Ministry of Education and Science of Ukraine
V. N. Karazin Kharkiv National University

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HUMAN PHYSIOLOGY

Laboratory manual

for self-preparation of 2nd year students of the School of medicine
in the discipline «Physiology»

Electronic resource

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The practicum for students of the 2nd year of study in the discipline "Physiology" is developed in accordance with the current programs in physiology for students of medical faculties of universities. The guide is intended for students' work during preparation for classes in the "Physiology" course. Recommendations for the implementation of practical work are provided for each topic, a list of practical skills and control questions has been developed. The topics are illustrated with pictures and diagrams, which facilitate the perception of the material and contribute to its better assimilation. For students of the Faculty of Medicine.

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CONTENT

ENTRY

Physiology is the science of life processes, the activity of individual organs and a living organism. The subject of study of physiology is the functions of a living organism, their relationships with each other, regulation and adaptation to the environment, origin and development in the process of evolution and individual development of an individual.

The discipline program is structured into sections*. The amount of students' workload is described in ECTS credits - credit credits, which are credited to students upon successful completion of the relevant section (credit credit). Number of credits: 9. Total hours: 270.*

The human physiology course is divided into 10 sections.

Module 1. "Introduction to physiology. Physiology of excitatory structures".
Module 2. "Nervous regulation of body functions".
Module 3. "Physiology of the cardiovascular system".
Module 4. "Physiology of analyzers and HNA".
Module 5. "Physiology of the blood system".
Module 6. "Humoral regulation of body functions".
Module 7. "Physiology of the respiratory system".
Module 8. "Physiology of the digestive system".
Module 9. "Physiology of metabolism and energy. Thermoregulation".
Module 10. "Physiology of the excretory system".

The object of study of human physiology is the human body, the peculiarities of the functioning of which depend on whether this organism is healthy or sick. The purpose of teaching this discipline is to form a complete understanding and assimilation of theoretical material on the basic principles and mechanisms of functioning of the human body as a whole at different levels – from membrane-cell to systemic, to acquire skills of manipulation on a living organism and assess the state of individual systems and the body as a whole, and the ability to use them in clinical practice.

The final program learning outcomes include knowledge of human physiology, which in the further formation of a qualified specialist will become the main basis for the study of pathophysiological, pathomorphological processes of the body, clinic and diagnosis of diseases.

The system of organization of the educational process encourages students to study systematically during the academic year. Types of training sessions in accordance with the curriculum are:

a) lectures; b) practical classes; c) students' independent work;

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

Practical classes include:
students' knowledge of the physiological processes taking place in the body;
knowledge of the technique of manufacturing neuromuscular drugs;
ability to manufacture preparations for the study of bioelectrical phenomena;
study of irritability, excitability, conduction of excitation by nerve cells;
measurements of static and dynamic indicators of human health;
knowledge of motor reflexes of the spinal cord; unconditioned reflexes of the brain; cerebellar reflexes; reflexes of the midbrain and diencephalon;
study of simple and complex reflex arcs;
study of nervous regulation of autonomic functions;
knowledge of methods of conducting physiological studies of the functioning of human body systems;
knowledge of laboratory methods for the manufacture of preparations for microscopy of blood cells;
knowledge of capillary blood sampling techniques;
mastering the primary technique of medical manipulations: auscultation, percussion, measurement of blood pressure, arterial pulse, ECG recording;
development of ECG deciphering skills;
mastering the methods of stress tests in cardiology;
assessment of age and individual characteristics of the course of these processes;
mastering the technique of studying sensory systems;
study of the basic rules for compiling a daily diet;
mastering test methods for the study of higher nervous activity;
solution of situational problems that have clinical and physiological justification.

The mastery of the topic is controlled in practical classes in accordance with specific goals.

This manual is designed to strengthen the knowledge gained in lectures and during self-study. This manual contains methods for determining laboratory parameters and other functional methods for studying human bioenvironments to adequately present the picture of the functioning of the human body under normal conditions.

At the end of the document, in the section: "Appendices", reference indicators of blood, urine, gastric juice and other digestive fluids are collected, which are a signal for the doctor's conclusions on the management of the patient or for conclusions on the issuance of a conclusion on the professional suitability of a person in the case of a medical examination.

It is recommended to use the following means of diagnosing the level of students' training: computer tests, solving situational problems, control of practical skills, knowledge of schemes of physiological processes with subsequent analysis and assessment of sex, age, individual characteristics of the human body; analysis of morpho-functional relationships of human organs and systems; analysis of patterns of prenatal and early postnatal development of human organs, variants of organ variability, developmental defects.

Module 1. Physiology of excitable structures

Topic: The potential for rest and action of nerve and muscle fibers.

Practical work 1.1 Manufacture of spinal frog.

Purpose: to master the method of manufacturing the preparation spinal frog.
Materials and equipment: large scissors, tweezers, probe, diethyl ether, tripod, cotton wool, napkins, disposable rubber gloves.
The object of study: a lake frog or an edible frog.

Procedure:

1. Take the frog in the left hand with the dorsal surface of the body to the palm. Embrace it with your thumb and forefinger at the level of the forelimb girdle so that its forelimbs are pressed against the torso and the hind limbs are extended. The middle and ring fingers will support the frog's abdomen, and the little finger should be between the hind limbs of the animal. Thus it is necessary to fix the head of the frog between the index and middle fingers, while fixing its hind limbs.
2. A cotton ball is moistened with a 3% aqueous solution of ether (chloroform) and pressed to the frog's head in the nostrils to sprinkle the animal.
3. After sprinkling, one branch of scissors is inserted into the mouth of the frog, the other branch is above its skull. Carry out decapitation - cut off the upper jaw together with the skull and brain, making an incision along the line passing behind the eyes at the corners of the mouth and leaving the lower jaw (while removing the frog's brain). The resulting preparation is called **a spinal frog** (Pic. 1).
4. Fix the received preparation of a frog for a lower jaw on a support (Pic. 2).
5. Use the tip of tweezers to apply mechanical irritation to the hind limb of the decapitated frog, and observe the reaction.
6. Insert the probe into the spinal canal until it stops, destroying the spinal cord (Pic. 3). Repeat mechanical irritation.

Pic. 1.

Pic.2.

Pic.3.

Results:
What was observed when applying mechanical irritation to the spinal frog?

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What was observed when applying mechanical irritation after the destruction of the spinal cord?

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Conclusion: Does the disappearance of the reaction to the stimulus after the destruction of the spinal cord? Where are the motor centers located?

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Practical work 1.2 Preparation of neuromuscular preparation of a frog.

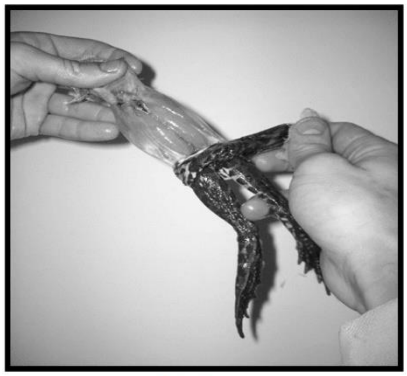
Purpose: to master the method of manufacturing a neuromuscular preparation.
Materials and equipment: dissecting board, scissors, tweezers, probe, cotton wool, napkins, pipette, glass rod (glass hook), Ringer's solution. disposable rubber gloves.
The object of study: a lake frog or an edible frog.

WARNING! AT ALL STAGES OF THE NEXT WORK, IT IS NOT POSSIBLE TO TOUCH THE SCIATIC NERVE AND CALVARY MUSCLE WITH METAL TOOLS OR HANDS. DURING THE PREPARATION OF THE PREPARATION SHOULD PREVENT THE DRYING OF THE NERVES AND CALF MUSCLES BY WETTING THEM WITH RINGER SOLUTION.

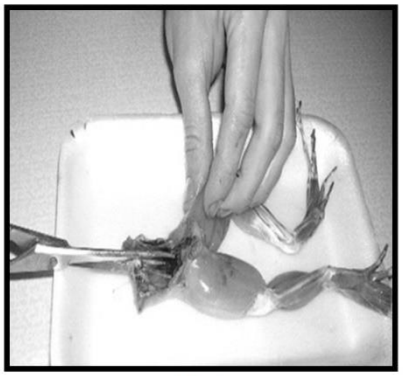
Procedure:

1. Prepare a preparation of a spinal frog (see practical work 1.1).
2. Destroy the spinal cord by inserting a metal probe (or needle) into the spinal canal (insert the inserted probe several times in the canal without removing it). At the same time the muscular tone disappears.
3. Put the frog on the dissecting board belly up. With tweezers pull the skin in the middle of the frog's abdomen. Make a cross-section of the skin and continue it around the circle with small scissors, turning the frog.
4. Holding the frog by the hind limbs, use scissors to cut the spine in the middle of the torso - about 1 cm above the bend formed by the vertical position of the hind legs.
5. Continuing to hold the frog by the hind limbs and turning it to a horizontal position (abdominal surface down), cut the skin and muscles of the abdomen on the right and left sides along the pelvic bones. Remove the upper torso along with the internal organs. At the same time it is necessary to find a place of an exit of a sciatic nerve in the field of a backbone and not to damage it (Pic. 3).
6. Remove the skin from the rest of the torso and hind legs by grabbing it with a gauze napkin.
7. Remove the back of the spine (urostil).
8. Thoroughly clean the preparation from the remains of the viscera and rinse with Ringer's solution.

