinal cord

C. Cut above the midbrain

D. Cut below the midbrain

E. Cut below the hindbrain

7. What is the name of the reflex reaction in a person under the conditions of sudden exposure to a light or visual stimulus and what does its loss indicate?

A. Adaptation reaction, damage to the hypothalamus

B. "Start reflex", lesion of the quadrituberous body

C. Reflex "what is this", lesion of RF

D. Adaptation reaction, lesion of the globus pallidus

E. The "what is that" reflex, red lesions nuclei

8. A person has hypokinesia and resting tremor. What part of the brain is affected?

A. Pallidum and substantia nigra

B. Striatum, pallidum

C. Nigra substance, cerebellum

D. Striatum, substantia nigra, cerebellum

E. Pallidum and cerebellum

9. The hindbrain does not receive information from:

A. Vestibuloreceptors

B. Visual receptors

C. Auditory receptors

D. Proprioceptors

E. Taste receptors

10. At the level of the midbrain, all reflexes close for the first time, except:

A. Rectifiers

B. Statokinetic

C. Zinychny

D. Eye nystagmus

E. Perspiration

Answers

1.D, 2.D, 3.C, 4.C, 5.E, 6.A, 7.B, 8.A, 9.B, 10.E.

Situational tasks for the final stage of the lesson:

1. A particularly clear footwork is required from a skater while running on the turn of the stadium track. Explain whether the position of the athlete's head is important in this situation?

Answer: Impulses from neck muscle receptors play an important role in the distribution of limb muscle tone. Therefore, the athlete's head must occupy a certain position during the execution of certain movements. So, if a skater turns his head in the direction opposite to the direction of the turn, he can spin and fall.

2. It is known that under the conditions of narcotic sleep during surgery, the anesthesiologist constantly monitors the reaction of the pupils of the person being operated on to light. For what purpose does he do this and what can be connected with the lack of this reaction?

Answer: Anesthesiologists judge the depth of narcotic sleep by the nature of the pupil's reaction to light. If the pupils stopped responding to light, it means that the anesthesia has spread to those areas of the midbrain where the nuclei of the III pair of cranial nerves are located. This is a dangerous sign for a person, because vital centers can be turned off. The dose of the drug should be reduced.

3. Explain what will happen to a cat that is in a state of decerebration rigidity after cutting the brainstem below the red nucleus, if the posterior roots of the spinal cord are now cut.

Answer: Rigidity will disappear, because at the same time the fibers of the gamma loop of the myotonic reflex are cut.

4. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated

5. List of recommended literature (main, additional, electronic information resources):

Basic literature:

1. Physiology [textbook] /V. M. Moroz, O.A. Shandra.– 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728p.

4. *Further reading:*

41. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier. - 6th ed.,2017.- 528 p

42. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, J. Yuan, H. L. Brooks. - McGraw Hill Professional. – 26th edition,2019.–752 p.

43. Guyton A. Textbook of Medical Physiology / A. Guyton, J. E. Hall. - Elsevier. - 14th Edition, 2021. – 1820 p.

44. Koeppen B. M.«Berne and Levy Physiology / B. M. Koeppen, B. A. Stanton. - Elsevier. - 7th edition, 2018. – 880 p.

45. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 8th ed., 2019.–1186 p.

Electronic information resources:

33. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

34. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

35. National Scientific Medical Library of Ukraine http://library.gov.ua

36. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua

Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua

SEMINAR CLASS

Seminar session No. 10

Topic: Comparison of clinical and laboratory studies in a healthy person at rest and physically stressed from the humoral system and to be able to apply registration methods and analyze the obtained data.

Purpose: to form a clear idea of the basic concepts of the work of the endocrine system, the apparatus of regulation, research methods

Basic concepts:

Endocrine glands and the hormones secreted by them are in close interaction with the nervous system, forming a general integral mechanism of regulation. The structures of the central nervous system, in particular the cortex of the large hemispheres, the diencephalon and other parts of the brain, are involved in the regulation of the activity of the endocrine glands. Control over the activity of endocrine glands is carried out by mediators of the sympathetic and parasympathetic departments of the autonomic nervous system. The direct regulator of endocrine glands is the hypothalamus, which is closely connected with the cortex of the large hemispheres, the reticular formation, subcortical structures, the thalamus, the brain stem, and the spinal cord. The hypothalamus regulates endocrine glands through the pituitary gland through neurosecretion. The axons of hypothalamic neurons end on blood vessels, through which blood enters the anterior lobe of the pituitary gland (adenohypophysis), where there is a so-called portal system of blood circulation, characterized by a double capillary network. Small neurosecretory cells of the hypothalamus produce peptide hormones that regulate the function of adenohypophysis cells - liberins (releasing hormones) and statins (inhibiting hormones). Liberins stimulate, statins inhibit the synthesis of pituitary hormones. Liberins exist for all pituitary hormones. For example, there are thyroliberin - activates the synthesis of thyroid-stimulating hormone, luliberin - activates the synthesis of luteinizing, follicle-stimulating and gonadotropic hormones of the vygopyphus, corticoliberin - activates the synthesis of adrenocorticotropic hormone, somatoliberin - stimulates the synthesis of growth hormone, prolactoliberin - stimulates the synthesis of prolactin, melanoliberin - activates the synthesis of melanocyte-stimulating hormone. Statins are not found for all hormones. Only somatostatin, prolactostatin, and melanostatin are present. The pituitary gland is located in the Turkish saddle of the posterior sphenoid bone of the skull. It is connected to the hypothalamus with the help of a leg. The pituitary gland is divided into three lobes: anterior (adenohypophysis), middle and posterior (neurohypophysis). Adenohypophysis produces a number of tropic hormones (influence the secretion of other hormones) - Follicle-stimulating and luteinizing hormones affect male and

female gonads and are called gonadotropic hormones. By their nature, they are branched proteins. Follicle stimulant stimulates the growth and maturation of follicles in the ovaries, in males it stimulates the maturation of spermatozoa. Luteinizing ensures ovulation and the formation of the corpus luteum, stimulates the secretion of sex hormones. thyroidotropic - regulates the growth and development of the thyroid gland and its production of hormones, adrenocorticotropic - causes the growth of the bundle and reticular zone of the adrenal cortex, stimulates the synthesis and secretion of glucocorticoids, on metabolism, increasing the breakdown of fats in the body. and several effector hormones (acting directly on tissues) - growth hormone or somatotropin - a protein hormone that stimulates growth and development due to increased cell division and increased protein synthesis. It stimulates protein synthesis, increases the secretion of glucagon, which leads to an increase in the concentration of glucose in the blood, regulates fat metabolism, stimulating fat oxidation in the liver. Hyperfunction in young individuals leads to gigantism (proportional growth with proportional bone size), and in adults to acromegaly (uneven bone growth), hypofunction at a young age - to dwarfism, prolactin - stimulates the development of mammary glands and milk secretion, melanocyte-stimulating - stimulation of the synthesis of skin melanin pigment. In the middle the (intermediate) zone of the pituitary gland produces the hormone melanotropin, which causes the darkening of the pigment cells of melanocytes. In addition, two nuclei are located in the area of the hypothalamus - supraoptic and paraventricular. The axons of the neurons of these nuclei end in the posterior part of the pituitary gland (neurohypophysis), where the hormones vasopressin (antidiuretic) and oxytocin are released into the blood. These hormones are made up of amino acids. Vasopressin (ADH) has an antidiuretic effect, stimulates the reabsorption of water from primary urine in the renal tubules and collecting ducts. It affects mineral metabolism, as it inhibits the reabsorption of calcium and chlorides from primary urine. In addition, ADH increases blood pressure, causing narrowing of arterioles and capillaries. ADH secretion is stimulated by irritation of osmo- and baroreceptors. Oxytocin causes contraction of the smooth muscles of the uterus and mammary glands. Increased secretion of oxytocin occurs when the receptors of the uterus and nipples are irritated. The thyroid gland is the largest of the endocrine glands, located on the sides of the trachea in the form of two lobes - right and left, connected by an isthmus. The mass of the gland in an adult man is about 20 g. The tissue is formed by glandular vesicles, follicles in which the hormones triiodothyronine (T3) and tetraiodothyronine (thyroxine, T4) are formed. The amino acid tyrosine and iodine are necessary for the formation of these hormones. The action of thyroxine and triiodothyronine is similar, although the activity of triiodothyronine is much higher. Since the effect of T4 develops after a certain time and its ability to transform into T3 in tissues has been discovered, it is possible that it acts as a

prohormone. Thyroxine and triiodothyronine stimulate oxidative processes in tissues. They increase the absorption of O2 by cells and the release of CO2. As a result, the main metabolism and heat generation increases, the breakdown of proteins, fats and carbohydrates increases. Thyroid hormones also increase the effects of adrenaline and the sympathetic nervous system. Thyroxine stimulates the overall growth of the body. Dysfunction of the thyroid gland leads to serious consequences in the adult body as well. The activity of the thyroid gland is reflected, first of all, at the level of the basic metabolism, which decreases with its hypofunction and increases in response to the increased release of hormones. In particular, with basal disease caused by gland hyperfunction, activation of protein cleavage, increased mobilization of fats, violation of carbohydrate and mineral metabolism occurs. This disease is accompanied by weight loss, tachycardia, increased excitability of the nervous system, and restlessness. With hypofunction of the thyroid gland in early childhood, cretinism develops - growth retardation, violation of body proportions, delay in sexual development, mental retardation. Along with this, in high mountain areas, marshy, peaty areas, where the soil lacks enough iodine, a disease develops - endemic goiter, with all the signs of hypofunction. Hypofunction of the thyroid gland can occur when eating a large amount of cabbage and turnips, because they contain antithyroid substances that block the synthesis of iodine-containing hormones. In adults, hypofunction of the gland causes mental and physical retardation. At the same time, there is a decrease in the rate of synthesis and breakdown of proteins, hypoglycemia, and bradycardia. This syndrome is called myxedema, it is also accompanied by dough-like thickening of the skin due to an increase in the volume of connective tissue. The hormone thyrocalcitonin (calcitonin) reduces the level of Ca2+ and P ions in the blood plasma due to the weakening of its mobilization from bones, and also, like phosphorus, by increasing its excretion in the urine. The release of this hormone is regulated by the content of Ca2+ in the blood plasma, when it increases, the secretion of calcitonin increases, which supports calcium homeostasis in the body. The activity of the thyroid gland is regulated by the central nervous system, in particular by nerve fibers coming from the cervical sympathetic node of the vagus, glossopharyngeal and hypoglossal nerves, as well as from nerve plexuses located near the carotid and subclavian arteries. The activity of the thyroid gland is under the control of the cortex of the large hemispheres. A major role in the regulation of the thyroid gland is played by the reticular formation and the hypothalamus, which stimulate its activity by increasing impulses along the sympathetic nerves. In addition, the regulation of T3 and T4 secretion is carried out with the participation of the hypothalamic-pituitary system. In particular, under the influence stress factors, excitation of thermoreceptors, impulses from the limbic system, stimulation of the synthesis of thyrotropin-releasing hormone in the hypophysiotropic zone of the hypothalamus, which stimulates the synthesis of thyrotropin-releasing hormone in

the pituitary gland, is observed. Thyroid-stimulating hormone acts on the membranes of thyroid cells, causing stimulation of the secretion of T3 and T4. The functioning of the hypothalamic-pituitary regulatory system is based on the principle of feedback, i.e. an increase in the concentration of T3 and T4 leads to a decrease in the concentration of thyroid-stimulating hormone of the pituitary gland. The thyroid gland plays an important role in the body's adaptive reactions that occur under the influence of various factors of the external and internal environment. This is evidenced by the morphological and functional changes of the thyroid gland in connection with changes in the temperature of the surrounding environment, seasonality, winter hibernation, during pregnancy. In all these cases, the cortex of the large hemispheres and subcortical structures receive impulses from extero- and interoreceptors and through the hypothalamic-pituitary system and autonomic nerves affect the thyroid gland, regulating its functions.

Plan:

1. Organizational measures:

- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,
- motivation of students of higher education regarding the study of the topic.

2. Control of the reference level of knowledge:

- written test,
- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes:

Know:

- hypothalamic-pituitary system
- thyroid hormones
- hormones of the pancreas
- adrenal hormones

Be able:

- study physiological hormones and be able to analyze the obtained data
- master the skills of using physiological methods of hormone research in clinical practice

List of didactic units: textbooks, manuals, methodological recommendations on the topic of practical training, instructional materials for practical work.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

1. Structural and functional organization of the pituitary gland. Classification of its hormones, their functions and mechanisms of interaction with cells of target organs.

2. The role of somatotropic hormone (STH) in ensuring the processes of growth and development.

3. Contour of regulation of secretion of STH, circadian rhythms. Metabolic influence of STH.

4. Somatomedins: insulin-like growth factor I (IGF-I), insulin-like growth factor II (IGF-II).

5. Thyroid gland, its hormones, mechanisms of action on cells of target organs.

6. The influence of thyroid hormones on the state of mental functions, growth and development processes, metabolic processes, and the state of visceral systems.

7. List the hormones that affect normal growth processes (insulin, gonadal steroids, cortisol), and explain their role.

Test tasks:

1. If the subject's basic metabolism is increased by 45%, hyperfunction is most likely to occur:

A. Epiphysis

B. Adenohypophysis

C. Cortex of the adrenal gland

D. -cells of islets of Langerhans

E. Thyroid gland

2. A 25-year-old woman complains of a disorder of the menstrual cycle, secretion of milk from the mammary glands, which is not related to pregnancy and feeding a child. She has signs of obesity. What hormonal changes in the blood will be detected under these conditions?

A. Decrease in concentration of T3 and T4 hormones

B. Increase in FSH level

C. High level of estrogens

D. High level of androgens

E. Increase in prolactin concentration

3. How does STH ensure the activation of plastic processes in the body?

A. Increases protein synthesis on ribosomes

B. Increases the flow of amino acids into cells

C. Activates the synthesis of DNA, RNA

D. Reduces catabolism of protein and amino acids

E. All answers are correct

4. Lack of which hormones in childhood causes stunted growth, disproportionate physique, retarded mental development?

A. T4, T3

B. STG

C. Parathyroid hormone

D. Testosterone

E. FSH

5. Hyperproduction of iodine-containing thyroid hormones in adults causes the development of:

A. Myxedema

B. Itsenko's - Cushing's diseases
C. Addison's disease
D. Basedov's disease
E. Acromegaly

6. An increase in the secretion of THG above the norm in childhood before the closure of the epiphyseal growth zones causes the development of:
A. Obesity
B. Gigantism
C. Acromegaly
D. Thyroid dwarfism
E. Pituitary dwarfism

7. A 42-year-old woman complains of constant thirst, abundant and frequent urination, decreased appetite, and headache. General and biochemical blood analysis — no changes. Urine is colorless, transparent, weakly acidic, does not contain sugar and other pathological impurities. The relative density of urine is 1.002. Daily diuresis up to 20 l. Deficiency of which hormone leads to this condition?
A. ADH
B. Atrial natriuretic factor
C. Vasopressin
D. Insulin
E. Glucagon

8. Secretion of THG is inhibited by:
A. Cortisol
B. Serotonin
C. Thyroid hormones
D. Androgens
E. Somatostatin

9. Hyperproduction of which hormone causes limb tremors?
A. Corticotropin
B. Insulin
C. Glucagon
D. T4
E. STG

10. Which of the hormones listed below have an anabolic effect, stimulate bone growth and closure of growth zones, increase erythropoiesis?
A. Leukopoietins
B. Androgens
C. Estrogens
D. Progestogens
E. Calcitonin

Answers
1.E, 2.E, 3.E, 4.A, 5.D, 6.B, 7.A, 8.E, 9.D, 10.B.
Situational tasks to test basic knowledge:
1. Hypoglycemia is more dangerous for the body than hyperglycemia. What indirect confirmation of this can be given by making a list of hormones that regulate blood sugar? Explain the mechanism of action of these hormones. Answer: In the body, the most important

mechanisms are duplicated. There is only one known hormone that lowers the sugar level (insulin) and seven hormones that increase this level.

2. Under the influence of which hormone are carried out: glycogen synthesis in the liver and muscles; intensive oxidation of glucose in tissues; decrease in the amount of sugar in the blood; decrease in protein catabolism? Explain the mechanism of action of this hormone. Draw a diagram of its interaction with cells of target organs. Answer: Under the influence of insulin.