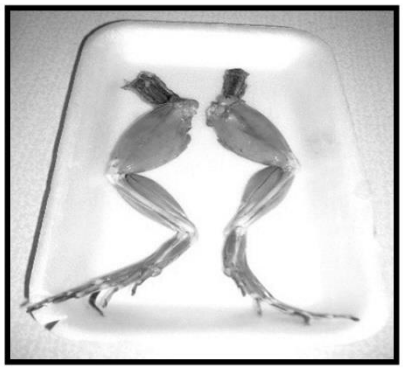
Pic.1.



Pic.2.



Pic.3.



Pic.4.

Pic.5.

Pic.6.

9. Cut the preparation along the midline into 2 parts - separate from each other both legs with the nerves that go to them. It is important not to damage the nerve (Pic. 6,7).
10. Put the paws dorsally side up on the dissecting board. Begin careful dissection of the nerve. Dissect the nerve in the torso. To do this, you need to release it from the surrounding tissues with a glass rod (!), Which is brought under the nerve moving from the direction of the spine of the hip joint. ***During dissection, the sciatic nerve must not be stretched, taken with tweezers or touched with other metal equipment with your hands!***
11. Dissect the nerve in the thigh. By turning the foot, gently spread the fascia, spread the thigh muscles and find the sciatic nerve. It has the appearance of a white cord near a dark blood vessel (vein). After finding it with a glass rod (!) Carefully release it from the surrounding tissues - get the stick under the nerve, lift it and release it all the way moving from the direction to the knee joint. ***During the preparation, the sciatic nerve must not be stretched, taken with tweezers or touched with metal equipment, hands!***
12. Next, select the nerve in the hip joint. Take the foot in your hands ***without touching the nerve and calf muscle.*** Using a glass rod, spread the muscles around the hip joint and highlight the nerve. By trimming the spine below the nerve (without damaging the nerve itself), cut off the remnants of muscle between the spine and the hip joint (the joint itself must be left undamaged).
13. Holding the foot by the rest of the spine, separate the head of the femur from the joint, dissect the femur and release it from the muscles to the knee joint - cross-cut four muscles adjacent to the bone. The rheoscopic paw consists of the sciatic nerve and the hind paw of a frog with the femur and thigh muscles removed.
14. In the area of the leg, dissect the calf muscle, insert a glass rod under it and move it along the muscle from the knee joint to the ankle joint, while the fascia of the muscle must remain intact.
15. Bring a branch of small scissors under the tendon of the calf muscle in the ankle joint and cut it off. ***It is necessary to preserve the maximum length of the tendon.***
16. Below the knee joint, cut off the shin bones and muscles, ***EXCEPT the calf muscle***. This muscle remains attached to the knee joint. The resulting preparation is called ***a neuromuscular preparation***, which includes the calf (Achilles) tendon, calf muscle, knee joint, sciatic nerve, a fragment of the femur, part of the spine. The resulting neuromuscular preparation is a convenient

object for studying the properties of excitable tissues: nervous (sciatic nerve) and muscular (calf muscle).

17. The resulting preparation is carefully washed with Ringer's solution.
18. Using an electrical stimulator to check the functional state of the neuromuscular preparation: 1. irritating the sciatic nerve (indirect irritation); 2. irritating the calf muscle (direct irritation).

Results:

What was observed when applying electrical irritation to the sciatic nerve?

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Describe the structure of the rheoscopic foot? _____
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Practical work 1.3 Determination of the threshold of irritation of nerves and muscles. Dependence of muscle contraction force on stimulus force.

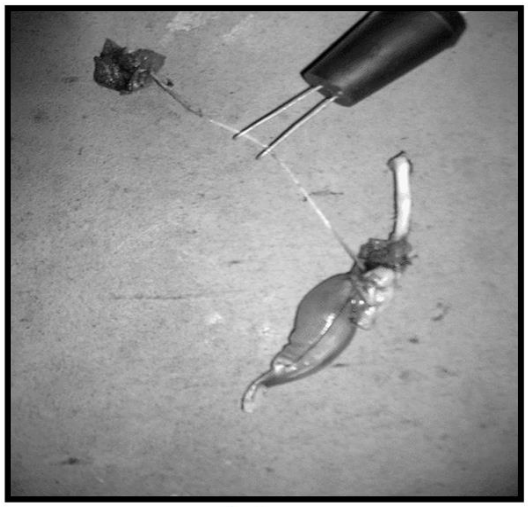
Purpose: to determine the thresholds of irritation for the nerve and muscle on the neuromuscular preparation.

Materials and equipment: neuromuscular preparation of the frog, dissection table, electrical stimulator, Ringer's solution. disposable rubber gloves.

The object of study: a neuromuscular preparation.

Procedure:

1. Prepare a neuromuscular preparation and place on a dissecting table.
2. Before connecting the stimulator to the mains, check the grounding of the device. Connect the appliance to the mains. Switch on the appliance from the front panel. Prepare the instrument scales on the front panel for operation. On the scale "Frequency" set the value to 1.0 Hz (operating frequency for this task). On the scale "Delay" set the value to 1.0 ms. On the scale, the duration is 10 ms. On the scale "Amplitude" values will be selected in the course of work. This scale is working, the selection of values is carried out starting from the minimum value - 0.036 V.
3. Place the nerve on the electrodes (indirect stimulation) (Pic. 1).
4. Choose a voltage that does not cause muscle contraction. Then, gradually increasing the voltage, test the effect of current on the nerve. Note the amount of tension at which the first minimal muscle contraction occurs. At a frequency of 1.0 Hz starting with U = 0.036V, increase the voltage until the **COMPLETE** contraction of the calf muscle. The voltage is applied through the electrodes to the sciatic nerve, the interval between simulations should be 15-20 s. The nerve and muscle are periodically moistened with Ringer's solution. Write the value of U with indirect stimulation.
5. Place the electrodes directly on the muscle (direct stimulation) (Pic. 2). Repeat the determination of the threshold of irritation, as for the nerve. To do this, set the initial voltage value that corresponds to the voltage threshold value for indirect stimulation. Stimulate the muscle, gradually increasing the tension until the entire calf muscle contracts. The interval between simulations should be 15-20 s. The nerve and muscle are periodically moistened with Ringer's solution.
6. Thus determine the minimum strength of the stimulus in the direct and indirect form of muscle stimulation, which leads to its excitation - ie the threshold of stimulation. Enter the data in the table. Compare the thresholds of irritation for the nerve and muscle.



Pic.1.

Pic.2.

The nature of the stimulus	Irritation thresholds (stimulator values)
Direct irritation	
Indirect irritation	

Conclusions: Compare both voltage values and explain the reasons for their differences in direct and indirect stimulation: _____

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Topic. Mechanisms of electrical stimulation of excitatory structures and conduction of excitation through nerve and muscle fibers.

Practical work 2.1 Study of bioelectrical phenomena in living tissues. Galvani's first experiment (reduction with metal).

Purpose: to show the presence of bioelectrical phenomena in excitable tissues.

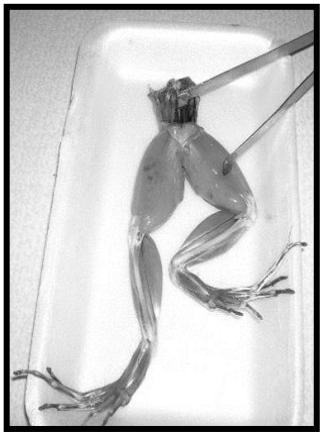
The first attempts to study bioelectrical phenomena ("animal electricity") have been known since the eighteenth century, when research was performed on the "electric" organs of fish. Bioelectrical phenomena in excitable tissues can be detected by both biological and physiological methods using devices. The biological method has now lost its significance, but it allowed Luigi Galvani (1737–1798) to be the first to prove the existence of "animal electricity." In 1786 L. Galvani. when studying the effect of atmospheric electricity on a living organism, he placed the hind legs of a frog on a iron lattice of a balcony, fixed on a copper hook. When the legs collided with the iron bars of the balcony, muscle contraction was observed. According to Galvani, this was the result of a short circuit, as a result of which "animal electricity" caused a reduction. According to him, it originated in the spinal cord, was carried out on metal and when the chain was closed, the muscle was irritated. In 1792, the Italian physicist Alessandro Volta repeated Galvani's experiment and refuted this explanation, believing that the reduction was due to the presence of a "galvanic pair" - iron-copper. The essence of the first Galvani experiment is that when bimetallic tweezers touch the neuromuscular preparation, muscle contraction is observed. The current that occurs between two dissimilar metals, copper and iron (zinc), causes muscle irritation.

Materials and equipment: a set of dissecting tools (anatomical tweezers, small scissors, large scissors, scalpel, probe), saline solution, dissecting boards, napkins, cotton wool, tray, disposable rubber gloves.

The object of study: a lake frog or an edible frog.

Procedure:

1. Prepare the preparation of the spinal frog (see practical work 1.1)
2. Destroy the spinal cord. Remove the skin from the bottom of the frog.
3. Open the abdomen of the frog. Find the exit of the roots of the sciatic nerve.
4. Use a glass rod (hook) to separate the sciatic nerve in the torso.
5. Separate the lower part of the frog from the upper.
6. Place the resulting preparation on a dissecting board. Periodically moisten the preparation nat. solution.



7. Take bimetallic tweezers. Bring one branch of this tweezers under the posterior roots of the sacral spinal cord of the frog. The second branch of the tweezers touch the muscles of the thigh or lower leg (see Pic.). Monitor the condition of the preparation.
8. Then touch both ends of the tweezers simultaneously to the sciatic nerve. Do the same with tweezers made of one metal. Monitor the condition of the preparation.