3. The animal has increased breakdown of glycogen in the liver and muscles, hyperglycemia. Under the influence of which hormones can these phenomena occur? Explain the mechanism of their action. Draw a diagram of their interaction with cells of target organs. Answer: Under the influence of glucagon and adrenaline.

3. Formation of professional skills and abilities (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

- To study tendon and skin reflexes of a person.
- To solve situational tasks on the topic of practical training.

Instructional materials on the performance of tasks:

Study of the effect of removal of the adrenal gland in rats on resistance to hypoxia using educational video materials. (Make a conclusion, enter it in the research protocol and solve the relevant situational and test tasks).

Tests for the final stage of the lesson

1. Increased excitability of the central nervous system, irritability, emotional lability is a sign of hyperproduction of hormones:

A. Parathyroid glands
B. Neurohypophysis
C. Thymus
D. Thyroid gland
E. Glomerular zone of adrenal cortex

2. How many times more pronounced is the metabolic effect of T3 compared to T4?

A. 2–3
B. 4–5
C. 8–10
D. 25
E. 50

3. Oxytocin causes contraction of the uterus in the body of a pregnant woman, which is an example of it:

A. Kinetic effect
B. Morphogenetic effect
C. Metabolic effect
D. Permissive effect
E. Anabolic effect

4. Inhibit the secretion of THG:

A. Somatostatin
B. Hyperglycemia

C. Progesterone
D. Stress
E. Pregnancy

5. Which of the following effects are characteristic of oxytocin?
A. All answers are incorrect
B. Stimulation of uterine contraction during childbirth
C. Contraction of the smooth muscles of the ducts of the mammary glands
D. Regulation of water-salt exchange and drinking behavior
E. All of the above effects except A

6. The production of which hormone is reflexively stimulated during nipple irritation during breastfeeding?
A. Progesterone
B. Placental lactogen
C. Oxytocin
D. □-estradiol
E. Gonadotropin

7. An increase in the secretion of THG above the norm after the closure of the epiphyseal growth zones causes the development of:
A. Gigantism
B. Acromegaly
C. Obesity
D. Thyroid dwarfism
E. Pituitary dwarfism

8. Lack of which hormone in childhood causes growth retardation without violations of the proportionality of the physique and mental development?
A. T4, T3
B. ADH
C. Parathyroid hormone
D. Testosterone
E. STG

9. Under the conditions of hyperfunction of the thyroid gland, body weight:
A. Does not change
B. Increases
C. Thyroid obesity occurs
D. Decreases
E. Decreases until the body is exhausted

10. Lack of iodine-containing hormones of the thyroid gland in adults causes the development of:
A. Basedov's disease
B. Itsenko's - Cushing's diseases
C. Myxedema
D. Acromegaly
E. Addison's disease

Answers
1.D, 2.B, 3.A, 4.D, 5.E, 6.C, 7.B, 8.E, 9.D, 10.C.

Situational tasks for the final stage of the lesson:

1. The dogs were injected with a large amount of saline solution. Explain whether this will affect the activity of the pituitary gland? Describe the mechanism of this effect. Answer: Yes. In response to an increase in the volume of circulating blood (CCB) as a result of a reflex from the

volume receptors of the right atrium, the secretion of ACTH will decrease. This will lead to a decrease in the secretion of aldosterone and a weakening of the reabsorption of sodium and water, which will be excreted in large quantities by the kidneys.

2. People living in the Chernobyl NPP risk zone were administered iodine preparations as a preventive measure after the accident. Explain the purpose of this. Answer: Iodine in large quantities is absorbed by the cells of the thyroid gland until it is completely saturated. During the accident, a large amount of radioactive isotopes of iodine got into the atmosphere and soil. Its entry into the body leads to the concentration of radioactive iodine in the thyroid gland. Pre-saturation of the gland with ordinary non-radioactive iodine prevents such a danger.

3. Tachycardia, exophthalmos, and a 40% increase in basic metabolic rate were detected during the examination. We can think about damage to the function of which gland of internal secretion? Explain the mechanism of action of the hormone. Draw a diagram of its interaction with cells of target organs. Answer: Such symptoms are observed under the conditions of hyperfunction of the thyroid gland (Bazedov's disease).

4. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated.

5. List of recommended literature (main, additional, electronic information resources):

Basic literature:

1. Physiology [textbook] /V. M. Moroz, O.A. Shandra.– 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728p.

4. *Further reading:*

46. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier. - 6th ed.,2017.- 528 p

47. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, J. Yuan, H. L. Brooks. - McGraw Hill Professional. – 26th edition,2019.–752 p.

48. Guyton A. Textbook of Medical Physiology / A. Guyton, J. E. Hall. - Elsevier. - 14th Edition, 2021. – 1820 p.

49. Koeppen B. M.«Berne and Levy Physiology / B. M. Koeppen, B. A. Stanton. - Elsevier. - 7th edition, 2018. – 880 p.

50. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 8th ed., 2019.–1186 p.

Electronic information resources:

37. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

38. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

39. National Scientific Medical Library of Ukraine http://library.gov.ua

40. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua

Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua

SEMINAR CLASS

Seminar session No. 11

Topic: Comparison of clinical and laboratory studies in a healthy person at rest and during physical stress on the part of the blood system

Purpose: to form a clear idea of the basic concepts of the blood system, its composition. But to understand which indicators can change and under which violations.

Basic concepts:

The blood system is one of the most dynamic systems of the body. This is due to the role played by both formed elements of blood and plasma in the body. Nevertheless, in intact animal organisms, the composition of blood is quite constant, which is due to the precise coordination of the processes of hematopoiesis and hematopoiesis. The blood system includes blood, organs of hematopoiesis and blood destruction, as well as the regulatory apparatus. Blood as a tissue has the following features: - all its components are formed outside the vascular bed, - the intercellular substance is liquid, - the main part of the blood is in constant motion. The blood of animals is enclosed in a system of closed tubes - blood vessels. Blood consists of a liquid part (plasma, 52-60%) and formed elements (erythrocytes, leukocytes and platelets, 40-48%). This ratio was called the hematocrit number. The main functions of blood are transport, protective and regulatory. All three functions of blood are interconnected and inseparable from each other. Transport function — blood carries various substances, gases, and metabolic products necessary for the vital activity of organs and tissues. The transport function is carried out by both plasma and shaped elements. Many substances are transported unchanged, others enter into unstable compounds with various proteins. Thanks to the transport, the respiratory function of the blood is realized. Blood carries out the transport of hormones, nutrients, metabolic products, enzymes, peptides, various biologically active compounds (prostaglandins, leukotrienes, cytomedins, etc.), cations, anions, microelements, etc. The excretory function of blood is also connected with transport — excretion from the body by the kidneys and extrarenal ways of water, metabolites. Protective functions of blood are extremely diverse. The presence of leukocytes in the blood is associated with specific (immunity) and non-specific (mainly, phagocytosis) protection of the body. Blood contains all the components of the so-called complement system, which plays an important role in both specific and non-specific protection. The protective functions include the preservation of circulating blood in a venous state and the stopping of bleeding (hemostasis) in case of violation of the integrity of blood vessels. Humoral regulation of the body's activity is primarily associated with the release of hormones, biologically active substances and metabolic products into the circulating blood. Due to the regulatory function of blood, the constancy of the internal environment of the body, the water and salt balance of tissues and body temperature,

control over the intensity of 6 metabolic processes, maintenance of the constancy of the acid-base state, regulation of hematopoiesis (blood formation) and the course of other physiological processes are preserved. Blood color is determined by the presence of a special protein in erythrocytes - hemoglobin. Arterial blood is characterized by a bright red color, which depends on the content of hemoglobin in it, saturated with oxygen (oxyhemoglobin). Venous blood has a dark red color with a bluish tint, which is explained by the presence in it not only of oxyhemoglobin, but also of reduced hemoglobin. The relative density of blood fluctuates from 1.052 to 1.062 and depends mainly on the content of erythrocytes. The relative density of blood plasma is mainly determined by the concentration of proteins and is 1.029 – 1.032. The viscosity of blood is determined in relation to the viscosity of water and corresponds to 4.0 - 5.0. Blood viscosity depends mainly on the content of erythrocytes and to a lesser extent degrees from plasma proteins. The viscosity of venous blood is slightly higher than that of arterial blood, which is due to the influx of CO2 into erythrocytes, which slightly increases their size. The viscosity of blood increases when the blood depot containing a larger number of erythrocytes is emptied. Plasma viscosity does not exceed 1.8–2.2. With an abundant protein diet, the viscosity of plasma, and, consequently, blood may increase. Osmotic blood pressure. Osmotic pressure is the force that causes a solvent (for blood, it's water) to pass through a semipermeable membrane from a less to a more concentrated solution. The osmotic pressure of blood is determined by the cryoscopic method of determining the depression (freezing point), which for blood is 0.54—0.58 °C. The osmotic blood pressure is 7.3-7.6 atm. The osmotic pressure of the blood depends on the low molecular weight compounds dissolved in it, mainly salts. About 95% of the total osmotic pressure is due to inorganic electrolytes, of which 60% is due to NaCl. Osmotic pressure in blood, lymph, tissue fluid, tissues is approximately the same and differs in constancy. Even in cases when a significant amount of water or salt enters the blood, the osmotic pressure does not undergo significant changes. In case of excess water entering the blood, the water is quickly excreted by the kidneys and passes into the tissues and cells, which restores the initial value of the osmotic pressure. If the concentration of salts in the blood increases, then water from the tissue fluid moves into the vascular bed, and the kidneys begin to excrete salts intensively. Digestion products of proteins, fats and carbohydrates, absorbed into the blood and lymph, as well as low molecular weight products of cellular metabolism can change the osmotic pressure within small limits. Maintaining the constancy of osmotic pressure plays an important role in the vital activity of cells. 9 Oncotic pressure depends on the content of macromolecular compounds (proteins) in the solution. Although the concentration of proteins in plasma is quite high, the total number of molecules due to their large molecular weight is relatively small, due to which the oncotic pressure does not exceed 30 mm Hg. Art. Oncotic pressure largely depends on albumins

(80%), which is due to their relatively small molecular weight and a large number of molecules in the plasma. Oncotic pressure plays an important role in the regulation of water exchange. The greater its value, the more water is retained in the vascular bed, and the less it passes into the tissues. Oncotic pressure affects the formation of tissue fluid, lymph, urine and absorption of water in the intestines. Therefore, blood-replacing solutions must contain colloidal substances capable of retaining water. With a decrease in the concentration of protein in the plasma, edema develops, as water ceases to be retained in the vascular bed and moves into the tissues. Hydrogen ion concentration and blood pH regulation. The normal blood pH in the capillaries is 7.36, i.e. the reaction is weakly basic. Fluctuations in the pH value are insignificant. At rest, arterial blood pH is 7.4, and venous blood is 7.34. In cells and tissues, the pH reaches 7.2 and even 7.0. that depends on the formation in them in the process of metabolism of acidic products of metabolism. In various physiological states, the pH of the blood can change both in the acidic (up to 7.3) and in the basic (up to 7.5) side. More significant pH deviations are accompanied by severe consequences for the body. Thus, at a blood pH of 6.95, loss of consciousness occurs, and if these changes are not eliminated as soon as possible, then death is inevitable. If the concentration of H+ ions decreases and the pH becomes equal to 7.7, severe convulsions (tetany) develop, which can also lead to death. In the process of tissue metabolism, acidic metabolic products are released into the tissue fluid, and, consequently, into the blood, which should lead to a shift in pH to the acidic side. As a result of intense muscle activity, up to 90 g of lactic acid can enter the human blood within a few minutes. If this amount of lactic acid were added to the volume of distilled water equal to BCC, then the concentration of H+ ions would increase in it by 40,000 times. Reaction the same blood under these conditions practically does not change, which is explained by the presence of blood buffer systems. In addition, in the body, the constancy of pH is maintained due to the work of the kidneys and lungs, which remove C02, excess acids and bases from the blood. Constancy of blood pH is maintained by buffer systems: hemoglobin, carbonate, phosphate — and plasma proteins. The buffer system of hemoglobin is the most powerful (75% of the buffer capacity of blood). This system includes reduced hemoglobin (HHB) and potassium salt of reduced hemoglobin (HHB). The buffer properties of the system are due to the fact that KHB, being a salt of a weak acid, gives off the K+ ion and at the same time adds the H+ ion, forming a weakly dissociated acid: H + + KHb = K+ + HHb. The pH value of the blood flowing to the tissues remains constant thanks to the reduced hemoglobin, capable of binding C02 and H+ ions. In these conditions, NNb performs the functions of the base. In the lungs, hemoglobin behaves like an acid (oxyhemoglobin HHbO2 is a stronger acid than carbon dioxide), which prevents blood alkalinization. The carbonate buffer system (H2C03/NaHCO3) ranks second in terms of power. Its functions are carried out as follows: NaHCO3 dissociates

into Na+ and HCO3. If an acid stronger than carbonic acid enters the blood, Na+ ions are exchanged with the formation of weakly dissociated and easily soluble carbonic acid, which prevents an increase in the concentration of H+ in the blood. An increase in the concentration of carbonic acid leads to its disintegration into water and carbon dioxide (this happens under the influence of the carbonic anhydrase enzyme found in erythrocytes). CO2 enters the lungs and is released into the environment. If a base enters the blood, then it reacts with carbonic acid, forming sodium bicarbonate (NaHCO3) and water, which prevents the pH shift to the basic side. The phosphate buffer system consists of sodium dihydrogen phosphate (NaH2PO4) and sodium hydrogen phosphate (Na2HPO4). The first of them behaves as a weak acid, the second as a salt of a weak acid. If a stronger acid enters the blood, it reacts with Na2HPO4, forming a neutral salt and increasing the amount of slightly dissociable NaH2PO4: Na2HP04 + H2C03 = NaHC03 + NaH2P04. At the same time, the excess amount of sodium dihydrogen phosphate will be removed with urine, so the ratio of NaH2P04 and Na2HP04 will not change. If a strong base is introduced into the blood, it will interact with sodium dihydrogen phosphate, forming weakly basic sodium hydrogen phosphate. At the same time, the pH of the blood will change very slightly. In this situation, an excess of sodium hydrogen phosphate will be excreted in the urine. Blood plasma proteins play the role of a buffer, because they have amphoteric properties, thanks to which they behave as bases in an acidic environment, and as acids in a basic environment. Nervous regulation plays an important role in maintaining pH stability. At the same time, the chemoreceptors of the vascular reflexogenic zones are mainly irritated, the impulses from which are sent to the central nervous system (CNS), which reflexively involves peripheral organs in the reaction - kidneys, lungs, sweat glands, gastrointestinal tract, the activity of which is directed to the restoration of the initial value of pH. It was established that when the pH shifts to the acidic side, the kidneys intensively secrete the anion $H2PO4^-$ with urine. When the pH of the blood shifts in the basic direction, the release of anions $НПО2^-$ and $HCO3^-$ by the kidneys increases. 13 The sweat glands of a person are able to remove excess lactic acid, and the lungs - C02. Buffer systems of blood are more resistant to the action of acids than basic ones. The basic salts of weak acids contained in the blood form the so-called alkaline reserve of the blood. Its value is determined by the amount of carbon dioxide that can be bound by 100 ml of blood at a pressure of C02 equal to 40 mm Hg. Art. A constant ratio between acid and alkaline equivalents ensures the acid-base state of the blood. In various conditions, a shift in pH can be observed both in the acidic and in the alkaline side. The first of them is called acidosis, the second - alkalosis. Suspension stability of blood (the sedimentation rate of erythrocytes - SOE). Blood is a suspension, or suspension, of formed elements. The suspension of erythrocytes in plasma is supported by the hydrophilic nature of their surface, as well as by the fact that erythrocytes carry

a negative charge, thanks to which they repel each other. If the negative charge of the formed elements decreases, which may be due to the adsorption of such positively charged proteins as fibrinogen, γ-globulins, etc., then the electrostatic repulsion between erythrocytes decreases. At the same time, erythrocytes, sticking to each other, form the so-called coin columns. If the aggregation of erythrocytes is observed in the body, then blood viscosity increases, which can create favorable conditions for intravascular blood clotting, as well as an increase in blood pressure. If the blood is placed in a test tube, having previously added to it substances that prevent coagulation, after some time it can be seen that it is divided into two layers: the upper one consists of plasma, and the lower one is formed elements, mainly 14 erythrocytes. Based on these properties, Farreus proposed to study the suspension stability of erythrocytes, determining the speed of their sedimentation in blood, the coagulation of which was eliminated by the preliminary addition of sodium citrate. This indicator was called the erythrocyte sedimentation rate (ESR). Determination of ESR is carried out with the help of a Panchenkov capillary, on which millimeter divisions are applied. The capillary is placed in a tripod for 1 hour and then the size of the plasma layer above the surface of settled erythrocytes is determined. The value of ESR depends on age and gender. In a newborn, it is equal to 1–2 mm/h; in children older than 1 year and in men - 6–12 mm/h; in women – 8–15 mm/h; in elderly people of both sexes up to 15–20 mm/h. Fibrinogen content has the greatest influence on the value of ESR: when its concentration increases by more than 4 g/l, ESR increases. ESR increases sharply during pregnancy, when the content of fibrinogen in the plasma increases. An increase in ESR is observed in inflammatory, infectious, and oncological diseases, in burns, frostbite, and also in a sharp decrease in the number of erythrocytes (anemia). The value of ESR depends to a greater extent on the properties of plasma than on erythrocytes. So, if you place the erythrocytes of a man with a normal ESR in a capillary with the plasma of a pregnant woman, they will begin to settle at the same rate as in women during pregnancy.