Conclusions: What is observed when bimetallic tweezers touch the neuromuscular preparation? What causes muscle irritation?

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Practical work 2.2 Study of bioelectrical phenomena in living tissues. Galvani's second experiment (reduction without metal).

Purpose: to show the presence of the potential difference between the excited and unexcited area of the muscle.

Galvani's second experiment was first conducted in 1791 and proved the existence of "animal electricity". The experiment was that the contraction of the frog's paw muscles was reproduced without the involvement of metal, by placing the dissected sciatic nerve in the damaged area of the thigh muscles. The outer surface of the muscle has a positive charge and the inner has a negative charge. When a nerve enters a damaged area of muscle, a circuit closes, in which the damaged area is played by the damaged area of the muscle, and the role of the electropositive pole is played by the intact area of the muscle and the nerve in contact with it. The potential that arises between undamaged and damaged areas is called "damage potential", or "demarcation potential". Thus, in the second Galvani experiment, the cause of nerve excitation is a potential difference that occurs directly in the tissues.

Materials and equipment: a set of dissecting tools (anatomical tweezers, small scissors, large scissors, scalpel, probe), saline solution, dissecting boards, napkins, cotton wool, tray, disposable rubber gloves.

The object of study: a lake frog or an edible frog.

Procedure:

1. The lower part of the frog from the previous experiment cut with scissors in half along the midline, without damaging the sciatic nerve on each side (Pic. 1).
2. Dissect the nerve in the thigh from the dorsal side, minimally damaging the thigh muscles from the abdomen. The thigh muscles will be needed in the future to create damaged muscle tissue during this practical work.
3. Dissect the sciatic nerve in the hip joint with a glass rod (hook). After complete separation of the sciatic nerve in the torso, hip joint, thigh, cut the muscles of the torso, thigh above the knee joint with scissors, preserving part of the spine, shin, foot, the entire sciatic nerve. During the experiment it is necessary to moisten the preparations with saline.

Pic.1.

Pic.2.

Pic.3.

4. After receiving the neuromuscular preparation according to the simplified method described above, make a fresh incision of the thigh muscles on the abdominal side, which were preserved during the preparation of the preparation (Pic. 2).
5. Using a glass rod or hook, repeatedly place the sciatic nerve in such a way that it simultaneously touches the damaged and undamaged surfaces of the thigh muscles (Pic. 3). If all the rules of this experiment are followed correctly, the muscles of the lower leg and foot will contract.

Conclusions: What is observed when the sciatic nerve of the rheoscopic paw is in contact with a damaged area of muscle? What happens between damaged and undamaged areas of muscle, and how does this affect the rheoscopic foot in this practical work? _____

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Practical work 2.3 Detection of electric current in an experiment with secondary reduction (secondary reduction, Matteucci experiment).

Purpose: to show the possibility of conducting biocurrents on excitable tissues.

In 1840, the Italian physicist and physiologist Carlo Matteucci showed that muscle contraction of a neuromuscular preparation can be caused by contact of his nerve with the muscle of the second preparation, which is contracted. This experiment shows that currents occur in the contracting muscle, which are so significant that they can be used as an irritant to the nerve of the second preparation. These currents are called "action currents".

Materials and equipment: a set of dissecting tools (anatomical tweezers, small scissors, large scissors, scalpel, probe), saline solution, dissecting boards, napkins, cotton wool, tray, stimulator.

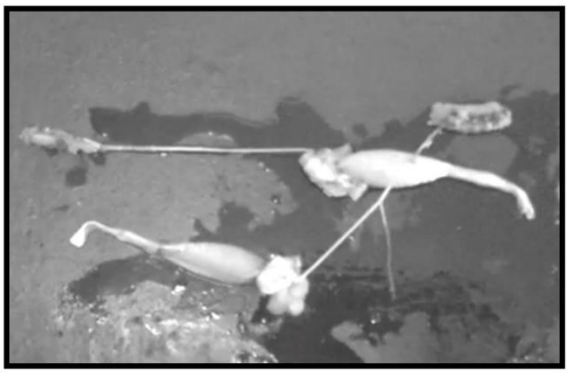
The object of study: a lake or edible frog.

Procedure:

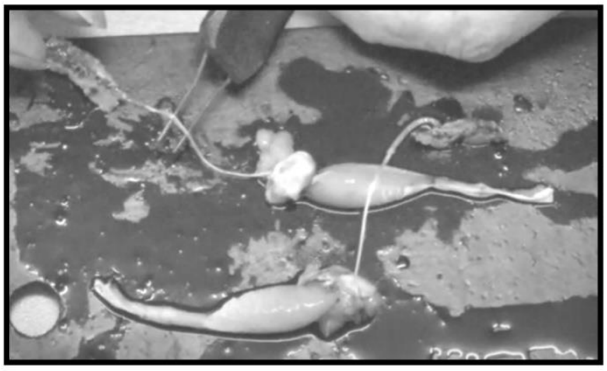
1. Use one neuromuscular preparation from the previous experiment, prepare a second rheoscopic foot from half of the frog carcass. The stages of manufacture are similar to the stages analyzed in the previous practical work (see practical work 2.2.).
2. Determine the thresholds of irritation of both preparations during direct and indirect stimulation (through the nerve), respectively, U1 and U2 at a frequency of 1 Hz.
3. Put both neuromuscular preparations on a dissecting board, periodically moisten the phys. solution. The preparations are placed in such a way that the sciatic nerve of the preparation with a lower threshold of irritation (more excitable) is mixed on the calf muscle preparation with a higher threshold of irritation (less excitable) (Pic. 1).
4. Place the nerve of the first rheoscopic foot on the electrodes.
5. Electric current for a few seconds stimulate the nerve less excitable neuromuscular preparation (Pic. 2) voltage threshold, but with a frequency sufficient for the development of tetanic muscle contraction (frequency of electrical stimulus is selected during practical work). This should result in tetanic muscle contractions of both neuromuscular preparations - the one whose nerve is directly irritated by the current, and the other - in which the nerve lies on the muscle of the first preparation. The muscle contractions of the second preparation are called secondary.

Tetanic muscle contraction occurs when high-frequency nerve impulses enter the muscle through a motoneuron. In this case, the relaxation between successive single contractions does not occur, and there is their summation, which leads to a stable maximum muscle contraction.

The transmission of excitation during the experiment is carried out through the system: the nerve of the first neuromuscular preparation → the muscle of the first neuromuscular preparation → the nerve of the second neuromuscular preparation → the muscle of the second neuromuscular preparation. Thus, the excitation of the second preparation occurs under the influence of the action potential of the first preparation.



Pic.1.



Pic.2.

Conclusions: 1. How does muscle excitation and contraction of the first preparation affect the condition of the second preparation?

2. Why at reduction of muscles of the first preparation reduction of muscles of the second preparation is observed? _____

Practical work 2.4 Kulliker-Mueller experiment (irritation of the neuromuscular preparation by the action potential of the working heart)

Purpose: to show the possibility of conducting biocurrents when the heart muscle is excited.
Materials and equipment: frog heart, neuromuscular preparation, set of dissecting tools (anatomical tweezers, small scissors, large scissors, scalpel, probe), saline, dissecting plates, Petri dish, napkins, cotton wool, tray
The object of study: a lake or edible frog.
At reduction of a cardiac muscle in it there are currents of action which are capable to cause irritation in neuromuscular preparations and to cause reduction of a skeletal muscle.

Procedure:

1. Prepare a preparation of a spinal frog (see practical work 1.1.)
2. Open the thoracic-abdominal cavity, select the heart and remove the pericardium. tie the aortic arch. Highlight the heart.
3. Place the isolated heart on a Petri dish (or bath) in Ringer's solution.
4. Prepare a neuromuscular preparation of the hind paw of a frog (see practical work 1.2).
5. Throw the nerve with a glass hook or stick on the contracting heart. Observe the contraction of the frog's paw muscles.

Conclusion: Explain what this work shows _____
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Practical work 2.5 Isolated conduction of nerve excitation.

Purpose: to show the law of isolated conduction of nerve excitation
Materials and **equipment**: electrostimulator, set of tools for preparation, Ringer's solution, glass hook, disposable rubber gloves
The object of study: a lake or edible frog.
Each nerve contains a large number of fibers. According to this law, the excitation propagating through the nerve is not transmitted to neighboring nerve fibers. Isolated conduction of excitation is provided by a myelin cover. Due to this, there is an opportunity to perform precise and varied movements and obtain subtle, differentiated sensations.

Procedure:

1. Make a preparation of a spinal frog. Destroy the spinal cord. (see practical work 1.1.)
2. Make a circular incision in the skin in the middle of the frog's body. Remove the skin from the bottom of the frog.
3. Open the abdominal cavity of the frog. Raise the internal organs.
4. Find the place of exit from the spine 7, 8, 9th roots that form the common trunk of the sciatic nerve.
5. Separate the upper part of the frog's body from the lower part at the level above 1-2 vertebrae from the place of exit of the upper roots of the sciatic nerve.
6. Cut the lower part of the frog's body along the spinal cord into two halves, **without damaging the sciatic nerve.**
7. Rinse the nerve and muscle tissue with Ringer's solution.
8. Allocate the sciatic nerve in the torso.

9. Using a glass hook or stick, alternately pull one of the three roots and apply irritation of sufficient force (U cf.).
10. When done correctly, only those groups of muscle fibers that are irritated by the root of the irritated nerve will be reduced.
11. Record the contracted muscles in the table.

A branch of the sciatic nerve that is irritated	Contracting muscle groups
Upper	
Middle	
Lower	

U=0.036 B

Conclusion: Explain what this work shows. _____

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Practical work 2.6 Bilateral conduction of nerve excitation.

Purpose: to show the existence of the law of bilateral conduction of nerve excitation

Materials and equipment: electrostimulator, set of tools for preparation, Ringer's solution, galvanic tweezers, glass hook, disposable rubber gloves

The object of study: a lake or edible frog.

On a nerve fiber excitation is capable to extend in both parties from a place of drawing of irritation.

Procedure:

1. For work we use the preparation made for preliminary practical work 2.5.
2. In the center of the thigh on the dorsal side, dissect the sciatic nerve without damaging its branches, which innervate the thigh muscles closer to the hip joint. To do this, you need to spread the thigh muscles with your fingers (without using metal tools), find the sciatic nerve that runs between the muscles and dissect it only in the center of the thigh.
3. Then under this part of the sciatic nerve put 2 glass sticks and between them irritate the nerve with an electric current of sufficient strength (U cf.)
4. Record the results of what you saw.

Conclusion: Explain what the work shows: _____

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Practical work 2.7 The law of physiological integrity of the nerve.

Purpose: to show the existence of the law of physiological integrity of the nerve.
Materials and equipment: electrical stimulator, set of tools for preparation, glass hook, anesthetic solution (novocaine or lidocaine), cotton wool, Ringer's solution or saline solution, disposable rubber gloves.
The object of study: a lake frog or an edible frog.

The spread of excitation along the nerve fiber is possible only if its anatomical and physiological integrity is preserved.
The law of physiological continuity or physiological integrity of the fiber - for the implementation of the conduction is necessary for the normal functional state of the fiber membrane. If it is damaged by treating, for example, a local anesthetic such as novocaine, the conduction will stop, despite the fact that morphologically the fibers are not damaged.
That is, the conduction of pulses is disrupted not only by mechanical destruction of the fiber, but also by blocking the sodium channels of the excitable membrane, which leads to the loss of the nerve of its properties (excitability and conductivity)

Procedure:

1. For carrying out work we use the preparation made for preliminary practical work 2.6.
2. In the thigh area, the sciatic nerve should be completely isolated with a glass rod or hook, releasing it throughout the thigh.
3. Place a small cotton swab on the central area of the nerve that has been pre-moistened with an anesthetic solution (novocaine or lidocaine).
4. 2 minutes after application of the anesthetic to perform electric stimulation of the nerve areas below and above the application site. The cotton swab remains on the nerve.
5. While maintaining the conduction of excitation through the site of alteration, it is necessary to extend the time of exposure to the anesthetic, without removing the tampon from the nerve.
6. Achieve a state of absence of excitation through the altered area of the nerve.
7. Try to restore the conduction of excitation along the nerve in the altered area by removing a cotton swab from the surface of the nerve and thoroughly rinsing the anesthetic with saline or Ringer's solution.
8. Check the conduction along the entire length of the sciatic nerve.

Conclusion: Record the results of observation during practical work. Explain what this work shows.

Topic. Skeletal and smooth muscle contractions.

Practical work 3.1 Determination of the absolute strength of the muscles of the hand.

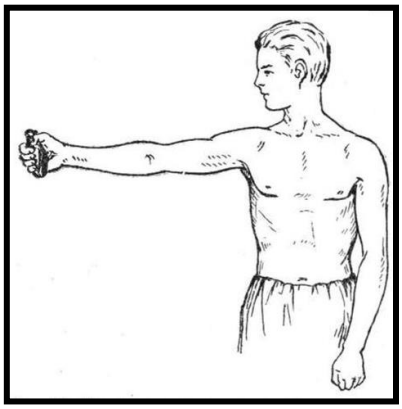
Purpose: to master the method of measuring the strength and endurance of the muscles of the hand with a dynamometer. determine the absolute strength of the muscles of the hand.

Materials and equipment: dynamometer, stopwatch.

The basis of the following practical work is the method of wrist dynamometry. Wrist dynamometry is a method of measuring the strength of the muscles that bend the fingers of the hand. Due to the indicators of absolute and relative magnitude of muscle strength, the degree of physical development of a person can be assessed. Muscle strength is directly dependent on the number of muscle fibers (muscle thickness).

Procedure:

1. The subject in a standing position withdraws his outstretched hand with a dynamometer to the side at right angles to his torso. The other arm is lowered and relaxed (see Pic. 1).
2. At the signal, the subject performs the maximum force on the dynamometer 5 times with an interval of 5 seconds. The dynamometer is squeezed with your fingers without jerks with all your might.
3. Measurements are taken alternately for each hand. Record each result. The data of dynamometric measurements are the values of the absolute forces developed by the muscles of the hands.
4. Assess muscle strength for the best result. Pic. 1



Results: Right hand f1 = _____ f2 = _____ f3 = _____ f4 = _____ f5 = _____

Left hand f1 = _____ f2 = _____ f3 = _____ f4 = _____ f5 = _____

Conclusion: The absolute strength of the muscles of the hand is _____ kg / cm^2

Practical work 3.2 Determining the level of efficiency of the muscles of the hand.

Materials and equipment: dynamometer, stopwatch.

Purpose: to determine the level of efficiency of the muscles of the hand.

Procedure:

The subject measures the absolute strength of the muscles of the hand 10 times with an interval of 5 seconds.

Record the results.

The level of muscle performance is determined by the formula:

$$P = (f1 + f2 + f3 + f4 + f5 + f6 + f7 + f8 + f9 + f10):10, \text{ where}$$

P – level of efficiency,

f – the dynamometer reading.

Conclusion:_____

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Practical work 3.3 Determining the rate of decrease in the efficiency of the muscles of the hand.

Materials and equipment: dynamometer, stopwatch.
Purpose: to determine the rate of decline in the efficiency of the muscles of the hand.

Procedure:

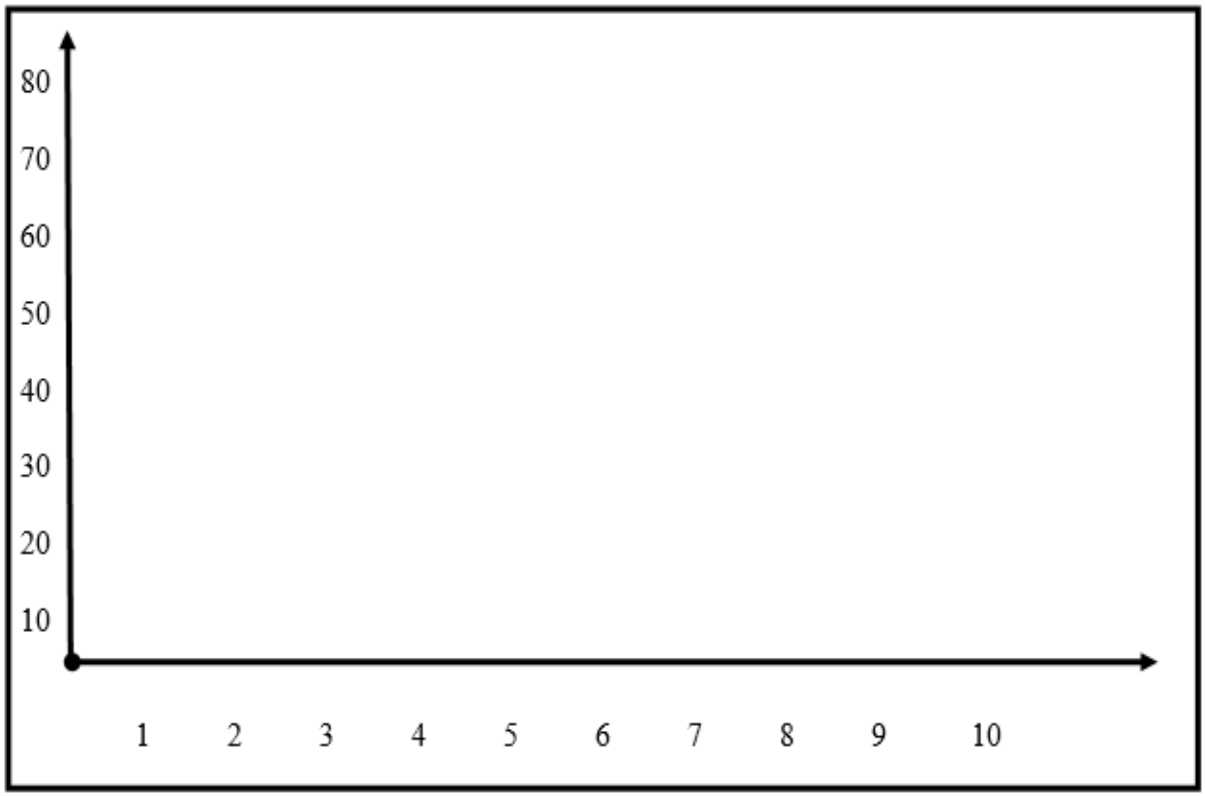
1. Using the results obtained after the practical work 3.2 to calculate the rate of reduction of efficiency according to the formula:

$$S = (f1 – f\ min): f\ max) \times 100\%$$

where S is the rate of incapacity,
f1 - the value of the initial dynamometry = _____
f max - maximum force = _____
f min - minimum force = _____

S = (___ - ___): ___) x 100%, S = _____

2. To construct the schedule reflecting characters of decrease in working capacity: on an abscissa axis to postpone serial number, on an ordinate axis - indicators of the dynamometer at each effort.