Plan:

1. Organizational measures:

- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,
- motivation of students of higher education regarding the study of the topic.

2. Control of the reference level of knowledge:

- written test,
- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes:

Know:

- blood functions
- buffer systems
- osmotic pressure
- oncotic pressure

Be able:

- to investigate the method of counting erythrocytes of blood in Goryaev's counting chamber
- master the skills of using physiological methods of blood research in clinical practice

List of didactic units: textbooks, manuals, methodological recommendations on the topic of practical training, instructional materials for practical work.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

1. Composition and functions of blood
2. Blood and buffer systems
3. Oncotic blood pressure
4. Osmotic blood pressure.
5. Erythrocyte sedimentation rate.
6. Composition of blood plasma.
7. Blood plasma proteins.

Test tasks:

1. In humans, the albumin content in blood plasma is lower than normal. This is accompanied by tissue swelling. What blood function is impaired?

A. Maintenance of pH
B. Maintaining body temperature
C. Maintenance of oncotic blood pressure
D. Support of the blood coagulation system
E. All answers are correct

2. A climber at an altitude of 5,000 m has a heart rate of 120 beats/min, breathing — 26/min. The skin is pale, the urine pH is 1.5. Where will the greatest activity of Hb buffer be observed?

A. Liver
B. Heart
C. Kidneys
D. Lungs
E. Tissue capillaries

3. The patient had vomiting an hour ago. Where will the greatest activity of Hb buffer be observed?

A. The heart
B. Lungs
C. Kidneys
D. Liver
E. The brain

4. The patient has a normal pH of arterial blood. Specify the limits of the norm:

A. 7.25–7.35

B. 7.35–7.40

C. 7.40–7.50

D. 7.36–7.44

E. 7.33–7.52

5. A 38-year-old woman with uterine bleeding was brought to the reception and diagnostic department. What changes on the part of the blood are most possible?

A. Erythrocytosis

B. Leukocytosis

C. Decrease in hematocrit number

D. Leukopenia

E. Increase in hematocrit number

6. The norm of the content of total protein in the blood plasma was found in the examined patient. Specify the limits of the norm:

A. 65–80 g/l

B. 2–4 g/l

C. 20–30 g/l

D. 38–50 g/l

E. 0.2–0.7 g/l

7. People got into a shipwreck and, suffering from thirst, began to drink sea water. As a result, thirst increased, weakness, hallucinations, loss of consciousness, and a threat of death appeared. How can this be explained?

A. By reducing oncotic pressure

B. An increase in oncotic pressure

C. An increase in blood pressure

D. An increase in blood osmotic pressure

E. A decrease in blood osmotic pressure

8. In experimental conditions, long-term perfusion of an isolated cat heart with Ringer-Locke solution leads to myocardial edema. Violation of which indicator of the perfusion solution causes this condition?

A. Isooncotic properties

B. Isoosmotic properties

C. Isoionicity

D. Isovolumes

E. KLR

9. As a result of a car accident, a woman suffered acute blood loss. What is the main physiological mechanism of maintaining the stability of the body's internal environment immediately after blood loss?

A. Excitation of proprioreceptive skeletal muscles

B. Release of blood from the blood depot

C. Inhibition of vascular volume receptors

D. Increase in activity

E. Increasing water reabsorption

Answers

1.C, 2.E, 3.B, 4.D, 5.C, 6.A, 7.D, 8.A, 9.B, 10.A.

Situational tasks to test basic knowledge:

1. Calculate what the osmotic pressure of blood is, if the freezing point is –0.4 °C during its freezing.

2. Calculate the percentage of blood loss if a person lost 1.5 liters of blood as a result of an injury? Human body weight is 75 kg.

3. 5 ml of a 5% colloidal dye solution was injected into the animal's blood. After 5 minutes, blood was taken from the vein, the concentration of the dye in the plasma was 0.02%. Calculate the BCC in the body if Ht is 45%?

4. As a result of blood loss, the amount of blood in a person decreased by 20%. Calculate what the plasma protein concentration is under these conditions, if so much polyglucin was transfused as a blood substitute that the Ht was 30%. The normal amount of blood should be taken for 5 l, Ht — 42%.

5. During the experiment, 3 liters of the animal's blood were replaced with a solution with the following characteristics: volume — 3 liters; pH — 7.35–7.45; Rosm — 6.6–6.7 atm. Explain:

1) How and why will BCC change a few hours after the transfusion (decrease or increase)?

2) Which parameter of homeostasis was not taken into account?

3) What compensatory mechanisms will be included under the conditions of a change in the BCC?

6. A blood test was taken from a person participating in a marathon race in Death Valley (USA) at an air temperature of about 50 °C after 1 hour of the race. Explain:

1) What homeostatic blood parameters could change and why?

2) What recommendations can be given to the athlete before the competition?

Answers to situational tasks:

1. Osmotic pressure is directly proportional to the concentration of the solution, as is the freezing point. It is known that a temperature of 0.56 °C corresponds to an osmotic pressure of 7.6 atm (0.9% NaCl solution). If the freezing temperature is 0.4 °C, then the osmotic pressure of such blood is 5.5 atm (0.65% NaCl solution).

2. Before blood loss in the human body, blood was 7% of 75 kg, i.e. 5.25 liters. One and a half liters is equal to 28.6% of this value, so this is the level of blood loss.

3. The concentration of the dye in the blood decreased by 250 times. Therefore, there was 250 times more plasma than the injected dye, i.e. 1250 ml. Since Ht is equal to 45%, it means that 1250 ml of plasma is 55% of all BCC. From here it is easy to determine that the amount of blood in the body is 2270 ml.

4. Since the amount of blood decreased from 5 to 4 liters, the amount of plasma was equal to 2320 ml (56%). The total amount of protein in this plasma before the introduction of polyglukin was equal to 7.5%, or 17.4 g. After adding the blood substitute Ht, the indicator decreased by 1.4

times. Therefore, the amount of the liquid part of the blood increased by the same amount. Plasma became 3240 ml. If 17.4 g of protein is dissolved in it, then its concentration is equal to 5.35%, that is, sharply reduced.

5. 1) BCC will decrease, the cause of which is the movement of fluid from the lumen of the vessels to interstitial space. This happens due to the difference in oncotic pressure inside the vessel and outside.

2) Oncotic pressure is a parameter of homeostasis that was not taken into account when replacing blood with another solution.

3) With a change in BCC (in this case, with a decrease) as compensatory mechanisms, a feeling of thirst will arise, heart rate will increase, vascular tone will change (an increase in tone will lead to a decrease in diameter), a redistribution of blood flow will occur, blood will leave the depot, and erythropoiesis (Er production) will increase. , kidney function will change (decrease).

6. 1) Homeostatic indicators of blood will change: Rosm, pH, blood viscosity, BCC. This is due to a significant loss of fluid and electrolytes during intense physical exertion (during a marathon run) at a high ambient temperature.

2) Taking into account the difficult climatic conditions (50 °C) and intense physical exertion (marathon running), it is possible to predict the occurrence of the above-mentioned changes in the body in advance. Recommendations: constant (throughout the run) drinking sports drinks to compensate for the loss of fluid and electrolytes.

3. Formation of professional skills and abilities (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

- to investigate the method of counting erythrocytes of blood in Goryaev's counting chamber
- To solve situational tasks on the topic of practical training.

Instructional materials on the performance of tasks:

For work, you need: scarifiers, cotton balls, alcohol, ether, Goryaev's counting chamber, a mixer (melanger) for counting Er, 3% NaCl solution, a microscope.

The object of research is a person.

Conducting work. The counting chamber is placed under the microscope and the Goryaev grid is viewed first under low and then under high magnification. The chamber is covered with a cover glass, pressing its edges to the glass of the chamber until Newton's rainbow rings appear. Leaving the camera under the microscope, pierce the finger according to the previously described method. The first drop of blood that has appeared is wiped from the finger with a cotton swab. Dip the tip of the Er mixer into the second drop, hold it vertically and draw blood up to the 0.5 mark, making sure that no air bubbles get into the capillary. Wipe the end of the capillary with filter paper and quickly, until the blood has coagulated, transfer it to a cup with a

3% NaCl solution, continuing to hold the mixer vertically. The solution is drawn up to the 101 mark (that is, the blood is diluted 200 times), after which the mixer is transferred to a horizontal position and placed on the table.

To count erythrocytes, take a filled melanger, clamping the lower end with a finger, remove the rubber bulb and, clamping both ends of the mixer with the middle and thumb fingers, mix the blood for 1 minute. Under these conditions, Er shrink and become more visible. Three drops are released from the mixer onto the cotton, and the fourth is applied to the middle plane of the chamber from the edge of the cover glass. By capillary forces, the drop is drawn into the cover glass and fills the chamber. Excess blood solution flows into the groove. If air gets on the grid or there is an excess of solution on the side surfaces, the chamber should be rinsed with distilled water, dried and filled again. The filled chamber is placed under a microscope and if the formed elements are evenly spaced (which is an indicator of good mixing of the blood), counting is started. It is better to count Er under a small objective (8), while using eyepiece 15. Count the number of Er in five large squares (divided into 16 small ones), located diagonally from the upper left square down to the right. Counting is done within a small square in rows (from top to bottom). In order to avoid double counting of cells lying on the border between small squares, Egorov's rule is applied: "To a given square belong Er, which are located both inside the square and on its left and upper boundaries; Er, which are on the right and lower borders, do not belong to this square." After counting the sum of Er in five large squares (which is 80 small ones), find the arithmetic average amount of Er in one small square. Knowing that the volume of the chamber space above one small square is equal to 1/4000 mm3, multiply the obtained number by 4000. The amount of Er in 1 mm3 of diluted blood is obtained. Multiplying it by the dilution value (200), the amount of Er in 1 mm3 of whole blood is obtained. Thus, the formula for calculating the amount of Er is as follows: X = (E □ 4000 □ 200) : 80, where X is the desired number of Er in 1 mm3 of whole blood; E is the sum of Er in 80 small squares; 80 is the number of small squares in which the calculation was made; 200 — blood dilution. Then the obtained amount of Er is recorded in terms of 1 liter of blood, that is, the amount of Er found in 1 mm3 is multiplied by 1012.

Forming the results and their evaluation. Write down how much Er is contained in 1 liter of blood being tested. Compare the obtained results with the norm. In adults, this indicator is 5.0•1012 in men, (3.9–4.5)•1012 in women, (4.0–4.5)•1012 in school-age children, (5.5–7, 0)•1012 in newborns in the first days of life.

Tests for the final stage of the lesson

1. The negative charge Er is due to:

A. Er membrane proteins

B. Sialic acid of Er membranes

C. Spectrin and ankerin

D. Sodium-potassium dependent ATPase

E. Carbonic anhydrase

2. The listed factors determine the ESR value, with the exception of:

A. Numbers of leukocytes

B. Quantities of albumin

C. Quantities of globulins

D. Quantities of fibrinogen

E. Quantities Er

3. How to estimate the shift of the Price-Jones curve to the left?

A. Spherocytosis

B. Macrocytosis

C. Microcytosis

D. Poikilocytosis

E. Anisocytosis

4. The amount of Er in a newborn is about:

A. 4.0 T/l

B. 5.0 T/l

C. 3.7 T/l

D. 4.5 T/l

E. 5.9 T/l

5. Specify the states of the body characterized by the release of Er from the depot, with the exception of the following:

A. Sleep

B. Pain

C. Physical activity

D. Hypoxia

E. Blood loss

6. Minimal hemolysis of Er occurs in NaCl solution:

A. 0.52–0.48%

B. 0.46–0.42%

C. 0.40–0.36%

D. 0.34–0.32%

E. 0.30–0.28 %

7. Maximum hemolysis of Er occurs in NaCl solution:

A. 0.52–0.48%

B. 0.46–0.42%

C. 0.40–0.36%

D. 0.34–0.32%

E. 0.30–0.28%

8. ESR is a measure of the following physical and chemical properties of blood:

A. Stability of the colloidal solution

B. Suspension properties of blood

C. The volume of the cellular part of the blood

D. Blood viscosity

E. Blood plasma volume

9. Er perform functions, with the exception of:

A. Erythropoietic

B. Immunological

C. Homeostatic

D. Hemostatic

E. Trofichny

10. Under the conditions of a chronic experiment, the animal's renal artery was compressed. In 3 days, the Er content in her blood was determined. How can the obtained result be evaluated?

A. Normal content of erythrocytes

B. Relative erythrocytosis

C. Absolute erythrocytosis

D. Absolute erythropenia

E. Relative erythropenia

Answers

1.B, 2.A, 3.C, 4.E, 5.A, 6.B, 7.D, 8.B, 9.E, 10.C.

Situational tasks for the final stage of the lesson:

1. During the counting of cells in 5 large squares of Goryaev's chamber, 580 Er were found. Calculate how many of them are contained in 1 liter of blood, if the blood was collected in the mixer up to the 0.5 mark? Answer:. The large squares contain 80 small ones, the volume of each of them is 1/4000 mm3. Blood is diluted 100 times (label 0.5) to count Er. So, 1 mm3 of blood contains (580•4000•200) : 80 = = 5,880,000 Er, and 1 liter of blood contains 5.88 • 1012

2. 1 mm3 of blood contains 6 million Er. Calculate how many of them are in the circulating blood, if 20% of all blood is in the depot? Take body weight as 80 kg. Answer: If we assume that 7% of body weight in the body is blood, then in a person with a body weight of 69 kg, its volume is 5.6 liters. In the conditions of the problem, it is said that 80% circulates, that is, 4.5 liters. If there are 6•1012 Er in 1 liter of blood, then there are 27•1012 of them in the circulating blood of a given person.

3. During the measurement of the diameter Er of arterial and venous blood, it was found that it is not the same. Is this phenomenon normal? Can you tell which Er are taken from an artery and which from a vein? Answer: 3. Venous blood cells are larger, because in the process of gas exchange, relatively more salts appear inside them, following which, according to the laws of osmosis, water enters the cell.

4. During the experiment, the animal underwent a gene change, which led to a violation of the Hb structure. At the same time, signs of hypoxia appeared - an increase in heart rate and respiratory rate (HR). According to the blood analysis, a decrease in the Hb content in Er was noted. In 2 weeks an increase in the amount of Er in the blood was noted, heart rate and BP normalized (hypoxia signs gradually disappeared). Explain:

1) Which blood function was disturbed in the experiment, what caused it?

2) What compensatory reactions led to a decrease in the manifestations of hypoxia in the body, and how did they manifest themselves?

3) What blood indicators depend on the level of Hb content? Answer: 1) In the experiment, a violation of the transport (respiratory) function of blood was noted, namely: a violation of oxygen transport to the organs and tissues of the body. This was caused by a decrease in the content of Hb in Er blood.

2) Under conditions of hypoxia as a compensatory reaction, an increase in heart rate and an increase in BH were noted in the animal.

3) The oxygen capacity of the blood will depend on the level of Hb content in the blood, it is also necessary to remember the buffer function of Hb - participation in the regulation of blood pH.

5. When added to the solution of table salt, Er acquired a spherical shape. What is the approximate concentration of salt in this solution? What is the name of this process?

Answer: The concentration of salts is less than 0.9%, but more than 0.5%. The presence of spherulation Er.

8. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated.

5. List of recommended literature (main, additional, electronic information resources):

Basic literature:

1. Physiology [textbook] /V. M. Moroz, O.A. Shandra.– 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728p.

4. *Further reading:*

51. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier. - 6th ed.,2017.- 528 p

52. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, J. Yuan, H. L. Brooks. - McGraw Hill Professional. – 26th edition,2019.–752 p.