Conclusions: 1. What characterizes muscle endurance? 2. What factors affect endurance?

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Module 2. Nervous regulation of body functions

Practical work 4.1. Motor reflexes of the spinal cord.

Purpose: to determine and investigate the motor reflexes of the spinal cord.

Materials and equipment: large scissors, tweezers, probe, diethyl ether, tripod, cotton wool, napkins, disposable rubber gloves, filter paper, 0.5% and 1% sulfuric acid solutions.

4.1.1 Bending reflex

Procedure:

1. Prepare a preparation of a spinal frog (see practical work 1.1).
2. Fix the received preparation of a frog for a lower jaw on a support.
3. Leave the preparation for 15 minutes (the time required for the disappearance of spinal shock).
4. Clamp the tips of the fingers of the hind limb with tweezers.
5. Observe the reaction in response to the stimulus.

Results:_____

4.1.2 Rubbing (wiping) reflex

Procedure:

1. To work, use the preparation from the previous experiment.
2. On the outer surface of the upper third of the frog's thigh alternately apply pieces of filter paper (area 4-6 mm^2), moistened with 0.5% and 1% sulfuric acid solution.
3. Repeat the experiment, now apply pieces of filter paper soaked in 0.5% and 1% sulfuric acid solution to the lower abdomen.
4. Observe and record the reaction in response to the stimulus.

Results:_____

Conclusion: What determines the reaction in response to a stimulus?

General conclusions:

Practical work 4.2. Study of reflex time (according to Turk).

Ludwig Turk (1810-1868) - Austrian neurologist, physiologist and anatomist. Known for his pioneering research at the time on the anatomy of the central nervous system, including both the brain and spinal cord.

The total reflex time (latent period) is determined from the beginning of the stimulus to the beginning of the reflex reaction. It consists of:

a) the time required for the occurrence of excitation in the receptors;

b) the time of excitation from the receptors to the nerve center;

c) the time of excitation through the nerve center ("central reflex time");

d) the time required for the transmission of excitation from the efferent nerve fiber to the effector organ and for the manifestation of its function.

Turk's reflex – bending the hind limb of a decapitated frog when applying chemical or mechanical irritation to the skin of the limb.

Materials and equipment: set of dissecting tools (anatomical tweezers, small scissors, large scissors, scalpel, probe), tripod, saline solution, dissecting boards, napkins, cotton wool, tray, solutions 0.1%, 0.3%, 0.5 %, 1%, 3%, 5% sulfuric acid, a glass of water, stopwatch.

The object of study: a lake or edible frog.

Procedure:

1. Prepare a preparation of a spinal frog (see practical work 1.1).
2. Fix the received preparation of a frog for a lower jaw on a support.
3. Immerse the distal part of the foot of one of the hind legs in a glass with 0.1% sulfuric acid solution, at the same time turn on the stopwatch.
4. Count the time from the moment of immersion of the limb in acid to the beginning of the flexion reflex.
5. After the measurement, wash the acid from the preparation with water. Take a break for 1-3 minutes. 6. Repeat the experiment 2-3 times, at intervals of 2-3 minutes and calculate the average reflex time for a given stimulus force.
6. Repeat the experiment with increasing concentrations of 0.3%, 0.5%%, 1%, 3%, 5% sulfuric acid solutions.
7. Calculate the average time of reflexes. Enter the measurement results in the table.

Results:

Acid concentration, %	Reflex time,c			
	The first measurement	The second measurement	The third measurement	Average value
0,1				
0,3				
0,5				
1				
3				
5				

Conclusions: Explain the dependence of reflex time on the strength of the stimulus _____

_____

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Practical work 4.3. Investigation of the phenomenon of summation

Purpose: to determine and investigate the phenomenon of summation of excitation in nerve centers.

Materials and equipment: set of dissecting tools (anatomical tweezers, small scissors, large scissors, scalpel, probe), tripod, saline, dissecting boards, napkins, filter paper, cotton wool, tray, solutions 0.1%, 0.3% and 0.5% sulfuric acid, stopwatch, vessel with water, stimulator.

The object of study : a lake frog.

4.3.1 Study of spatial summation

Procedure:

1. Prepare a preparation of a spinal frog (see practical work 1.1). Attach the resulting preparation of the frog to the lower jaw on a tripod.
2. Select a solution of sulfuric acid of subthreshold concentration (a piece of filter paper moistened with this solution, applied to the skin, does not cause a reflex).
3. On the dorsal surface of the thigh or the lateral surface of the abdomen in the lower area is applied irritation with this acid solution by applying one piece of filter paper. Rinse the irritant with water.
4. Repeat the experiment after 10 s., Placed on the same area at the same time 2 pieces of application paper with the specified solution of sulfuric acid.
5. If the reflex does not occur, rinse the stimulus with water and repeat the experiment after 10 s. placed on the same site at the same time 3 application pieces of paper with the specified solution of sulfuric acid.
6. The experiment is performed before the reflex, increasing the area of the irritated surface.

Results: _____

_____

_____

Conclusion: Explain the reasons for the phenomena observed during the work _____

_____

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4.3.2 Study of time summation

Procedure:

1. Prepare a preparation of a spinal frog (see practical work 1.1). Attach the resulting preparation of the frog to the lower jaw on a tripod.
2. The electrodes of the stimulator are applied to the lateral surface of the body (in the lower part), where the receptor area of the rubbing protective reflex is located.
3. Using an electrical stimulator, apply a rhythmic stimulus with a frequency of 15-40 Hz. Increase the voltage until the reflex movement of the hind limb. It is necessary to distinguish the reflex reaction from the twitching of muscles under the action of electrodes, as a consequence of the propagation of current to the motor nerve fibers and muscles).
4. Without changing the position of the electrodes and the voltage to inflict rare stimuli 1-2 Hz. Is there a corresponding reaction?
5. Repeat the increase in the frequency of irritation until the reflex response.

Results: _____

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Conclusion: Explain the reasons for the phenomena observed during the work of _____

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Practical work 4.4. Research and analysis of the reflex arc

Purpose: to investigate and analyze the reflex arc. During the experiment, the various links of the reflex arc are successively switched off.

Materials and equipment: a set of dissecting tools (anatomical tweezers, small scissors, large scissors, scalpel, probe), tripod, saline solution, dissecting plates, napkins, cotton wool, tray, solutions of 0.5% sulfuric acid solution, a glass of water.

The object of study: a lake or edible frog.

Procedure:

1. Prepare a preparation of a spinal frog (see practical work 1.1).
2. Fix the received preparation of a frog for a lower jaw on a support.
3. Leave the preparation for 15 minutes (the time required for the disappearance of spinal shock).
4. To reproduce the Turk reflex (practical work 4.2) for the right limb.
5. Rinse the preparation.
6. On the right lower limb in the thigh make a circular incision of the skin and remove it from the foot.
7. Repeat the Turk reflex. Monitor the condition of the preparation. 8. Reproduce the Turk reflex for the left limb.
8. On the left lower limb cut the skin of the thigh, find the sciatic nerve and cut it.
9. Repeat the Turk reflex.
10. Monitor the condition of the preparation.
11. Prepare the second spinal frog. Attach it to the tripod.
12. Reproduce the Turk reflex.
13. Destroy the spinal cord. Repeat the Turk reflex.
14. Monitor the condition of the preparation.

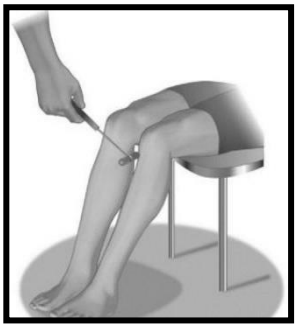
Results and conclusions: _____

Practical work 5. Research of reflex reactions of the person.

Purpose: to identify and investigate the main reflex reactions of human.
Materials and equipment: neurological hammer.
The object of research: a person.

5.1 Knee reflex. The knee reflex was first described simultaneously by the German physician Karl Westphalia and the German neurologist Wilhelm Erb in 1875, before all other tendon reflexes. This is an unconditioned tendon myotatic reflex, the reflex arc of which is formed by the femoral nerve. The reflex occurs when the quadriceps femoris is stretched and manifests itself in its sharp contraction. The knee reflex is caused for the medical diagnosis of the nervous system. The mechanism of the reflex - when tapping on the patellar ligament below the patella tendons are stretched, acting in turn on the extensor muscle, which causes involuntary extension of the leg. This reflex is a classic example of a monosynaptic reflex. The fibers of the femoral nerve, segments L2 - L4 of the spinal cord are involved in the implementation of the reflex.

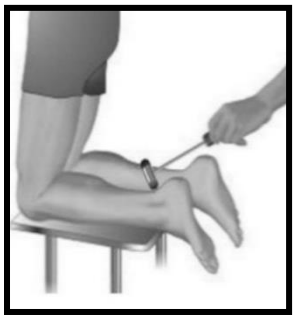
Procedure:



1. The subject sits on a chair, placing his feet so that the legs are at an obtuse angle to the thighs, and the soles completely touch the floor. (see Fig.). Another way - the subject should sit on a chair and put his foot on his foot.
2. Apply a light hammer blow to the tendon of the quadriceps femoris below the patella.
3. Observe the nature of the extension of the leg at the knee joint.
4. Compare the reflex reaction on both limbs.