53. Guyton A. Textbook of Medical Physiology / A. Guyton, J. E. Hall. - Elsevier. - 14th Edition, 2021. – 1820 p.

54. Koeppen B. M.«Berne and Levy Physiology / B. M. Koeppen, B. A. Stanton. - Elsevier. - 7th edition, 2018. – 880 p.

55. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 8th ed., 2019.–1186 p.

Electronic information resources:

41. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

42. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

43. National Scientific Medical Library of Ukraine http://library.gov.ua

44. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua

Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua

SEMINAR CLASS

Seminar session No. 12

Topic: Comparison of clinical and laboratory studies in a healthy person at rest and under physical stress on the part of the cardiovascular system

Purpose: to form a clear idea of the basic concepts of the physiology of the heart and vascular system, to understand the main approaches to laboratory research in the cardiovascular system in clinical practice; to develop the ability to apply research methods and to be able to analyze the obtained data.

Basic concepts:

The functional purpose of the circulatory system is to provide blood flow to various organs and tissues in accordance with their metabolic demands. This occurs by the ejection of LV blood, enriched in oxygen in the lungs, into the aorta with its subsequent distribution in the system of arterial vessels, ensuring full-fledged transcapillary exchange and the return of already deoxygenated venous blood to the right atrium. This part of the vascular system is defined as a large circle of blood circulation, as opposed to a small one, which begins in the left ventricle and ensures the flow of blood through the system of pulmonary vessels, where it gives off carbon dioxide, is enriched with oxygen, and returns to the left atrium. Each department of the cardiovascular system has a special functional purpose, the implementation of which is ensured by clear features of the structure, regulation mechanisms, and the completeness of its function is assessed by various indicators. The heart is a powerful muscular organ that acts as a pump and pumps blood into the aorta, which flows to it through the venous system. This function of the heart is provided by alternating rhythmic contractions and relaxations of the muscle fibers that form the wall of the atria and ventricles. Myocardial systole and diastole of the chambers of the heart are coordinated with each other in a certain way, and the cycle of the heart begins in the part of the right atrium in which the mouths of the vena cava are located. Then a wave of contraction covers both atria, which share a common myocardium. The duration of atrial systole at a heart rate of 75 bpm is 0.1 s. At the end of atrial systole, ventricular systole begins, lasting 0.3 seconds. At this time and for another 0.4 s, the atria are in a state of diastole. Both ventricles contract simultaneously, and at the end of their contraction, diastole occurs, lasting 0.5 seconds. At the end of ventricular diastole, 0.1 s before its end, a new atrial systole occurs and a new cycle of cardiac activity begins. Excitation of the heart is caused by the activity of the main pacemaker — the sinus or sinoatrial node, located near the mouth of the vena cava. It belongs to the conduction system of the heart and consists of poorly differentiated muscle fibers, similar in structure to Purkinje fibers in the wall of the ventricles. From the sinus node, the excitation spreads through the atrial myocardium and reaches the AV node, the function of which is to

transmit the excitation from the atria to the ventricles. The AV node is located in the right atrium in the area of the atrial septum, near the connective tissue ring that separates the atria from the ventricles. The bundle of His originates from the AV node, which is a muscle bridge that conducts the excitation further to the ventricles. The initial part of this path — the common leg of the bundle of His — enters the ventricle through the interventricular septum, divides into two branches (right and left legs), one of which goes to the RV, the other to the LV. The final branches of the conducting system are represented by a network of Purkinje fibers diffusely placed under the endocardium, which transmit excitation directly to the myocardial fibers. One of the most important properties of the heart is its automaticity — the ability to excite and contract independently of external influences. The reason for this automation is a rhythmic change in the value of the membrane potential of the cells of the conducting system. The pacemaker, the sinus node, has the greatest ability to automaticity, while the cells of other departments of the conduction system are called hidden pacemakers, because normally their automation is not manifested and they assume the function of pacemakers only after the function of the higher departments of the conduction system is disturbed. Automation is also characteristic of the AV node, and disconnections of the atrial pacemaker of the ventricular contractions are gradually restored due to the impulses coming from this node. In this case, the contraction of the atria and ventricles does not occur sequentially, but simultaneously, since the excitation reaches the myocardium of both the atria and the ventricles equally quickly (AV-heart rhythm). The ability of the cells of the conducting system to generate excitation is inversely dependent on the distance from the sinus node, which is referred to as the "falling gradient of automaticity". The sinus node is called the center of first-order automation, which sets the heart rate at the level of 70–75 beats/min. The AV node is considered as a center of second-order automation, the heart rate set by it is approximately half as low. The heart can also contract under the influence of the automation of pacemakers located more distally (in the Purkinje fibers), then the heart rate will be even lower. Restoration of the automation of centers of the second and lower order when shutting down higher centers takes place with a delay of several seconds or even tens of seconds. This is called the "pre-automatic pause", during which asystole is observed. Automaticity is characteristic only of atypical muscle fibers concentrated in the conduction system of the heart. A peculiarity of pacemaker cells is spontaneous depolarization in heart diastole. When the membrane potential decreases to a certain critical level, which requires its decrease by 20–30 mV, a sharp shift of PD occurs, which indicates the excitation of cells. Automatic centers of different orders differ in the speed of slow diastolic depolarization: the higher it is, the higher the frequency of the emulsification generated by it, and the greater the ability to suppress the automaticity of the centers located below. In these cells, the rate of

diastolic depolarization is lower, and the reduction of the membrane potential does not have time to reach the level necessary for cell excitation before the arrival of the impulse from the higher center. However, in the absence of these impulses, diastolic depolarization of cells of secondary automatism reaches the level necessary for their excitation, and they become pacemakers. In response to the arrival of an impulse, myocardial cells enter an excited state, which is manifested by a change in their membrane potential. At rest, the cells are maximally polarized, the value of the membrane potential of cardiomyocytes is (–80–90 mV). At the moment of excitation, the cell membrane becomes permeable to sodium ions, the appearance of a rapid sodium influx causes the cell membrane to depolarize and even reach a positive charge of 20–30 mV. As a result of the change in the membrane potential at this stage, the PD is 100–120 mV. Then there is a restoration of the membrane potential - "membrane repolarization" - at first it is fast, then it slows down and a "plateau of PD" appears, which is replaced by a phase of rapid repolarization. This type of change in the membrane potential is characteristic of the working myocardium, which differs both in form and in the mechanism of development from the type characteristic of the cells of the conducting system. At a heart rate equal to 70 beats/min, the duration of PD reaches 0.3 s. It increases when heart contractions slow down and decreases when they accelerate. During excitation, myocardial cells lose the ability to respond to the impulse that comes to them from the foci of excitation. This lack of excitability is called refractoriness, which has an absolute character in the initial period of PD, which is equal to 0.27 s, and is replaced by a period of relative refractoriness, the duration of which is 0.03 s. During this period, the heart muscle is able to respond only to extreme stimuli. After the period of relative refractoriness, there is a short interval when the excitability of cells is increased - a period of hyperexcitability, myocardial cells can be excited under the action of even subthreshold stimuli. Due to the existence of refractoriness, the heart muscle cannot respond to ultra-high frequencies of stimulation; at the same time, the response occurs depending on the pulse frequency and the state of cardiomyocytes for every second, third or fourth pulse that arrives until the end of the refractory period. Excitation of the myocardium is accompanied by its contraction, that is, an increase in tension and subsequent contraction of the fibers. The period of their reduction is proportional to the duration of PD, with a frequent rhythm, both the duration of PD and the duration of contraction become shorter. With sharp violations of the functional in the state of the myocardium, a violation of the connection between excitation and contraction is possible; "electromechanical dissociation" occurs when, while the electrical activity of the heart is preserved, its contractile activity is completely absent. The polarization of the cardiomyocyte membrane and the existence of a membrane potential (–90 mV) are caused by ionic asymmetry — the presence of a gradient of extracellular and intracellular concentration of individual ions,

primarily potassium and sodium ions. The largest transmembrane gradient is characteristic of the distribution of K+ ions, the intracellular concentration of which is 50 times higher than the extracellular one, while the extracellular concentration of Na+ ions is approximately 10 times higher than the intracellular one. The presence of ion gradients is due to the selective permeability of the membrane at rest: it is high for potassium ions and low for sodium ions. When the pulse arrives, a partial depolarization of the membrane occurs, and when the limit level (–50 mV) is reached, the permeability of the membrane for Na+ ions increases sharply. A PD occurs, the phase of rapid depolarization of which is a rapid inflow of sodium. As a result of PD development, the membrane potential is reversed, the inner side of the membrane becomes electropositive compared to the outer side. For ventricular cardiomyocytes, PD is 110 mV, which exceeds the resting potential by 20 mV. The phase of rapid depolarization is accompanied by repolarization of the membrane: first, fast, when the PD decreases by 10–15 mV, then slow — the plateau phase, due to the slow incoming sodium and calcium flow. The third phase — the phase of rapid repolarization is determined by the initial potassium current. In diastole, the functioning of the sodium-potassium pump ensures the restoration of the original ionic composition of the intracellular content due to the removal of sodium ions from the cell and the "pumping" of potassium ions into it. The electrical activity of pacemaker cells, which are characterized by the absence of a true resting potential and the ability to spontaneously rhythmically generate PD, has a significantly different character. PD of cells of the sinus node has 3 phases: the first is a phase of slow spontaneous depolarization, which is determined by a decrease in the potassium conductance of the membrane, a decrease in the incoming potassium flow, and a small increase in the incoming calcium and slow sodium flow. When the spontaneous depolarization reaches the threshold (–40 mV), a PD is generated, determined by a fast calcium influx. In the repolarization phase, the restoration of the membrane potential is achieved by the outgoing potassium flow and the decrease in the incoming calcium flow. The main structure of the membrane characteristic of pacemaker cells, which ensures slow diastolic depolarization, is f-channels, which are activated when the cell is hyperpolarized. Due to the regulation of the state of these channels, catecholamines have a positive, and acetylcholine - a negative chronotropic effect, respectively increasing or decreasing the speed of slow diastolic depolarization. Principles of functioning of the heart as a pump Each of the cavities of the heart has its own specific function. The atria play the role of a reservoir in which the blood that flows from the venous network and from where it enters the ventricles in their diastole accumulates during ventricular systole. The ventricles function as a pump that pumps blood into the arterial system. Under normal conditions, blood flows in only one direction — from the atria to the ventricles and from the ventricles to the system of arteries. This is caused, on the one hand, by

the presence of ring-shaped bundles of muscle fibers in the atria around the mouths of the cava and pulmonary veins, which play the role of sphincters, and on the other hand, by the presence of valves (AV-, which separate the atria from the ventricles and semilunar, which separate the RV from the LA and LV — from the aorta). The opening or closing of the valves is determined by the pressure gradient on both sides. The AV valves—tricuspid in the right and bicuspid, or mitral, in the left heart—prevent the backflow of blood from the contracting ventricles into the atria. During ventricular diastole, these valves are open because the blood pressure in the ventricular cavity is lower than in the atrial cavity. During ventricular systole, the blood pressure in them rises and the valves close. Near the edges of the valves, there are tendinous threads that are attached to the papillary muscles, which begin to contract at the very beginning of the contraction of the ventricles and prevent the valves from opening. Semi-monthly valves (aortic and pulmonary) prevent the return of blood from the aorta and LA to the ventricles in their diastole. In the systole of the ventricles, when the pressure in them becomes higher than in the corresponding vessels, the valves open, in the diastole of the ventricles, when the pressure in them decreases, the semilunar valves close. The movement of blood both in the cavities of the heart and in the entire vascular system is determined by the pressure gradient. Pressure changes in the atria are relatively small: at the height of systole, their pressure does not exceed 5–8 mm Hg. Art., during diastole it decreases to 0, and during ventricular systole it gradually increases as a result of filling the cavity with blood flowing from the veins. When ventricular systole ends and the AV valves open, the pressure in the atria decreases as a result of the free movement of blood into the ventricles. 0.1 s before the start of ventricular systole, atrial systole occurs, resulting in some additional filling of the ventricles with blood. Despite the small size of this volume, it has significant physiological significance, as it leads to stretching of the ventricular myocardium, an increase in its KDO, and is significantly reflected in the force of contraction of the ventricular myocardium. Ventricular systole begins immediately after atrial systole ends. The wave of contraction gradually spreads through the myocardium of the ventricles, as a result of which part of the muscle fibers are shortened, and the other part is stretched. The shape of the ventricles changes, but the pressure remains unchanged. This phase is called the "asynchronous contraction phase" and lasts approximately 0.05 s. After the contraction covers all the fibers of the ventricles, the blood pressure in their cavities begins to rise, the AV valves close. The semilunar valves at this time still remain closed, because the intracavitary pressure in the ventricles has not yet reached the level of blood pressure in the outgoing arterial vessels. Therefore, the volume of the ventricles remains unchanged and the "phase of isometric contraction" occurs. The phase of asynchronous contraction and the phase of isometric contraction together make up the "period of ventricular tension". After the blood pressure in the

contracting ventricular cavities exceeds the pressure in the corresponding vessels, the "expulsion phase" occurs, when blood from the ventricles flows into the aorta and LA. This phase occurs when the pressure in the LV exceeds 65–75 mm Hg. Art., and in PS — 5–12 mm Hg. Art. The initial period of ejection of blood from the ventricles occurs against the background of a rapid rise in intracavitary pressure and constitutes a “fast expulsion phase” lasting 0.10–0.12 s, and is replaced by a “slow expulsion” phase lasting 0.10–0.15 s, which coincides with a gradual decrease in intraventricular pressure. The maximum level of blood pressure in the LV under normal physiological conditions reaches 115–125 mm Hg. Art., in PS — 25–30 mm Hg. Art. This difference is determined by a significantly greater resistance to the ejection of blood from the LV and, accordingly, its greater mass and force of contraction. After the expulsion phase, ventricular diastole occurs. The ventricular myocardium begins to relax, the intracavitary pressure drops below that of the outflow vessels, and the semilunar valves close. The time from the beginning of the relaxation of the ventricles to the closing of the semilunar valves is designated as the "protodiastolic period", which lasts 0.04 s. Then, for 0.08 s, the ventricles continue to relax with the AV and semilunar valves closed—the “phase of isometric relaxation”—until the pressure in the ventricles falls below that in the atria, which by this time are already filled with blood. With the appearance of a sufficient pressure gradient between the cavities of the atria and ventricles, the AV valves open, and blood begins to fill the ventricles. Ventricular filling is rapid at first as the pressure in the ventricles falls to 0. This is the "rapid filling phase" lasting 0.08 s. As the ventricles fill, the pressure in them increases, the filling slows down, and a "slow filling phase" of 0.16 s duration occurs. The final filling of the ventricles at the end of their diastole is determined by atrial systole lasting 0.1 s. During the diastole of the ventricles, the blood pressure in the vessels departing from them decreases as blood flows out, and by the end of diastole it is 65–75 mm Hg. Art. in the aorta and 5–10 mm Hg. Art. — in LA. However, this pressure remains higher than the blood pressure in the ventricular cavities, so the semilunar valves remain closed. These temporal characteristics of contraction and relaxation of the atria and ventricles are typical of a heart contracting at a rate of 75 beats/min. When changing this Heart rate, the duration of phases and the ratio between their time characteristics change significantly. When the rhythm frequency increases, diastole is significantly shortened, mainly due to the shortening of the slow filling phase. Systole shortens relatively less pronounced, mainly due to the phase of slow expulsion of blood from the ventricles. However, with a high heart rate, the phase of rapid filling of the ventricles is shortened, the KDO and UOK decrease. When the heart rate decreases, opposite changes in the duration of the phases of expulsion and filling of the ventricles are noted. The filling of the atria with blood is caused both by the predominance of blood pressure in the venous vessels that flow

into them, and by the suction effect of the chest, especially during inspiration, when the intrathoracic pressure drops to negative values. As a result, blood pressure in the vena cava and atria also becomes negative, which promotes blood flow from the periphery. In addition, in the systole of the ventricles and the shortening of their longitudinal size, the AV septum shifts down, which causes an increase in the cavity of the atria, a decrease in pressure in them and absorption of blood from the vena cava. Since the main function of the heart is to expel blood, one of the most important indicators of its activity is the UOC, that is, the volume of blood ejected by each ventricle during one contraction. Under normal physiological conditions, the UOC of an average person is 65–70 ml. IOC, which characterizes the hemodynamic performance of the heart in 1 minute, is determined by calculation as the product of UOC and heart rate, and in an average person at rest it is 4.5–5 liters. However, in conditions of intense physical or emotional stress, in hypoxia, in various other extreme conditions, HOC can increase 5 times or more, reaching 25–30 l/min, which is caused by an increase in both UOC and heart rate. In trained people, this effect is achieved to a large extent due to an increase in UOC, which is much less energy-consuming, while in untrained people, the main way to increase the hemodynamic performance of the heart is to increase the heart rate. This adaptation of the work of the heart to the needs of the body is achieved thanks to the presence of a number of regulatory mechanisms, both intra- and extracardial. Regulation of heart contraction force is carried out in two ways: heterometric and homeometric. The heterometric principle is based on the Frank-Starling law, according to which the force of contraction of the myocardial fiber is proportional to its initial length. With regard to the LV as a whole, this means the existence of a direct relationship between the value of its KDO and the force of contraction. The existence of this dependence is the basis of the principle of assessing the functional state of the ventricle: the steeper the increase in the force of contraction with the growth of KDO, the higher the contractile capacity of the myocardium. In clinical practice, the main index of the functional state of the myocardium is the ejection fraction, which is defined as the ratio of the difference between KDO and KSO to KDO. An increase in UOC with an increase in KDO is one of the forms of adaptation of the heart's work both to an increase in venous blood flow (preload) and to an increase in the resistance to ejection of blood from the ventricles (afterload). The activating effect of atrial systole on the work of the ventricles is also implemented according to the principle of heterometric regulation and contributes to the realization of the dependence of the work of the heart on the inflow of venous blood. It should be noted that the full implementation of Starling's law, in which the UOC increases to a greater degree than the ventricular KDO increases, is possible only with a normal functional state of the myocardium. Under pathological conditions, with a decrease in myocardial contractility, the value of the increase in UOC per unit increase in KDO decreases, high values of KDO to a

greater extent indicate myocardial insufficiency than adaptation of the heart to preload or afterload. The principle of homeometric regulation is realized with an unchanged initial length of myocardial fibers and in the conditions of a whole heart is manifested by a decrease in KSO, an increase in UOK and the ejection fraction at an unchanged value of KDO. This principle of heart adaptation is based on the increase in myocardial contractility, caused by external factors, primarily the increased activity of sympathoadrenal influences. The homeometric principle of heart regulation also determines the presence of a rhythmoinotropic one dependence, that is, an increase in strength and speed of contraction of myocardial fibers with an increase in heart rate. This effect develops gradually over several cardiac cycles and is called the "Bowditch staircase". Due to the presence of rhythmoinotropic dependence, the ability of the heart to increase blood output against the background of stable or even increasing UOC is preserved when the heart rate increases. However, rhythmoinotropic dependence, as well as Starling's law, work fully only in normal conditions, and in the presence of even moderate myocardial insufficiency, the effectiveness of their implementation in the hemodynamic performance of the heart is sharply reduced. Therefore, an increase in both KDO and heart rate at rest indicates a decrease in the functional reserves of the heart. In most situations, the principles of homeo- and heterometric regulation of heart activity act strictly in combination. Thus, during intense physical exertion, the strengthening of sympathoadrenal effects on the heart is accompanied by a direct inotropic effect, and the increase in blood flow to the heart due to the contraction of skeletal muscles is accompanied by an increase in KDO and the implementation of the Frank-Starling mechanism. Nervous regulation of the heart is carried out by impulses coming from the central nervous system via sympathetic and vagus nerves. An increase in sympathetic stimulation leads to positive inotropic and chronotropic effects (that is, an increase in strength and heart rate, respectively). The increase in heart rate under these conditions is determined by the ability of sympathetic nerves to increase the rate of slow diastolic depolarization of cells — the pacemakers, the increase in contraction force — by the influence of nerves on the working myocardium. Activation of sympathetic nerves also increases the speed of conduction of excitation to the heart (positive dromotropic effect) and increases the excitability of the myocardium (positive bathmotropic effect). Elimination of sympathetic influences on the heart significantly limits its adaptive capabilities, with intense muscle work, the heart rate increases only by 10–12 beats/min, signs of circulatory failure quickly appear. The parasympathetic part of the autonomic nervous system also has a significant impact on the functional activity of the heart, the increase in activity of which has the opposite effect compared to the sympathetic nerves. Negative ino-, chrono-, bathmo- and dromotropic effects are characteristic of vagal influence. The vagal influence leads to a tonic inhibitory effect on the heart even at rest, and this

effect increases up to the complete stop of the heart in diastole with sharp activation of the vagus nerves. However, with long-term growth of vagal activity, the effect of "heart slipping" develops, its contractions, which stopped at first, gradually resume.

Plan:

1. Organizational measures:

- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,
- motivation of students of higher education regarding the study of the topic.

2. Control of the reference level of knowledge:

- written test,
- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes:

Know:

- the structure of the heart
- the structure of the conducting system of the heart
- Frank-Starling law
- influence of the autonomic nervous system on the heart

To be able to:- The method of determining the duration of the cardiac cycle in a person based on the pulse at rest and under conditions of physical exertion

- master the skills of using physiological methods of heart research in clinical practice

List of didactic units: textbooks, manuals, methodological recommendations on the topic of practical training, instructional materials for practical work.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

1. Cardiac cycle and dependence of its duration on heart rate.
2. Phases and periods of the cardiac cycle, their sequence and duration.
3. Dynamics of heart activity (BP value in the cavities of the heart and large vessels, the condition of the valves and the direction of blood movement during each phase of the cardiac cycle).
4. Volumes of the heart, their size and clinical significance.
5. The work of the heart as a pump. Methods of its research.

Test tasks:

1. What ensures the impossibility of reverse flow of blood from the ventricles to the atria in a healthy person?

A. Mitral and aortic semilunar valves

B. Mitral and tricuspid valves

C. Mitral and pulmonary semilunar valves

D. Aortic and pulmonary semilunar valves

E. Tricuspid and pulmonary semilunar valves

2. The patient needed to determine the peculiarity of the phase structure of the cardiac cycle. How to do it?

A. Rheography

B. ECG

C. Polycardiography

D. Plethysmography

E. Apexcardiography

3. In a healthy adult, sounding of the heart cavity and large vessels is performed. Where is the probe located, if pressure changes from 0 to 120 mm Hg are registered during the cardiac cycle. Art.?

A. Left ventricle

B. Right ventricle

C. Aorta

D. Pulmonary artery

E. Atrium

4. How can cardiac output be determined?

A. According to Fick's formula and the rheography method

B. According to Fick's formula and cardiac index

C. According to the cardiac index formula and the rheography method

D. According to Star and Fick's formula

E. According to the Stara formula and according to the cardiac index

5. Approximately to what value does the pressure in the left ventricle fall during diastole?

A. 120 mm Hg. Art.

B. 100 mm Hg. Art.

C. 80 mm Hg. Art.

D. 40 mm Hg. Art.

E. 0 mm Hg. Art.

6. A 70-year-old man. The ECG revealed signs of partial heart ischemia. How can this be explained?

A. Changes in the number of capillaries, sclerotic changes develop in the vessel walls

B. Sclerotic changes develop in the vessel walls

C. Changes in vascular elasticity, closing of semilunar valves

D. Changes in the duration of the cardiac cycle, sclerotic changes develop in the vessel walls

E. All answers are correct

7. In which of the phases or periods of the heart cycle are all heart valves open at the same time?

A. At the end of the isometric contraction phase

B. In the protodiastolic period

C. During the period of rapid filling of the ventricles

D. At the very beginning of isometric contraction

E. In none of the phases of the cardiac cycle

8. Why does blood not return to the veins during atrial systole?

A. Leaf valves close

B. The semilunar valves close

C. The ring muscles at the base of the veins are shortened

D. Great blood resistance in the veins

E. Leaf valves open

9. What indicators on the SFG coincide with the beginning of the 1st tone?

A. With an incision

B. With the beginning of the anakrota

C. With the onset of catacracy

D. With the apex of a dicrotic tooth

E. With the top of the SFG

10. What is the origin of the II tone?

A. Closing both flap valves

B. Closure of the tricuspid valve

C. Closing of the mitral valve

D. Closure of both semilunar valves

E. Closure of the semilunar aortic valve

Answers

1.B, 2.C, 3.A, 4.A, 5.E, 6.A, 7.E, 8.C, 9.B, 10.D

Situational tasks to test basic knowledge:

1. In 10 minutes, a person absorbed 5600 ml of O2. Determination of the amount of O2 in the blood showed that its content in arterial blood is equal to 200 ml in 1 liter, and in venous blood - 120 ml in 1 liter. Calculate the stroke volume of the heart (SV) if the heart rate is 75 bpm. Answer: UOS is equal to IOC divided by heart rate; IOC is determined by Fick's method as the ratio of the amount of O2 absorbed in 1 min (in milliliters) to the arteriovenous difference of O2 (in milliliters). In this case, the HOC is 7 liters, the UOS is 93.5 ml.

2. The minute volume of the heart (blood flow) is 7500 ml. The arteriovenous difference in O2 is 80 ml. Calculate how much O2 the body absorbs under such conditions in 1 hour. Answer: Based on Fick's formula, 36.0 L of O2 is absorbed in 1 hour under these conditions.

3. Calculate the UOS, if it is known that the minute volume is 8 L, and the R-R distance on the ECG is 0.6 s. Answer: UOS = IOC : Heart rate.

Heart rate = 60 : 0.6 = 100.

UOS = 80 ml.

4. Explain how the UOS and the duration of the phase of slow blood filling of the ventricles will change if the heart rate increases by 1.5 times? Answer: The duration of the slow filling phase will decrease by about the same amount. The stroke volume may remain the same

5. Explain what changes in heart sounds will occur under conditions of narrowing of the mitral valve opening (mitral valve stenosis)? Draw a diagram of the phonocardiogram observed under these conditions. Answer: With stenosis of the mitral valve opening, a diastole murmur occurs at the apex of the heart

6. What phase of cardiac activity corresponds to a pressure in the left ventricle of 50 mm Hg. Art.? Answer: Isometric contraction phase or isometric relaxation phase.

3. Formation of professional skills and abilities (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

- to investigate the method of determining the duration of the cardiac cycle in a person based on the pulse at rest and under conditions of physical exertion
- To solve situational tasks on the topic of practical training.

Instructional materials on the performance of tasks:

For work you need: a stopwatch

The object of research is a person.

Conducting work. In a person who is in a state of physical and emotional rest, the heart rate ranges from 60 to 80 bpm. Under conditions of physical exertion, the heart rate increases in proportion to the intensity of work. Heart rate can be determined by the value of the arterial pulse, that is, by the oscillations of the walls of the arteries associated with the increase in blood pressure in these vessels during heart systole. Palpate the pulse of the radial artery in yourself or another student. Count the number of pulses in 20 seconds. Multiply the acquired value by three, thus determining the heart rate in 1 minute. Divide 60 s by heart rate and find the average duration of the cardiac cycle at rest. Then they perform 20–30 squats and immediately after performing the physical activity, the heart rate and duration of the heart cycle are determined. Then the heart rate is determined 3, 5 and 10 minutes after the cessation of physical activity.

Forming the results and their evaluation. Enter the obtained data in the table. 8. 3. Note that the duration of the cardiac cycle depends on the functional state of the body. On the basis of the obtained data, draw a graph of the dependence of the duration of the cardiac cycle on the heart rate.

Tests for the final stage of the lesson

1. Why does blood not return from the aorta to the ventricles during cardiac arrest?

A. Closed flap valves

B. The semilunar valves of the vessels are closed

C. Open semilunar valves

D. Open flap valves

E. Open semilunar, closed leaflet valves

2. To what level does the pressure in the left ventricle increase during the period of blood expulsion?

A. 20–25 mm Hg. Art.

B. 30–50 mm Hg. Art.
C. 60–80 mm Hg. Art.
D. 90–110 mm Hg. Art.
E. 125–130 mm Hg. Art.

3. The pressure in the aorta during ventricular systole is equal to:
A. 125–130 mm Hg. Art.
B. 100–90 mm Hg. Art.
C. 40–30 mm Hg. Art.
D. 15–10 mm Hg. Art.
E. About 0 mm Hg. Art.

4. The end diastole volume of the left ventricle is equal to:
A. 25–30 ml
B. 35–50 ml
C. 60–70 ml
D. 70–100 ml
E. 130–140 ml

5. The final systolic volume of the left ventricle is equal to:
A. 25–30 ml
B. 35–50 ml
C. 60–70 ml
D. 70–100 ml
E. 130–140 ml

6. Closure of the atrioventricular valves occurs in the phase:
A. Contraction of the atrium
B. Isovolumic ventricular contraction
C. Rapid expulsion of blood from the ventricles
D. Slow expulsion of blood
E. Isovolumic relaxation

7. Opening of the aortic valve occurs during:
A. Contraction of the atria
B. Isovolumic ventricular contraction
C. Rapid expulsion of blood from the ventricles
D. Slow expulsion of blood
E. Isovolumic relaxation

8. The occurrence of the first heart tone is due to:
A. By opening the aortic valve
B. Opening the valve of the pulmonary artery
C. By closing the aortic valve
D. Closing the mitral and tricuspid valves
E. Closing the valve of the pulmonary artery

9. What indicators on SFG coincides with the beginning of the II tone?
A. With the onset of catacracy
B. With the beginning of the anakrota
C. With an incision
D. With the apex of a dicrotic tooth
E. With the top of the SFG

10. Where are the semilunar valves of the aorta heard?
A. In the V intercostal space 1–1.5 cm to the right of the mid-clavicular line
B. At the base of the xiphoid process
C. In the II intercostal space on the right behind the edge of the sternum

D. In the II intercostal space on the left behind the edge of the sternum

E. In the V intercostal space at the level of the anterior axillary line

Answers:

1.B, 2.E, 3.A, 4.E, 5.C, 6.B, 7.C, 8.D, 9.A, 10.C.

Situational tasks for the final stage of the lesson:

1. During the examination, a slowing of conduction through the AV node was detected in a person. Explain which examination method is the most objective in such a situation and why? Name this condition. Answer: The spread of excitation in the heart is most clearly presented on the ECG. In this case, there will be an increase in the duration of the PQ interval on the ECG, since this interval reflects the processes of propagation of excitation through the atria and AV node. This condition is called AV delay.

2. During the analysis of the ECG, bifurcation of the R wave was noted. Explain what this may indicate. Answer: The R wave reflects the excitation of the base of the heart, which occurs in both ventricles synchronously. That's why the tooth turns out to be fused. If the wave is bifurcated, then the excitation in one ventricle was delayed compared to the other. This indicates a violation (slowing down) of the conduction of excitation in one of the legs of the bundle of His.

3. The examinee is suspected of having a dysfunction of the conduction system of the myocardium. Explain:

1) On the basis of which functional study can such a conclusion be drawn?

2) What properties of the myocardium can be assessed by this method?

3) What diagnostic criteria are characteristic of this condition?

Answer: 1) On the basis of ECG registration and analysis.

2) ECG allows to assess the excitability, conductivity, automaticity of the myocardium.

3) Disruption of conduction at the level of the AV node is expressed in the lengthening of the PQ interval, at the level of the legs of the bundle of His — in the bifurcation of the R wave.

4. The distance between R waves on the subject's ECG is 40 mm. The recording was made at a speed of 50 mm/s. Calculate heart rate. Answer: At a speed of 50 mm/s, 1 mm of recording will be made in 1 : 50 = 0.02 s. This means that the electrocardiograph will record the distance between the R teeth of 40 mm in 0.02 • 40 = 0.8 s, which is the duration of the subject's cardiac cycle. Thus, HR in 1 min : 60 s : 0.8 s = 75 beats.

5. The distance between R waves on the subject's ECG is 20 mm. The recording was made at a speed of 25 mm/s. Calculate heart rate. Answer: At a speed of 25 mm/s, 1 mm of recording will be made in 1 : 25 = 0.04 s. Therefore, the electrocardiograph will record the distance between the

R waves of 20 mm in 0.04 • 20 = 0.8 s, which will be the duration of the examinee's heart rate. Thus, the heart rate will be equal to: 60 s : 0.8 s = 75 beats.

6. Explain what changes should be expected on the ECG and in which leads if the left border of the heart is determined in the V intercostal space 3 cm lateral to the midclavicular line.