5.2 Achilles reflex. This is a contraction of the calf muscles (m. Tricipitis surae) and plantar flexion of the foot in response to a hammer blow on the heel (Achilles) tendon. Refers to deep tendon reflexes. The fibers of the sciatic nerve, segments S1 - S2 of the spinal cord are involved in the implementation of the reflex.

Procedure:



1. The subject should kneel on a chair so that the feet of his feet hang freely (see Pic.).
2. Apply a light blow with a hammer on the Achilles tendon.
3. Observe the nature of the plantar flexion of the foot.
4. Compare the reflex reaction on both limbs.

5.3. Flexion-elbow reflex (reflex of the biceps tendon of the shoulder (forearm flexor)).

Bending of the forearm when hit with a hammer on the tendon of the biceps (biceps) is caused by a half-bent and relaxed forearm. Reflex arc: musculoskeletal nerve, closed in C5 - C6 segments of the spinal cord.

Procedure:

1. The researcher places the examined person's hand slightly bent at the elbow joint on his forearm, covers the elbow joint with four fingers from below, and the thumb is on top of the biceps tendon (biceps shoulder).
2. Apply a short and quick blow with a hammer on the thumb of your hand.
3. Assess the contraction of the biceps and the degree of flexion of the arm.
4. Compare the reflex reaction on both limbs.

5.4. Reflex of the triceps tendon of the shoulder muscle (extensor of the forearm).

Reflex from the tendon of the triceps muscle of the shoulder - extension of the forearm in response to a hammer blow to the tendon of the triceps muscle. The response is a contraction of this muscle and extension of the forearm at the elbow. Reflex arc: radial nerve - VII, VIII cervical segments of the spinal cord; reflex deep, tendon.

Procedure:

1. Stand on the side of the subject, passively take his shoulder
1. outwards to a horizontal level, supporting it with the left hand at the elbow so that the forearm hangs at a right angle.
2. Strike with a hammer at the elbow joint.
3. Observe the extension of the forearm.

5.5 Plantar reflex. Occurs when the sole is irritated by a stroke (usually with the handle of a neurological hammer) and is manifested by plantar flexion of the toes, dorsiflexion of the foot, flexion of the leg and thigh. The reflex normally has a fast pace and thus differs significantly from pathological protective reflexes, which are characterized by slow reflex movement. The amount of reflex individually is very different in the norm: in some cases it is limited to bending the fingers, in others after the irritation of the sole is a vigorous pulling of the entire lower limb. The reflex arc of the reflex has a sciatic nerve, and corresponds to the segments of the spinal cord L5-S1-2. At disturbance in the field of these segments or the corresponding roots, or peripheral nerves the reflex goes out.

Procedure:

1. The subject lies down and bends his legs a little, in this position the reflex occurs better.
2. Apply a blunt object dashed irritation on the skin of the outer edge of the foot.
3. Observe the reflex.
4. Compare the reflex reaction on both limbs.

5.6 Superficial abdominal reflexes. Abdominal skin reflexes are caused by a dashed irritation of the skin of the abdomen on both sides towards the midline. For the upper abdominal reflex, the stimulus is applied directly below the costal arches (the reflex arc closes at the level of T7-T8). To induce the middle abdominal reflex (T9 -T10), irritation is applied horizontally at the level of the navel, the lower abdominal (T11-T12) - above the pupar ligament. For irritation use a blunt wooden stick or a handle of a neurological hammer. In response, the contraction of the abdominal muscles. At repeated irritation superficial abdominal reflexes decrease ("are exhausted"). Abdominal reflexes are often absent in obesity, in the elderly, in women who have given birth to many, in patients who have undergone abdominal surgery (abdominal surgery).

Procedure:

1. The subject lies down.
2. Quickly apply a dashed stimulation with a blunt object on the skin of the abdomen in the direction from the lateral side to the midline (below the costal arches - for the upper reflex, at the level of the navel - for the middle, above the inguinal ligament - for the lower).
3. Observe the reflex - the contraction of the muscles of the anterior abdominal wall.

Conclusions: The results of research (the degree of reflexes, the nature of the reaction, symmetry) enter in the conclusions. Make a conclusion about the state of the reflex reaction.

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Draw diagrams of reflex arcs of the knee, Achilles, plantar, flexion-elbow reflexes

Module 2. Nervous regulation of body functions

Practical work 6. Study of unconditioned reflex reactions of the human brain.
The aim of the work is to study the features of some unconditioned reflexes of the brain.
Materials and equipment: pencil, stopwatch, book or glass, ruler.
The object of research is a person.

Procedure:

REFLEXES OF THE MEDULLA OBLONGATA

6.1. Swallowing reflex. The receptors of this reflex are located at the root of the tongue, the central section is in the medulla oblongata. This reflex can be brought to an unconditional character by making several swallowing movements in a row. In the absence of an irritant (saliva), it is impossible to make a swallowing movement. When a stimulus acts (even if it is inedible) on the root of the tongue, the act of swallowing is carried out involuntarily. The reflex arc of the swallowing reflex closes in the nuclei of the vagus nerve of the medulla oblongata.

Your observations:_____

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6.2. Respiratory reflex. Regulation of the rhythm and depth of inspiration and exhalation is carried out by the medulla oblongata. The subject takes several quick and deep breaths in and out in a row, after which his breathing stops for a while (involuntary breath retention occurs - apnea).

Your observations:_____

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CEREBELLAR REFLEXES

Maintaining normal coordination of movements is the result of the joint activity of several parts of the central nervous system, which include areas of the cortex of the frontal and temporal lobes, cerebellum, basal nuclei, as well as the vestibular apparatus, muscle receptors. Therefore, the imbalance may be associated with abnormalities in the work of each of them. However, the leading organ of motor coordination is the cerebellum. Efferent signals of the cerebellum are involved in the regulation of the activity of vestibular neurons (Deiters' nucleus), red and other motor nuclei of the brainstem, and through them in the regulation of the activity of interstitial (α and γ motor neurons) of the spinal cord and cranial nerve nuclei. In addition, the cerebellum affects the state of activity of thalamic and cortical neurons involved in the implementation of central regulation of movements. Through these pathways, the efferent signals of the cerebellum are involved in the regulation of tonic muscle tension, the distribution of tone at rest and during movements, as well as the strength of muscle contractions, their coordination.

6.3. Finger-nasal test (for dysmetria and tremor). The examinee needs to close his eyes, stretch his right arm forward, then, bending his arm, touch the tip of his nose with his index finger. The accuracy of movement and the sequence of inclusion of the muscles of the hand in it (there are 28 of them in this case, about 30) is controlled by the cerebellum. This reflex is complex, since multiple impulses from the proprioceptors of the arm muscles converge in the cerebellum. Coordination of muscle work is carried out by unconditional reflex principle.

Evaluation of results. Normally, a person makes smooth movements of the hand, touches the tip of the nose (with an accuracy of 1 cm) without trembling the fingers - "the test for dysmetria and tremor is negative." With overwork, neuroses, brain injuries and other functional conditions, there is a mismatch, trembling of the index finger or hand - "the test for dysmetria and tremor is positive." Elimination of inertial movements. The experimenter holds the subject's hands by the forearm, who is asked to pull his hands towards him, overcoming the resistance of the experimenter. Once the subject begins to perform this action with sufficient force, the arms are released. Observe the examinee's jerk with his hands. The movement that has arisen by inertia is inhibited by the work of the cerebellum.

Your observations:_____

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MIDBRAIN REFLEXES

6.4. The Romberg test (proposed by the German therapist M.H. Romberg, 1795-1873) is a test for the detection of static ataxia: the subject is asked to stand up, close his feet tightly and stretch his arms forward. At first he stands with his eyes open, then he closes them. It is observed whether the subject can maintain balance. Determine the stability of the posture and the time it is held. With ataxia (ataxia is a violation of the coordination of movements of various muscles in the absence of muscle weakness) posture The subject is unstable, he sways from side to side and may fall. With a unilateral lesion of the cerebellum or vestibular apparatus, the subject may deviate mainly to the right or left. A sharp increase in instability when closing the eyes is characteristic of sensitive or vestibular ataxia (assessment of coordination of movements, or ataxia test).

Evaluation of results. Normally, a person maintains balance in Romberg's pose - "the ataxia test is negative."

Your observations:_____

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6.5. Complicated Romberg test. The experimenter asks the subject to close his feet tightly, raise his head slightly, stretch his arms forward and spread his fingers, then close his eyes, and then,

without opening his eyes, raise one leg. Determine the stability of the pose and the time it is held. Normally, in each pose, the subject maintains balance for 30-50 seconds and at the same time there is no shaking of the body, trembling (tremor) of the hands or swaying. **Evaluation of results.** Balance is maintained for 30-50 seconds, tremor and staggering are not observed - "excellent". Balance is maintained for less than 30-50 seconds, tremor is observed - "satisfactory". Equilibrium is disturbed within 15 seconds - "unsatisfactory".

Your observations:_____

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6.6. Test gait (assessment of coordination of movements, or ataxia test). The experimenter asks the subject to walk back and forth in a straight line across the room with his eyes open and closed, placing his feet so that the toe of one foot touches the heel of the other and observes the gait.

Evaluation of results. The test for ataxia is negative if the gait is normal, without swaying to the sides and without a wide placement of the legs.

Your observations:_____

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6.7. Dysmetria test. The subject is asked to take from the table, and then put in place any object (book, glass). Mark the place where the object lay and where the subject returned it. If necessary, measure the difference in the position of the object with a ruler.