Answer: On the ECG, one should expect a maximum increase in the amplitude of the R wave in lead I, a deviation of the EVS (leftogram), which is characteristic of left ventricular hypertrophy.

8. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated.

5. List of recommended literature (main, additional, electronic information resources):

Basic literature:

1. Physiology [textbook] /V. M. Moroz, O.A. Shandra.– 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728p.

4. *Further reading:*

56. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier. - 6th ed.,2017.- 528 p

57. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, J. Yuan, H. L. Brooks. - McGraw Hill Professional. – 26th edition,2019.–752 p.

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60. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 8th ed., 2019.–1186 p.

Electronic information resources:

45. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

46. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

47. National Scientific Medical Library of Ukraine http://library.gov.ua

48. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua

Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua

SEMINAR CLASS

Seminar session No. 13

Topic: Comparison of clinical and laboratory studies in a healthy person at rest and under physical stress on the digestive and respiratory systems

Purpose: to form a clear idea of the basic concepts of the physiology of the digestive and respiratory system, to understand the main approaches to laboratory research in the digestive and respiratory system in clinical practice; to develop the ability to apply research methods and to be able to analyze the obtained data.

Basic concepts:

Breathing is a set of processes that ensure the exchange of respiratory gases (oxygen and carbon dioxide) between the external environment and body cells. The morphological substrate of breathing is the respiratory system itself, which consists of the upper respiratory tract, lungs, respiratory muscles, and the bony apparatus of the chest. However, the respiratory system cannot provide breathing without the participation of the cardiovascular system, blood, and structures of the nervous and endocrine systems that regulate its function. It is customary to divide breathing processes into 5 stages. 1) lung ventilation - transport of gases from the external environment to the alveoli and back and gas exchange between the airways and alveoli in the transitory zone of the bronchial tree; 2) exchange of respiratory gases between alveoli and blood; 3) transport of respiratory gases by blood; Physiology of respiration 266 4) exchange of respiratory gases between blood and tissues; 5) internal (tissue) respiration - processes of biological oxidation of organic substrates that occur in the mitochondria of cells. The first 4 stages are traditionally designated by the term "external breathing". It is studied by physiology, and the last 5th stage is traditionally the subject of consideration in biochemistry. At certain stages of the breathing process, gas transport is ensured by two main mechanisms: diffusion and convection. Convection is carried out due to the pressure gradient, requires energy, and ensures the transport of gases over long distances. This type of gas transport is characteristic of stages 1 and 3. Diffusion is carried out due to the gradient of partial pressures of gases in their mixtures or gas tensions in liquids and does not require energy expenditure. However, with the help of this type of transport, gases are transported over short distances. It takes place at stages 1, 2 and 4. It is customary to divide the respiratory tract into upper and lower. The upper respiratory tract includes the nasal and oral cavity, pharynx and larynx. The main functions of this part of the respiratory tract are heating or cooling, humidification and purification of air coming from the outside environment. In addition, the upper respiratory tract is responsible for olfactory sensitivity (the olfactory epithelium of the nasal passages is the peripheral link of the olfactory analyzer) and voice production (the vocal cords of the larynx). The lower respiratory tract is represented by the

trachea and the bronchial tree of the lungs, consisting of 23 generations of bronchi. Generation means the level of dichotomous branching. At the same time, the trachea is considered the zero generation, the right and left main bronchi - the 1st generation, their branches - the 2nd generation, etc. The first 16 generations of bronchi form the conductive zone of the bronchial tree, as they conduct air to the next zone; 17-19 generations form a transient zone in which diffusion mixing of fresh (inhaled) and alveolar air occurs. In this zone, there are single alveoli that depart from the respiratory bronchioles. Therefore, to some extent, it also participates in gas exchange from the blood-pulmonary capillaries. The last 4 generations (from 20 to 23) are considered the respiratory zone, which is fully responsible for gas exchange with blood. This zone is formed by alveolar ducts and alveolar sacs. It is interesting to note that the composition of the air in it is relatively constant and does not depend on the phases of breathing. In addition to conducting air to the alveoli, the lower respiratory tract performs a protective function related to the secretion of mucus by the ciliated epithelium and submucosal mucous glands. Mucus captures small dust particles and constantly moves towards the pharynx thanks to the movement of the cilia, where it is swallowed. As you move from the trachea to the respiratory zone, the number of cilia and mucous glands decreases. The first 10 generations of bronchi have its wall has concentric cartilaginous elements that prevent bronchial collapse during exhalation. Starting from the 11th generation, the bronchi are devoid of cartilage and are called bronchioles. Their sticking together during exhalation is prevented only by the negative pressure in the pleural cavity. With lung ventilation disorders, they are most often responsible for a sharp increase in peripheral air resistance (obstructive disorders). All departments of the respiratory tract, including up to the 16th generation of bronchi, do not participate in gas exchange, since they do not contain alveoli. The volume of air located in these departments is called dead anatomical space. Its average value in adults is about 150 ml. The total cross-sectional area of the bronchial tree gradually increases from 2.5 cm2 (trachea) to 180 cm2 (16th generation). According to the laws of physics, the linear speed of air movement in the bronchi of the conductive zone gradually decreases by almost 70-80 times. In the transient zone, this speed is even slower, so gas exchange with the oncoming alveolar air is carried out over a very short distance due to diffusion, not convection. It is interesting that the total cross-sectional area of the bronchi at the level of 1 to 4 generations is smaller than that of the trachea, so the air moves here faster than in the trachea, which contributes to such a protective respiratory reflex as coughing. Alveoli first appear as single branches of respiratory bronchioles in the 17th-19th generation of bronchi. The 20th-22nd generation is formed entirely by alveoli that form alveolar passages, and the 23rd generation is represented by alveolar sacs in the form of bunches of grapes. All structures formed by the branching of one terminal bronchiole (16th generation), namely respiratory bronchioles,

alveolar ducts and alveolar sacs, are called a terminal respiratory unit or primary lobule. There are about 300 million alveoli in the lungs of an adult. The diameter of the alveoli varies from 75 to 300 μm, and their total surface area is within 50-100 m2. The wall of the alveoli is formed by flat alveolar epithelium, which is represented by two types of cells. Type I epithelium forms an alveolocapillary barrier, and type II epithelium secretes surfactant - a biologically active substance of a lipid nature that reduces the surface tension of the liquid film covering the surface of the alveoli. When the epithelium of type I is damaged, cells of type II proliferate and restore the integrity of the alveolar wall. Capillaries entwining the walls of the alveoli usually pass between two adjacent alveoli. These walls are connected by openings (pores of Kohn) that surround the capillaries. Their functional significance remains unclear. The thickness of the alveolar-capillary membrane is about 0.15-0.30 microns. The lungs receive blood from two sources: from the pulmonary artery and bronchial arteries (Fig. 6.5). At the same time, the alveoli receive venous blood from the pulmonary artery and ensure its oxygenation. The bronchial tree, on the other hand, receives arterial blood from the bronchial arteries, which, on the contrary, turns into venous blood, feeding the walls of the bronchi, and drains into the system of pulmonary veins, to some extent reducing the oxygenation of the mixed blood entering the left atrium from the lungs. This feature of blood supply to the lungs is called blood shunting. 1.3. Non-respiratory functions of the lungs. In addition to participating in gas exchange, the lungs perform a number of other functions and are involved in various functional systems. The following non-respiratory functions of the lungs can be distinguished: Participation in the compensation of hemodynamic disorders - is realized due to the ability of the vascular bed of the lungs to deposit a significant (up to 500 ml) amount of blood without significant violations of their respiratory function. Metabolic function. The lungs are the site of biosynthesis and metabolism of many physiologically active substances. Thus, the lungs convert angiotensin-1 into angiotensin-2, biosynthesis of prostaglandins, kinins, leukotrienes, etc. A special function. A large number of volatile toxic products of metabolism are released through the lungs (alcohol vapor in case of poisoning, ammonia in case of kidney disease, acetone in case of diabetes, etc.) Participation in thermoregulation. A large amount of heat can be released through the lungs along with heated and moistened air during hyperventilation or be retained in the body during hypoventilation. Participation in the maintenance of acid-alkaline balance is realized through a ventilated hydrocarbonate buffer system. Protective function. In the lungs

the blood comes into contact with a large number of lymphoid formations localized in the walls of the bronchi and a large number of macrophages located in the alveoli. All this contributes to its cleaning from dust and protection from carriers of foreign genetic information (microorganisms, own genetically defective cells). Blood filtration and its purification from

microemboli. When passing through the vessels of the lungs, venous blood is cleaned of microemboli (microclots of blood, microbubbles of air or fat) by filtering them into the alveoli and their subsequent removal with sputum. This prevents microemboli from entering the hemodynamic system. Participation in providing olfactory sensitivity. During inhalation, the air flow passes through the nasal passages, in the epithelium of which there are olfactory receptors. Thus, the act of breathing is a condition for the perception of olfactory stimuli. Participation in voice formation. The passage of air through the larynx creates vibrations of the vocal cords that generate the sounds that are the basis of human speech. Therefore, breathing is inextricably linked with voice production.

Plan:

1. Organizational measures:

- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,
- motivation of students of higher education regarding the study of the topic.

2. Control of the reference level of knowledge:

- written test,
- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes:

Know:

- partial pressure
- alveolar air
- gas exchange in the lungs
- influence of the autonomic nervous system on the lumen of the airways

To be able to:- Methodology of pneumotachometry

- master the skills of using physiological methods of heart research in clinical practice

List of didactic units: textbooks, manuals, methodological recommendations on the topic of practical training, instructional materials for practical work.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

1. Composition of inhaled, exhaled and alveolar air.
2. Partial pressure and tension of oxygen and carbon dioxide in alveolar air, venous and arterial blood.
3. Gas exchange in the lungs, its mechanism.
4. Gas exchange in tissues, its mechanisms.

5. Diffusion capacity of the lungs, factors affecting its value.

6. Arteriovenous oxygen difference.

7. Anatomical and physiological dead space.

8. Coefficient of utilization of oxygen, method of determination.

1. What data must be available to assess the vital capacity of the lungs (LVC)?

A. XEL of the examinee

B. Gender and age of the subject

C. Height and gender of the subject

D. Total lung capacity

E. Physical development data

2. The presence of which lung disease can be considered under the conditions of an increase in the residual volume?

A. Pneumonia

B. Pleurisy

C. Emphysema

D. Bronchitis

E. Tuberculosis

3. What does the decline in the Tiffno index indicate?

A. Increase in bronchial patency

B. Reduction of respiratory efficiency

C. Violation of oxygen absorption

D. Decreased bronchial conductance

E. Change in total lung capacity

4. What volumes make up the functional residual capacity?

A. Residual volume and expiratory reserve volume

B. Residual volume and alveolar dead space

C. Tidal volume and inspiratory reserve volume

D. Inspiratory volume and expiratory reserve volume

E. Respiratory volume and inspiratory and expiratory reserve volume

5. What volumes make up the ZHEL?

A. Residual volume and expiratory reserve volume

B. Residual volume and alveolar dead space

C. Tidal volume and inspiratory reserve volume

D. Inspiratory volume and expiratory reserve volume

E. Tidal volume and inspiratory and expiratory reserve volumes

6. The actual indicators of external respiration can be determined:

A. According to formulas and tables

B. According to tables and nomograms

C. By the spirography method

D. By the spirometry method

E. By the methods of spirography and spirometry

7. Proper indicators of external breathing can be determined:

A. According to formulas and tables

B. According to tables and nomograms

C. By the spirography method

D. By the spirometry method

E. By the methods of spirography and spirometry

8. What volume is not included in ЖЕЛ?

A. Tidal volume

B. Inspiratory reserve volume

C. Residual volume

D. Expiratory reserve volume

E. All of the above

9. On what factors does the life cycle depend?

A. Vic

V. Sex

S. Body height and weight

D. Level of physical development

E. All of the above

10. What is the minute volume of breathing, if BH — 15 in 1 min, DO — 500 ml, and VL —

4000 ml?

A. 20,000 ml

B. 9000 ml

C. 7500 ml

D. 6000 ml

E. 4000 ml

Answers:

1.B, 2.C, 3.A, 4.A, 5.E, 6.A, 7.E, 8.C, 9.B, 10.D

Situational tasks to test basic knowledge:

1. Calculate the efficiency of pulmonary ventilation at tidal volumes (TI) equal to 500, 1000, 1500 ml, and under the condition that the functional residual capacity is equal to 2500 ml. Answer: The efficiency of pulmonary ventilation is determined by the ratio of the volume of air that entered the alveoli to that which was there. The alveoli include the respiratory volume (DO), plus the volume of the dead space (ODV), which is 150 ml. Before inhalation, the lungs contain a functional residual capacity (FRC), which is equal to the sum of the residual volume and the exhalation reserve volume. From here it is easy to calculate that the effectiveness of pulmonary ventilation at given respiratory

volumes will be equal to 14, respectively; 34; 54%.

2. Calculate what the following are equal to: DO, ROvd and ROvid, functional residual capacity (FRC) and inspiratory capacity (ERC), if the RRC is 4000 ml, and the ratio of its component volumes is within the normal range. Answer: Normally, DO is 20%; ROvd and ROvid — each 40% of ZHEL; FZE = ROvid + OO; Evd = TO + ROvd; OO = 30 % XEJI. So, in this case, DO = 800 ml; ROvd and ROvid — 1600 ml each; FZE = 2800 ml; Eud = 2400 ml.

3. Calculate what the proper VL equals in a woman 165 cm tall at the age of 30. Answer: 3. A woman's proper VL = H (21.78 - 0.101 A), where H is height (cm), A is age (years) - Baldwin's formula. In this case, the proper VL = 3620 ml.

4. Calculate the proper VL for a 45-year-old man, if his height is 181 cm. Answer: 4. According to the Baldwin formula, the proper VL for a man = H (27.63 – 0.112 A), where H is height (cm), A is age (years). In this case, the proper VL = 4940 ml.

5. A study of respiratory volumes in a 65-year-old man with a height of 170 cm showed that the LVEF is 4800 ml, the total capacity of the lungs is 6800 ml. Determine whether there is a violation of pulmonary ventilation in this person, if the ratio of TO, components of VLDL remained within the normal range. Answer: 5. It is known that the normal ratio of respiratory volumes is as follows: TO = 20% of LV; POvd = POvid = 40 % ШЕЛ. Pulmonary ventilation (LV) is equal to: (DO – OMP) : FOE; FZE = OO + ROvid; OO = ZEL - ZEL.

6. Calculate the value of the CHO change, if at rest the number of respiratory movements (RB) was equal to 20 per 1 min, CO — 600 ml, and during physical work, the CO increased by two times, CO — by 300 ml. MOD at rest = DO • BH = 20 • 600 ml = = 12,000 ml. Answer: During operation BH = 40, DO = 900 ml, MOD = = 40 • 900 ml = 35,000 ml. Thus, MOD increased by 200% (three times) compared to rest.

3. Formation of professional skills and abilities (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

- Methodology of pneumotachometry
- To solve situational tasks on the topic of practical training.

Instructional materials on the performance of tasks:

For work, you need: pneumotachometer with pneumotachometric tube, alcohol, cotton cloth, nose clip

The object of research is a person.

Conducting work. Measuring the maximum speed of inhalation and exhalation under conditions of forced breathing — pneumotachometry — is a simple method of diagnosing violations of bronchial patency, which depends both on the strength of the respiratory muscles, and on the lumen of the bronchi and the mechanoelastic properties of the lungs. The indicators obtained during pneumotachometry are called inspiratory and expiratory power. They fluctuate within fairly wide limits, so the value of this method increases under the conditions of repeated studies of the same subject. A pneumotachometer is a needle differential manometer calibrated for airflow values that correspond to the pressure difference before and after the diaphragm in the pneumotachometer tube. Research is carried out in the position of the subject standing or sitting. To measure the maximum expiratory speed, he takes a full breath and then exhales as fast as

possible through the pneumotachometer tube. During the measurement of the maximum speed of inhalation, the subject after a deep exhalation takes the fastest and deepest inhalation possible.
Forming the results and their evaluation. Enter the readings of the pneumotachometer in the table. Draw conclusions.

Tests for the final stage of the lesson

1. What is the cause of lung collapse in pneumothorax?
A. In reducing intrapleural pressure
B. The intrapleural pressure is equal to atmospheric
C. In the increase of intra-abdominal pressure
D. In respiratory muscle atony
E. In violation of the automatism of the respiratory center

2. What is the intrapleural pressure at the end of calm exhalation under conditions of normal atmospheric pressure?
A. 757 mm Hg. Art.
B. 780 mm Hg. Art.
C. 760 mm Hg. Art.
D. 740 mm Hg. Art.
E. 100 mm Hg. Art.

3. What is the intrapleural pressure at the end of a calm inhalation under conditions of normal atmospheric pressure?
A. 860 mm Hg. Art.
B. 658 mm Hg. Art.
C. 754 mm Hg. Art.
D. 780 mm Hg. Art.
E. 100 mm Hg. Art.

4. What type of pneumothorax most quickly leads to a serious condition of a person?
A. Open
B. Closed
C. Valve
D. Unilateral
E. None of the above

5. What forces prevent inhalation?
A. Elastic traction of the lungs
B. Elastic resistance of the chest
C. Aerodynamic resistance of the respiratory tract
D. Inertia of the thoracic and abdominal organs
E. All of the above

6. A change in which indicator of external breathing is diagnostic under the conditions of a restrictive type of violation of lung ventilation?
A. JEL
B. FJEL
C. FEV1
D. FZE
E. Inspiratory capacity

7. A change in which indicator of external breathing is diagnostic under the conditions

of obstructive type of impaired lung ventilation?

A. JEL

B. TO

C. FEV1 (Tiffno test)

D. FZE

E. Inspiratory capacity

8. Who proposed the most famous model for studying the mechanism of inhalation and exhalation?

A. Sechenov

B. Pavlov

C. Sherrington

D. Donders

E. Schmidt

9. How much dead space a person has 70 kg breathing through a tube with a radius of 5 mm and a length of 100 cm?

A. 150 ml

B. 180 ml

C. 230 ml

D. 280 ml

E. 350 ml

10. What is the role of alveolar fluid surfactant?

A. It reduces the surface tension of the alveoli

B. Increases the surface tension of the alveoli

C. Has a bactericidal effect

D. Improves gas exchange

E. Regulates pulmonary circulation

Answers:

1.B, 2.A, 3.C, 4.C, 5.E, 6.A, 7.C, 8.D, 9.C, 10.A.

Situational tasks for the final stage of the lesson:

1. Explain which of the two people arguing is right? One states: "the lungs expand, and therefore air enters them," the other: "air enters the lungs, and therefore they expand." Answer: If we are talking about the natural way of breathing, then the first person is right. The breathing mechanism is suction. But if we mean artificial respiration, then the second person is right, since here the mechanism is pumping.

2. In some conditions, the extensibility of lung tissue decreases by 5–10 times. Explain which compensatory mechanism is activated under such conditions. Answer: Under the conditions of significant worsening of the alveolar distensibility, a deep enough breath is impossible. The body tries to compensate for the lack of air by increasing the frequency of breathing, which remains shallow (shortness of breath).

3. A person needs to walk along the bottom of the reservoir. In such a situation, if there are no special devices, they breathe through a tube, the end of which comes out of the water. There are three tubes. The length of each is 1 m, and the inner diameter is 68, respectively; 30; 5 mm.

Explain which tube to use. Justify your answer with an appropriate calculation. What main element of the tube can affect the efficiency of breathing? Answer:
Each tube, according to its volume, increases the anatomical dead space differently. The volume of the first tube is about 3.6 liters. Such a dead space is practically irresistible. Choosing this tube dooms a person to death from suffocation. The volume of the second tube is about 600 ml. This dead space can be overcome by breathing deeply and infrequently, using reserve inspiratory volume. Finally, the volume of the third tube is quite small. But due to its very small diameter, the air during breathing will move very quickly in the tube and its friction against the walls will increase sharply, which can significantly complicate breathing. Therefore, the dimensions of the second tube are optimal.
4. In the XX century. the cause of the disease of newborns, who died immediately after birth, being unable to breathe, was revealed. The solution was found when they began to prepare homogenates from the lung tissue of such children and children who died from other causes. In these homogenates, some physical and chemical parameters were measured and compared. Explain what was discovered. Answer: The impossibility of the inhalation process in this case may be associated with a violation of the alveolar distensibility function. It is determined by two factors - the condition of the walls and the presence of a surfactant - a substance that reduces the high surface tension at the boundary between the liquid that covers the inside of the alveolar wall and air. The cause of the death of newborns was a genetic defect — the absence of surfactant, without which the work of the respiratory muscles is unable to ensure the expansion of the lungs.

5. Under the conditions of narrowing of the respiratory tract, the movement of air becomes turbulent. This requires a significant expenditure of energy, and it is difficult for a person to breathe. The condition improves if the air is replaced with an oxygen-helium mixture (it contains the same amount of helium instead of nitrogen). Explain the reason for the improvement under these conditions. Answer: For each liquid and each gas, there is a certain Reynolds number - a dimensionless quantity that determines the limit of transition from laminar to turbulent flow. If it is exceeded, the laminar flow becomes turbulent. The higher the density of a liquid or gas, the greater the Reynolds number. Since helium is more than three times lighter than nitrogen, it accordingly reduces the Reynolds number for the respiratory mixture, its flow in the respiratory tract becomes laminar, which brings relief during breathing.

6. In two animals of different species, as a result of trauma, unilateral damage to the chest with depressurization of the pleural cavity (pneumothorax) occurred. As a result, one animal died, and the second one remained alive. Explain why the consequences of pneumothorax are so different.

Answer: If the damage appeared on only one side, it will lead to the collapse of the corresponding lung, but the other will be preserved and the animal will not die. However, there are species of animals in which both pleural cavities are damaged. In such a situation, pneumothorax will always be bilateral, therefore, fatal.

4. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated

5. List of recommended literature (main, additional, electronic information resources):

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Electronic information resources:

49. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

50. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

51. National Scientific Medical Library of Ukraine http://library.gov.ua

52. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua

Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua

SEMINAR CLASS

Seminar session No. 14

Topic: Comparison of urine analysis indicators in a healthy person at rest and during physical exertion of different intensities

Purpose: to form a clear idea of the basic concepts of the physiology of the excretory system, to understand the main approaches to laboratory research in the excretory system in clinical practice; to develop the ability to apply research methods and to be able to analyze the obtained data.

Basic concepts:

Maintenance of optimal relations of the organism with the environment and maintenance of homeostasis is ensured both by the arrival of vital substances from the outside and by the release of end products of metabolism. Excretory functions are carried out by many body systems: kidneys, gastrointestinal tract, external respiratory organs, sweat, sebaceous, lacrimal, mammary and other glands. The remains of digestive juices, undigested products, nitrogen compounds (urea, uric acid), salts, water, various medicinal substances and toxic compounds (mercury, bismuth, morphine, paints, iodide compounds, etc.) are removed from the body through the gastrointestinal tract. . Through the organs of external respiration, gaseous substances are released - carbon dioxide, medicinal substances, etc. However, the secretory functions of the kidneys and sweat glands play the main role in metabolic processes. The main functions of the kidneys: 1. regulation of the volume of fluids in the body's internal environment; 2. regulation of blood pH, acid-base balance, concentration of ions and osmotic pressure in body tissues; 3. removal from the body of end products of protein metabolism, foreign (including medicinal) substances, excess of organic and inorganic substances; 4. secretion of physiologically active substances, in particular renin, erythropoietin and others, which affect the tone of blood vessels, blood pressure, and the formation of erythrocytes. The functional unit of the kidney is the nephron. There are more than 2 million nephrons in human kidneys. Each nephron begins with a Malpighian body, which consists of a Shumlyansky-Bowman capsule, which contains a glomerulus. The capsule of Shumlyansky-Bowman has a double wall, the inner wall of the capsule is in close contact with the walls of the capillaries of the vascular glomerulus, forming a basal filtering membrane. Between it and the outer wall of the capsule there is a cavity into which plasma enters, which is filtered through the basal filtering membrane from the capillaries of the glomerulus. The vascular glomerulus consists of a complex network of arterial capillaries, afferent and efferent arterioles. The diameter of the efferent arteriole is smaller compared to the afferent arteriole, which contributes to the maintenance of relatively high blood pressure (70 mm Hg) in the capillaries of the glomeruli. The outer wall of the Shumlyansky-Bowman capsule

directly passes into the proximal convoluted tubule. This is a tubule of the 1st order. At some distance from the capsule, the proximal convoluted tubule straightens and forms the loop of Henle, which passes into the distal convoluted tubule (2nd order), which in turn opens into the collecting tube. In addition to such nephrons, which are called cortical, there are also others in the kidney - juxtamedullary nephrons. They are located in the medulla of the kidneys, produce renin, which regulates blood pressure. In 1 min. about 1200 ml of blood passes through the kidney, i.e. 25% of HOC. Taking into account that the weight of the kidneys is only 0.4% of the body weight, the extremely high level of blood supply to the kidneys becomes obvious. At the same time, 90-93% of all blood passes through the cortical substance of the kidneys. It should be noted that this blood circulation is quite constant and does not change when blood pressure changes twice - from 90 to 190 mm Hg. Art. A feature of the blood supply of the kidneys is the presence of a double network of capillaries. The first network of capillaries forms the glomeruli of the renal corpuscles, and the second - wraps around the tubule of the nephron. Capillaries collect into small veins that form the renal veins that drain into the inferior vena cava. 2. Mechanism of formation and allocation of urine. Urine formation is a complex process that, according to the modern filtration-reabsorption theory, consists of 2 phases - filtration and reabsorption. Today it is also believed that in secretory processes are involved in the release of individual substances. Filtration. Due to the high blood pressure in the vascular glomerulus (60-70 mm Hg), fluid passes from the lumen of the blood capillaries through the glomerular filter into the cavity of the glomerulus capsule. The glomerular filter consists of the endothelium of the capillaries, the basement membrane and the inner leaf of the Shumlyansky-Bowman capsule. The endothelium of capillaries does not pass the formed elements of blood and proteins, but low molecular weight substances dissolved in the blood plasma freely pass through it. The following layers limit the filtration of plasma albumins and other substances with a large molecular weight. As a result, almost protein-free blood plasma with all dissolved salts passes into the cavity of Shumlyansky Bowman's capsule. This filtrate is called primary urine. A person produces 190-200 ml of primary urine from each liter of blood plasma, which is 150-180 liters per day. At the same time, the final volume of urine is 1-1.5 l, that is, the majority of the liquid is reabsorbed in the renal tubules. Reabsorption. The first urine enters the convoluted tubules and the loop of Henle, where reverse absorption, i.e. reabsorption, occurs. The main purpose of this process is to return to the blood all the substances needed by the body. Thus, glucose, amino acids, vitamins, and small amounts of protein are reabsorbed in the proximal tubule. peptides, Na^+, K^+, Ca^{2+}, Mg^{2+} ions. Simultaneously with these substances, water is reabsorbed. In the following sections, organic substances are not absorbed, only ions and water are reabsorbed in them. It should be noted that at a high concentration, substances may not be fully reabsorbed and therefore excreted

from the body. For example, if the concentration of glucose is greater than 150-180 mg%, then there is an excess of it in the urine, that is, glucosuria is observed. Mechanisms of reabsorption of various substances are different. For example, glucose is reabsorbed in cotransport with Na+, the movement of which is carried out along the concentration gradient created by Na, K-ATPase. Protein molecules are transported by the mechanism of pinocytosis. There are also special amino acid transport systems. Reabsorption of Na+, Cl-, HCO3- ions, which were filtered in the glomeruli, requires the greatest energy expenditure. At the same time, sodium transport is primary active, i.e. ATP energy is spent on its maintenance. The main role in this process is played by Na,K-ATPase. At the same time, 2/3 of sodium is reabsorbed in the proximal tubule. Other ions are also reabsorbed in the proximal part. As a result of reabsorption in the proximal tubule of most of the components of the ultrafiltrate and water, the volume of primary urine sharply decreases and only about 1/3 of the primary filtrate enters the initial part of the loop of Henle. Absorption processes also continue here. In particular, up to 25% of sodium is absorbed in the area of the loop of Henle, and about 9% in the distal part of the tubule. Absorption here occurs against high concentration gradients. End products of protein metabolism - urea, uric acid, creatinine, ammonia, sulfates, medicinal substances and others are not reabsorbed and are excreted in the urine. Secretion. The secretion accelerates the removal by the kidneys of a number of foreign substances, end products of metabolism, and ions. In particular, such organic acids as penicillin and uric acid, organic bases - choline, guanidine and inorganic ions - potassium are secreted. The secretion of organic acids and bases occurs in the proximal segment of the nephron, and the secretion of potassium occurs in the cells of the distal convoluted tubule and collecting tubules. The secretory function is that some harmful substances that do not pass through the "sieve" are removed from the body as a result of secretion. 3. Regulation of urine formation and excretion. Urinary processes in the human body are regulated by nervous and humoral mechanisms. This regulation is aimed at maintaining the constancy of the ionic composition and volume of the intercellular fluid. In particular, the osmoticity of the internal environment can increase with insufficient water consumption or excessive water loss (e.g. with sweat). In this situation, there is reflex and humoral regulation of kidney activity aimed at water retention in the body. At the same time, afferent influences enter the CNS from osmoreceptors located in the area of the carotid artery and the hypothalamus. They react mainly to changes in sodium concentration. In addition, the intensity of urination is regulated with the participation of volume receptors that control the volume of extracellular fluid. Reflex effects on the process of urination pass through sympathetic and parasympathetic nerves. Pain stimuli coming through extra- or interoreceptors reduce or completely stop the formation of primary urine. This effect can also be reproduced in a conditional reflex way. It has also been shown that repeated

introduction of water into the animal's body in combination with a conditioned stimulus leads to the formation of conditioned reflexes to stimulate the release of urine. Humoral regulation is carried out by the hormone of the adrenal glands - aldosterone and the antidiuretic hormone (vasopressin) of the pituitary gland. It should be noted that adrenaline and norepinephrine also stimulate the release of aldosterone. Under the influence of aldosterone, the processes of reabsorption of Na+ increase and the reabsorption of K+ decreases at the same time. At the same time, retention of sodium and water in the body occurs. Antidiuretic hormone helps to increase the permeability of the wall of the nephron loop, as well as the walls of the collecting tubules. This leads to water retention in the body. Urinary excretion is also affected by thyroxine, which stimulates it by suppressing water reabsorption in the tubules of the nephrons. The process of excretion of calcium in the urine is also regulated. Thus, the parathyroid hormone parathyroid hormone increases its reabsorption in the renal tubules, while thyrocalcitonin increases the excretion of calcium in the urine. Excretion of urine. The final urine enters the renal pelvis, ureters, and bladder through the collecting tubules. When 25O-ZOO ml of urine is collected in the bladder, the pressure in it reaches 15-16 cm of water. Art. The receptors of the bladder walls are irritated and the excitation enters the coccygeal part of the spinal cord via afferent pathways, where the center of involuntary reflex urination is located. The centers of the spinal cord are under the control of the reflex centers of the bridge, hypothalamus and large hemispheres. Efferent innervation of the bladder is carried out by sympathetic and parasympathetic fibers. Impulses arriving via sympathetic fibers from the area of the upper lumbar segments relax the muscles of the bladder. This contributes to the filling of the bladder with urine and its retention. Upon arrival of an impulse along parasympathetic fibers from 2-4 coccygeal segments, the smooth muscles of the bladder wall contract, urine is squeezed out of the bladder and excreted. At the same time, relaxation of the internal smooth muscle sphincter of the urinary bladder and relaxation of the external sphincter, made of striated muscle tissue, occurs. The external sphincter is innervated by the fibers of the pubic nerve coming from the middle coccygeal segments. Prolonged physical work leads to a decrease in blood circulation of internal organs, a sharp decrease in pressure in the capillaries of the vascular glomeruli of the kidneys, and this leads to a decrease or even cessation of urination. The insufficient activity of the kidneys is compensated by the increased work of the sweat glands, which at the same time increases heat transfer. Under the conditions of anaerobic work, the concentration of lactic acid in urine can reach 0.22-0.24%, while under aerobic work it does not exceed 0.05-0.06%. At the same time, the removal of lactic acid is facilitated by the increased work of the sweat glands. Under conditions of physical and psychoemotional stress, glucose and protein may appear in the urine.

Plan:

1. Organizational measures:

- greetings,
- verification of those present,
- notification of the topic, purpose of the lesson,
- motivation of students of higher education regarding the study of the topic.

2. Control of the reference level of knowledge:

- written test,
- Frontal poll

Knowledge requirements for students' theoretical readiness to perform practical classes:

Know: 1. Mechanisms of urine formation.