Evaluation of results. Normally, a person puts an object in the same place with an error of no more than ± 2 cm - "the dysmetria test is negative".

Your observations:_____

_____

_____

6.8. Dysarthria test. The subject is asked to repeat several words that are difficult to pronounce: earthquake, aircraft construction, administration, etc. Note if there is any slowing, stretching, or jerkiness during pronunciation.

Your observations:_____

_____

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6.9. Orienting reflex. The experimenter, imperceptibly for the subject, hits the table with a ruler, and the subject has an orienting reflex. A similar reaction appears when exposed to any new stimulus: visual, auditory, tactile, attracting attention (turning the head, fixing the gaze, listening, etc.). The reflex center for auditory stimuli is located in the midbrain in the posterior tubercles of the quadruple tubercles and in the anterior tubercles for the visual ones. Coordination of the activity of the eye muscles. The subject is looking on a table lamp (or any object) when it is on. Then you need to gently press on the side of one of the eyeballs, without taking your eyes off the light source. The item is doubled. This is due to the fact that an external force has shifted the coordinated coordination of the eye muscles, which are regulated by the midbrain.

Your observations:_____

_____

_____

6.10. Convergence reflex. The subject picks up a pencil and holds it vertically at a distance of 20 cm from his eyes. The experimenter asks the subject to fix and not take his eyes off the pencil. The subject begins to slowly bring the pencil closer to his eyes and the experimenter monitors his reaction.

Evaluation of results. Normally, there is a process of convergence - the reduction of visual axes. If the subject shifts his gaze into the distance, the pencil image will be doubled.

Your observations:_____

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6.11. Accommodation reflex. The accommodation reflex is accompanied by the pupillary reflex and the reflex of convergence and divergence of the visual axes. All three components of the reflex are experimentally reproduced by stimulation of the occipital cortex of the brain. It should be noted that the convergent accommodative-pupillary reflex is not a true reflex. The change in pupil size, the processes of accommodation and contraction of the eyeballs is an associated movement provided by supranuclear connections between neurons innervating the circular pupil muscle, ciliary muscle and external eye muscles. This is evidenced by the fact that the diameter of the pupil changes in the absence of a change in illumination.

The experimenter asks the subject to look at a distant object, then quickly shift his gaze to a closely spaced text, for example, in his own record.

Evaluation of results. When shifting the gaze from a distant object to an object lying nearby, pupil constriction, accommodation and convergence occur simultaneously.

Your observations:_____

_____

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DIENCEPHALON REFLEXES

6.12. Posture reflex. The experimenter invites the subjects to go about their business, and then unexpectedly gives a loud command: "Freeze." Students freeze in different poses. The posture is maintained thanks to the complex coordination activity of the diencephalon.

Based on the results of the work, fill in the table.

Table. Unconditioned reflexes of the brain.

Brain Section	**Name of reflex**	**Irritant**	**Reaction - Response**
Medulla oblongata			
Cerebellum			
Midbrain			
Diencephalon			

Your observations:_____

_____

_____

6.13. Cutaneous vascular reflexes (dermographism method). The experimenter makes a uniform stroke movement on the skin on the inside of the forearm with the blunt end of the pencil. According to the stopwatch, it marks the time of appearance and disappearance of a red or white stripe.

Evaluation of results. In the severity of the reaction, the degree of pressure matters. Mild irritation causes a white mark. If, after stronger pressure, a "diffuse" persistent red mark appears, then this indicates a predominance of the tone of the parasympathetic nervous system; A white broad steady trail indicates a predominance of sympathetic nervous system tone. With age, the latent (hidden) period of the reaction increases from 3 minutes to 10 minutes.

Your observations:_____

_____

_____

Control questions:

1. Write the name and describe the features of the unconditioned reflexes of the medulla oblongata.

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2. Compare the features of the cerebellar and midbrain reflexes.

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3. Explain how unconditioned reflexes in the brain are involved in shaping a person's daily behavioral responses.

_____
_____
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Topic: Nervous regulation of autonomic functions.

Practical work 6. Assessment of the state of the centers of the autonomic (autonomic) human nervous system. Determination of autonomic tone.

Purpose: to study the state of the centers of the autonomic nervous system that regulate the cardiovascular system.
Materials and equipment: stopwatch, couch.
Object of research: human.

6.1 Ocular-cardiac reflex (Danina-Ashner reflex)

The ocular-cardiac reflex refers to parasympathetic reflexes and is manifested in a reduction in heart rate and a decrease in blood pressure when pressing on the eyeballs. A slowing of the pulse by more than 10 beats per minute indicates an increase in the excitability of the parasympathetic part of the autonomic nervous system. Slowing down by less than 4 beats or increasing heart rate indicate a predominance of sympathetic tone (perverted reaction). Reflex arc of the reflex: the main central links - the parasympathetic nucleus of the oculomotor nerve of the midbrain, the nucleus of the depressive center of the medulla oblongata, the motor nuclei of the vagus nerve; motor link - vagus nerve fibers innervating the heart muscle.
Procedure:

1. Wash your hands thoroughly before the examination. In the sitting position, the subject counts the number of heartbeats per minute.
2. Place both hands on the side of the subject's head and slowly press both eyeballs with your thumbs for 6-8 seconds. Pressing should not cause pain or light.
3. Immediately after exposure, calculate your heart rate. Record the results of observations.

Results: Heart rate 1 = _____ beats / min. Heart rate 2 = ____ beats / min.
Conclusions: Explain the mechanism of change in heart rate in the subject. Make a conclusion about the state of tone of the sympathetic and parasympathetic divisions of the autonomic nervous system

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6.2 Hering's respiratory and cardiac reflex

The respiratory-cardiac reflex allows you to assess the state of the parasympathetic center of the autonomic nervous system, which regulates the heart. Delayed breathing after a deep breath leads to increased tone of the vagus nerve nuclei. Normally, this is accompanied by a decrease in heart rate by 4-6 beats per minute. Slowing of the pulse by 8-10 beats per minute indicates an increase, less than 4 beats per minute - a decrease in the tone of the parasympathetic division of the autonomic nervous system.
Procedure:

1. In the sitting position, the subject counts the number of heartbeats per minute.
2. The subject is asked to take a deep breath and hold it.
3. Count the pulse during respiratory arrest. Record the results of observations.

Results: Heart rate 1 = _____ beats / min. Heart rate 2 = ____ beats / min.
Conclusions: Explain the mechanism of change in heart rate in the subject. Make a conclusion about the state of tone of the sympathetic and parasympathetic divisions of the autonomic nervous system.

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6.3 Clinostatic reflex

This reflex allows you to assess the state of tone of the sympathetic and parasympathetic divisions of the autonomic nervous system. When changing the position of the body from standing to lying position, the normal heart rate decreases by 4-6 beats per minute. A decrease in heart rate by more than 6 beats per minute indicates an increase in the tone of the parasympathetic division of the autonomic nervous system, which regulates the heart. Lack of response or increase in heart rate indicates a predominance of sympathetic tone.
Procedure:

1. In the standing position, the subject counts the number of heartbeats per minute.
2. The subject is offered to lie down.
3. After 10-20 seconds without changing the position of the subject's body count the pulse again.
4. Record the results of observations.

Results: Heart rate 1 = _____ beats / min. Heart rate 2 = ____ beats / min.
Conclusions: Explain the mechanism of change in heart rate in the subject. Make a conclusion about the state of tone of the sympathetic and parasympathetic divisions of the autonomic nervous system _____
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6.4 Orthostatic reflex

Orthostatic reflex allows you to assess the state of tone of the sympathetic and parasympathetic divisions of the autonomic nervous system. When a person transitions from a lying position to a standing position, the normal heart rate increases by 6-24 beats per minute. An increase in heart rate of more than 24 beats per minute indicates an increase in the tone of the sympathetic division of the autonomic nervous system, which regulates the heart, less than 6 beats - the predominance of the tone of the parasympathetic division.

Procedure:

1. The subject is offered to lie down. After 4-6 minutes of lying down, the subject counts the number of heartbeats per minute.
2. Invite the subject to stand up and after 15-25 seconds count the pulse again.
3. Record the results of observations.

Results: Heart rate 1 = _____ beats / min. Heart rate 2 = _____ beats / min.

Conclusions: Explain the mechanism of change in heart rate in the subject. Make a conclusion about the state of tone of the sympathetic and parasympathetic divisions of the autonomic nervous system. _____
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Module 3. Physiology of the cardiovascular system.

Practical work 7. Measurement of blood pressure in humans by the method of Korotkov and the method of Riva-Rocci.

Purpose: to get acquainted with the techniques of measuring blood pressure.