2. Physiological bases of clinical methods of functional state research organs of the urinary system.

To be able to:- Methodology of pneumotachometry

- master the skills of using physiological methods of heart research in clinical practice

List of didactic units: textbooks, manuals, methodological recommendations on the topic of practical training, instructional materials for practical work.

Tasks for checking basic knowledge on the topic of the lesson:

Theoretical questions:

1. The allocation system, its functions. Peculiarities of renal blood flow.
2. Excretory organs — kidneys, lungs, skin, gastrointestinal tract.
3. The structure and functions of the structural and functional unit of the kidneys — the nephron.
4. Mechanisms and speed of glomerular filtration, amount and composition of primary urine.
5. Mechanisms of reabsorption in tubules.
6. The rotary-counter-multiple system and its physiological role.
7. Secretory processes in proximal, distal tubules and collecting tubules.
8. Amount and composition of final urine.

:

1. Hydrostatic blood pressure in glomerular capillaries is 55 mm Hg. Art., oncotic pressure of plasma — 30 mm Hg. Art., the concentration of glucose in the plasma is 15 mmol/l, the daily diuresis is 2.5 liters. An increase in diuresis is a consequence of a decrease in:

A. Glomerular filtration rates
B. Isoosmotic reabsorption of water
C. Oncotic pressure of plasma
D. Tubular secretion

E. Effective filtration pressure

2. The clearance of inulin is 110 ml/min. In a woman with a body surface of 1.73 m2, this indicates a normal speed:
A. Glomerular filtration
B. Tubular secretion
C. Tubular reabsorption
D. Renal circulation
E. Renal plasma circulation

3. arterial blood pH 7.4; primary urine — 7.4; final urine — 5.8. A decrease in the final urine pH is the reason for the secretion of one of the following substances in the tubules of the nephron:
A. Potassium
B. Iodine
C. Urea
D. Water
E. Creatine

4. In the experiment, it was found that the blood pressure in the capillaries of the glomerulus is 47 mm Hg. Art., the pressure of urine in the capsule of the nephron is 10 mm Hg. Art., oncotic pressure of primary urine — 0 mm Hg. Art. Determine at what value of plasma oncotic pressure will stop glomerular filtration?
A. 57 mm Hg. Art.
B. 47 mm Hg. Art.
C. 37 mm Hg. Art.
D. 27 mm Hg. Art.
E. 10 mm Hg. Art.

5. Clearance of inulin per standard surface area in humans is 125 ml/min. The concentration of glucose in the blood is 4.5 mmol/l, glucosuria, increased diuresis. The reason for the changes is a violation of functions:
A. Klubochkiv
B. Proximal tubules
C. Descending division of the loop of Henle
D. Ascending division of Henle's loop
E. Distal tubules

6. Glucose is reabsorbed by secondary active transport in one of the following sections of the nephron:
A. Proximal tubules
B. Descending division of Henle's loop
C. Ascending division of Henle's loop
D. Distal tubules
E. Collecting tubes

7. In 1 minute, 125 ml of blood plasma was filtered into the Shumlyansky-Bowman capsule, and 1 liter of final urine was formed. Determine in which part of the nephron 2/3 of water is reabsorbed along the osmotic gradient:
A. Collecting tubes
B. Descending division of the loop of Henle
C. The ascending division of Henle's loop
D. Proximal tubules
E. Distal tubules

8. The patient was prescribed the antibiotic penicillin. In which department is it secreted and released from the body?

A. Proximal tubules

B. Descending division of the loop of Henle

C. The ascending division of Henle's loop

D. Distal tubules

E. Collecting tubes

9. In the experiment, the processes of energy generation in the epithelium of the tubules of the nephron were blocked, as a result of which diuresis increased 4 times. The reason for the increase in diuresis is a primary decrease in reabsorption:

A. Potassium

B. Sodium

C. Calcium

D. Glucose

E. Phosphates

10. During the study of kidney excretion of a low-molecular-weight substance, it was found that its clearance is greater than the clearance of inulin. What processes in the nephron lead to the release of this substance?

A. Glomerular filtration

B. Secretion in tubules

C. Secretion in collecting tubules

D. Secretion in the loop of Henle

E. Glomerular filtration and tubular secretion

Answers:

1.B, 2.A, 3.D, 4.C, 5.B, 6.A, 7.D, 8.A, 9.B, 10.E.

Situational tasks to test basic knowledge:

1. The efferent arteriole in the kidney, which receives blood from the capillaries of the glomerulus, has a smaller diameter than the afferent arteriole, which delivers blood to the glomerulus. Explain the physiological meaning of this anatomical difference. What would happen if the ratio of the diameters of these vessels changed to the opposite? Answer: The first stage of urine formation — filtration — takes place in the glomeruli. Blood pressure plays an important role under these conditions. A narrower efferent vessel creates additional resistance and therefore the pressure in the capillaries of the glomerulus increases, which contributes to filtration. Under the conditions of the inverse ratio of vessel diameters, the pressure would increase in front of the supplying vessel, and after overcoming it, the blood would enter the glomerulus with reduced pressure. The formation of urine would decrease dramatically. Therefore, sclerotic degeneration of the afferent vessels is very dangerous for the kidneys.

2. During the examination, it was found that the blood plasma contains: substance A, which in the kidneys is only capable of filtration processes; substance B, which is filtered in the kidneys and then reabsorbed; substance C, which is filtered and secreted in the kidneys. Explain:

1) Which of these substances has the lowest renal clearance, and which has the highest?

2) Which of the substances will be removed from the blood plasma faster?

Answer: Renal clearance is a hypothetical volume of plasma from which the kidney completely removes any substance per unit of time. The clearance is the higher, the more of the substance contained in the blood passes into the urine.

1) The blood will be purified the most from the substance that is filtered, not reabsorbed and secreted (substance C), the least — from the one that is filtered and reabsorbed (substance B).

2) Blood plasma is cleared of a substance that has a high renal clearance (in this case, substance C) the fastest. 3. Explain, if the concentration of a pharmacological drug, such as an antibiotic, must be maintained in the blood plasma at a constant level, what renal clearance — high or low — should this drug have? Answer: This drug should have low renal clearance.

4. During the examination, it was found that substance A has a renal clearance of 56%, substance B — 99%. Explain:

1) Which of these substances can be used to estimate the amount of renal blood flow?

2) What other indicator must be known to calculate renal blood flow?

3) What is the volumetric velocity of blood flow through the kidneys? Answer: 1) Clearance, which is equal to 99%, indicates that the blood plasma is almost completely cleaned of the substance, passing through the kidneys, that is, the clearance is equal to the value of the plasma flow. Such a substance is paraaminohippuric acid, which is freely filtered, secreted with the help of an organic acid carrier in the proximal tubules, but not reabsorbed.

2) To calculate the renal blood flow, it is necessary to know the value of the hematocrit.

3) About 20% of the volumetric blood flow passes through the kidneys, i.e. about 1 l/min.

5. Explain how to determine whether a newly synthesized substance can be used to determine the renal clearance rate. Answer: The main requirement is that the substance must be non-threshold, i.e. not subject to either reabsorption or secretion in the process of urine formation. To establish this, it is necessary to compare the effects obtained under conditions of administration to the same animal under identical conditions of this substance and a known

non-threshold substance (for example, inulin). If identical results are obtained, then the substance is non-threshold and can be used. If the purification coefficient is greater than that of inulin, it means that the substance is secreted into the tubule cavity in addition to filtration. And if the coefficient is smaller than in inulin, it means that part of the substance is reabsorbed from the tubules. In both of these cases, the substance is not suitable for use in determining the cleaning factor.

3. Formation of professional skills and abilities (mastery of skills, conducting research):

The content of educational practical tasks that must be completed during the practical session:

- to build a regulation circuit of the renin-angiotensin-aldosterone system
- To solve situational tasks on the topic of practical training.

Instructional materials on the performance of tasks:

To work, you need: knowledge of physiological processes in the body

The object of research is a person.

Conducting work. When blood pressure drops or in stressful situations, the kidneys secrete an enzyme called renin. Renin splits the protein angiotensinogen, resulting in angiotensin I. It is converted by another enzyme, called angiotensin-converting enzyme (ACE), into angiotensin II. Angiotensin II not only causes the narrowing of blood vessels (vasoconstriction), it simultaneously stimulates the release of the hormone vasopressin (also called ADH) in the pituitary gland, as well as adrenaline, norepinephrine, and aldosterone in the adrenal glands. While adrenaline and norepinephrine enhance vasoconstriction, aldosterone affects the filtration function of the kidneys. The kidneys retain sodium and water in the body, while increasing potassium excretion. Vasopressin prevents the removal of water from the body without having an effect on potassium and electrolytes

sodium Angiotensin, aldosterone and vasopressin can also have a direct effect on the heart. In certain remodeling processes, for example, after a heart attack, these hormones are involved in the pathological enlargement of the heart or the development of scar tissue, which, in the end, can lead to the development of heart failure. A number of drugs used in cardiology affect the renin-angiotensin-aldosterone system. For example, diuretics increase the excretion of water from the body and, thus, reduce blood volume; ACE inhibitors block the enzyme that is necessary for the formation of angiotensin II, thereby interrupting the signaling pathway. Bayer is also involved in research on the renin-angiotensin-aldosterone system (RAAS) and vasopressin receptors.

Forming the results and their evaluation. enter into the protocol the circuit diagram of the regulation of the renin-angiotensin-aldosterone system. Draw conclusions.

Tests for the final stage of the lesson

1. In an experiment on animals, the supraoptic nuclei of the hypothalamus were destroyed, which led to an increase in daytime diuresis. What process in the kidneys will be disrupted the most after this?
A. Glomerular filtration
B. Reabsorption of water in the proximal tubules
C. Reabsorption of water in the distal tubules
D. Water reabsorption in the loop of Henle
E. Secretion of osmotically active substances

2. In the experiment, blood filling of the atria was increased. This led to a decrease in the reabsorption of Na+ and H2O in the renal tubules. Increased secretion of which hormone contributes to this result?
A. Aldosterone
B. Vasopressin
C. Natriuretic
D. Renin
E. Angiotensin

3. After eating salty food, the amount of urine decreased significantly. Increased secretion of which hormone led to a decrease in diuresis?
A. Aldosterone
B. Natriuretic hormone
C. Angiotensin2
D. Renin
E. Vasopressin

4. The patient's prolonged vomiting led to dehydration. The increase in the secretion of which hormone under these conditions ensures the preservation of water in the body?
A. Aldosterone
B. Vasopressin
C. Calcitonin
D. Natriuretic
E. Adrenaline

5. The person complains of a persistent increase in blood pressure and swelling. During the examination, a narrowing of the renal artery was found. Activation of which system caused hypertension?
A. Sympathoadrenal
B. Hypothalamic-pituitary
C. Renin-angiotensin
D. Cute
E. Parasympathetic

6. In people adapted to the effect of high external temperature, increased sweating is not accompanied by the loss of a large amount of sodium chloride with sweat due to the action of one of the hormones:
A. Aldosterone

B. Cortisol
C. Vasopressin
D. Thyroxine
E. Natriuretic

7. In the blood plasma, the concentration of potassium ions is increased, which is accompanied by an increase in the secretion of this ion in the distal parts of the nephron. This will lead to a decrease in secretion in the same section of the nephron:
A. Ammonia
B. Potassium ions
C. Magnesium ions
D. Sodium ions
E. Hydrogen ions
8. In humans, the osmotic concentration of blood plasma is 350 mosmol/l. This leads to increased secretion of the hormone:
A. Vasopressin
B. Aldosterone
C. Cortisol
D. Adrenaline
E. Calcitonin
9. Due to the loss of 1.5 liters of blood, a person's diuresis decreased sharply. Increased secretion of which hormone caused changes in diuresis?
A. Parathyroid hormone
B. Cortisol
C. Vasopressin
D. Oxytocin
E. Natriuretic

10. The drug acetazolamide, which blocks carbonic anhydrase in the epithelium of the proximal tubules of the nephron, was administered to a person to get rid of altitude sickness. Under these conditions:
A. Sodium reabsorption increases
B. Potassium secretion increases
C. NH3 secretion increases
D. HCO3- reabsorption decreases
E. The reabsorption of H2PO4- decreases

Answers:
1.C, 2.C, 3.A, 4.B, 5.C, 6.A, 7.E, 8.A, 9.C, 10.D.
Situational tasks for the final stage of the lesson:
1. Explain why people with hypertension should be prescribed diuretics or use hirudotherapy. Answer: Both factors lead to a decrease in the amount of blood and a decrease in pressure.

2. Explain whether it can be expected that there are significant differences in kidney function in rodents that live in the desert and near water bodies. Answer: Animals living in the desert excrete the minimum possible amount of water through their kidneys. The concentrating

function of the kidneys is so developed in them that the osmotic concentration of urine exceeds that of plasma by 17–20 times. In moisture-loving rodents, the concentrating mechanism is reduced, all loops of Henle are shortened, the kidney is unable to increase the osmotic concentration of urine compared to blood plasma by more than 2-3 times. As a result, the excess amount of water is excreted with urine all the time.

3. In the process of experimental research, the animal is subjected to complete starvation. Explain which urine indicator will most informatively indicate the onset of the terminal stage of starvation. Answer: Evidence of this will be a sharp increase in the amount of nitrogen in the urine, which reflects the level of protein breakdown after the depletion of carbohydrate and fat reserves.

4. Under the conditions of the examination, it was found that in a young healthy woman, during the intake of 120 g of protein per day, 16 g of nitrogen was excreted in the urine during the same time. Explain what assumption can be made about the woman's condition. Answer: 16 g of nitrogen comes from 100 g of protein, and 120 g came with food. If such retention (delay) of nitrogen is observed for a long time, then it may be associated with pregnancy, when part of the protein goes to build the body of the fetus

5. The subject was diagnosed with hypertension. Explain whether the cause of increased pressure is always directly related to disorders in the cardiovascular system. What role can be played by disorders in the glomerular system of the kidneys?

Answer: Under conditions of insufficient blood supply to the kidneys, the blood constantly contains high concentrations of angiotensin2. This leads to the emergence of hypertensive disease - a persistent increase in blood pressure. Therefore, under the conditions of long-term ineffective treatment of people for hypertension, it is necessary to remember that the cause may be a serious malfunction of the kidneys, which often leads to a fatal outcome.

6. A decrease in blood pressure in the supply vessels of the kidneys can lead to catastrophic consequences, as glomerular filtration stops. In such cases, a protective mechanism begins to operate. Renin is produced in the kidneys, which, after some transformations, is transformed into angiotensin2, which exerts a strong vasoconstrictor effect, thus contributing to an increase in filtration pressure (PT). Do you think that angiotensin 2 also affects the formation of aldosterone? Explain why.

Answer: In this case, BP must be increased. Angiotensin2 provides this by constricting blood vessels. The blood pressure level is also influenced by the work of the heart and BCC. Aldosterone does not affect the heart directly, but it can change the BCC by increasing the

reabsorption of sodium and water. Hence the obvious conclusion that angiotensin2 acts in two ways: directly, by narrowing blood vessels, and indirectly, by stimulating the formation of aldosterone and thereby contributing to water retention in the body.

4. Summary:

At the end of the lesson, the teacher checks the results of the practical work and announces the received grades for all types of work. Evaluation of the success of studying the topic is carried out according to the traditional 4-point scale according to the evaluation criteria given in the work program for the discipline. At least 50% of students are evaluated.

5. List of recommended literature (main, additional, electronic information resources):

Basic literature:

1. Physiology [textbook] /V. M. Moroz, O.A. Shandra.– 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728p.

4. *Further reading:*

1. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier. - 6th ed.,2017.- 528 p

2. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, J. Yuan, H. L. Brooks. - McGraw Hill Professional. – 26th edition,2019.–752 p.

3. Guyton A. Textbook of Medical Physiology / A. Guyton, J. E. Hall. - Elsevier. - 14th Edition, 2021. – 1820 p.

4. Koeppen B. M.«Berne and Levy Physiology / B. M. Koeppen, B. A. Stanton. - Elsevier. - 7th edition, 2018. – 880 p.

5. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 8th ed., 2019.–1186 p.

Electronic information resources:

53. Official site of the Department of Physiology of ONMedU https://info.odmu.edu.ua/chair/physiology/files

54. Testing Center – database of licensed test tasks "Krok"-1 https://www.testcentr.org.ua/uk

55. National Scientific Medical Library of Ukraine http://library.gov.ua

56. Vernadsky National Library of Ukraine http://www.nbuv.gov.ua

Ministry of Health of Ukraine: official website. URL: https://moz.gov.ua