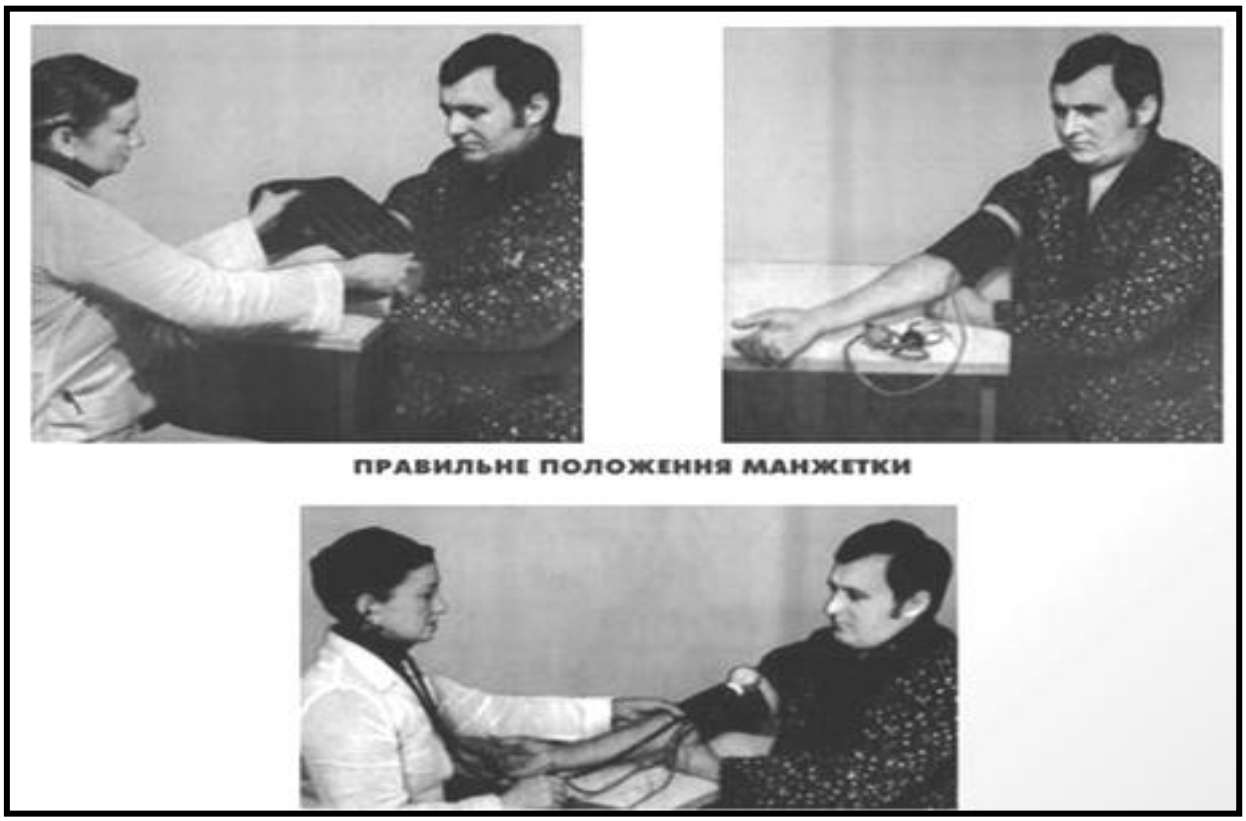
Materials and equipment: manual tonometer, phonendoscope. The object of study - a man.

To measure blood pressure in humans with a cuff and tonometer was first proposed in 1890 by the Italian physician S. Riva-Rocci. The pressure level was determined by the disappearance and appearance of a pulse on the wrist. Tonometers for measuring blood pressure have since undergone significant changes. In 1908, the Russian physician NA Korotkov proposed to use for the registration of upper and lower pressure levels, the appearance and disappearance of noise in the brachial artery, arising from the passage of blood through the vessels compressed by the cuff. In medicine, blood pressure measurement (abbreviation) is used as one of the initial parameters for diagnosing the patient's condition. Determined using a sphygmomanometer (tonometer), talk about the upper and lower blood pressure, respectively. Units of blood pressure - mm Hg. Article (millimeters of mercury).

7.1. Measurement of blood pressure in humans by the method of Korotkov

Procedure: When measuring pressure, follow these rules:

- Blood pressure should be measured in a quiet place after 5 minutes of rest of the person whose pressure is being measured, in a sitting position and leaning on the back of a chair, both feet should be kept on the floor.
- In 30 minutes Before measuring blood pressure, a person is not allowed to smoke, drink coffee or other beverages containing caffeine, drink alcohol or exercise.
- Use a cuff of the appropriate size for measurement: for most people, a standard one is suitable (width - 12-13 cm, length - 35 cm).



1. The person whose pressure is being measured sits sideways to the table, puts his hand freely on the table palm up.
2. Apply a tonometer cuff to the bare shoulder, fixing it so that it tightly covers but does not compress the tissue. The cuff should be applied so that its lower edge is ≈3 cm above the elbow flexion.
3. Close the screw valve on the rubber bulb.
4. Palpation to determine the location of a clear pulsation of the artery in the elbow and install a phonendoscope over this place. Apply the phonendoscope to the place where the pulse is best felt!
5. Using a pear in the cuff to inject air to a pressure of ≈30 mm Hg. Art. above that at which the pulse on a radial artery disappeared.
6. Open the screw valve and slowly release air from the cuff at a rate of 2-3 mm Hg. Art. per heartbeat (especially important for arrhythmias) or per second.
7. Monitor the pressure gauge. At some point there is a clear sound that is well heard through the phonendoscope. The pressure gauge at the time of the first sound in the artery corresponds to the value of systolic pressure.
8. Continue to release air from the cuff and monitor the pressure gauge. At some point the sound disappears. The pressure gauge at the time of sound disappearance in the artery corresponds to the value of diastolic pressure.

The most common causes of erroneous blood pressure measurement results: inconsistency of the measurement procedure (in particular, incorrectly selected or poorly applied cuff or too rapid release of air from the cuff), malfunction of the device, as well as arrhythmia.

9. Measure blood pressure twice on one hand with an interval of 1 min, and then additionally, if the results of the first two measurements differ significantly. The result is defined as the average value of the measurement indicators.
10. Record the results obtained.
11. Calculate the appropriate pressure indicators according to the formulas:
    a. The normal maximum pressure is calculated by the formula: blood pressure = 102 + 0.6 × age;
    b. For minimum pressure, the formula is different: blood pressure diast. = 63 + 0.4 × age.
12. Calculate the value of pulse and mean pressures:

    BP pulse. = BP syst. - BP diast.

    BP among. = BP diast. + ½ BP pulse (for central arteries);

    BP among. = BP diast. + ⅓ BP pulse. (For peripheral arteries).

Results:

BP_1 = BP_2 =

BP syst. = _____

BP diast. = _____

BP pulse. = _____

BP among. = _____

Conclusions: conclusions about the obtained indicators of blood pressure, compare them with the norms.

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7.2. Measurement of blood pressure in humans by the method of Riva-Rocci.

Procedure:

1. On the bare shoulder of a person whose blood pressure is measured, apply a cuff to the tonometer, fixing it so that it tightly covers but does not compress the tissue. The cuff should be applied so that its lower edge is ≈3 cm above the elbow flexion.
2. Close the screw valve on the rubber bulb.
3. Palpation to determine the location of a clear pulsation of the artery in the elbow flexion and install a phonendoscope over this place. Apply the phonendoscope to the place where the pulse is best felt!
4. Using a pear in the cuff to inject air until the pulse disappears.
5. Register the value of pressure at the time of disappearance of the pulse (P1).
6. Then slowly release the air from the cuff until a pulse.
7. Register the value of pressure at the time of pulse (P2).
8. Calculate the value of systolic pressure as the arithmetic mean between P1 and P2.

Results:

P1 =

P2 =

BP syst. = P1 + P2: 2 BP syst. =

Conclusions: conclusions about the obtained indicators of blood pressure, compare them with the norms_____
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Practical work 8. Indicators of heart function. Assessment of physiological reserves of the heart.

Purpose: to study the definition of heart rate, functional reserves of the human heart.
Procedure:
In a survey of healthy individuals, it was found that the higher the level of physical performance, the greater the volume of the heart as a whole organ, the volume of the cavity and the mass of the left ventricular myocardium and the maximum stroke volume of blood during exercise. Therefore, to assess the reserves of the heart, it is first necessary to determine the systolic and cardiac output, measured at rest and during exercise.
The most popular method of calculating the stroke volume (SV), and on its basis and MBV (minute blood volume) is the Starr formula:

SV = 90.97 + 0.54xPP - 0.57xDBP - 0.61xA, where
PP - pulse pressure equal to the difference between systolic and diastolic pressure;
DBP - diastolic pressure;
A - age.
MBV (minute blood volume) = SV x heart rate, where heart rate is the heart rate.

Due to the impossibility of extensive use of existing laboratory methods for the determination of MBV and SBV (systolic blood volume) on the basis of experimental data, formulas for their calculation were introduced. Starr's formula has become the most widespread:
SBV = {(101 + 0.5 PP) - (0.6DBP)} - 0.6 A.
Having the data on arterial pressure received in work 34 make calculations by Starr's formula of size of SBV at rest and after performance of physical activity. Also calculate the MBV at rest and after exercise (after 10 and 20 squats), for which the amount of SBV should be multiplied by the number of heartbeats per 1 minute.

MBV = SBV x heart rate.

Cardiac index is an indicator of heart function, which is the ratio of minute blood volume to body surface area.
Cardiac index = MBV x BSA
where BSA - body surface area = 0.0167 x m0.5 x h0.5 m = body weight in kg, h = height in cm

Perform calculations and record them in the results.
Results: _____
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Conclusions: will draw conclusions about the change of SBV and MBV after exercise. Due to which there is an increase in MBV after exercise. _____
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Practical work 9. Determining the type of reaction of the cardiovascular system to exercise.

Purpose: to learn to study the functional abilities of the cardiovascular system.
Materials and equipment: phonendoscope, tonometer.
The object of study: human.
The most important and responsible task of medical control is the correct assessment of the functional state and functional abilities of a person. The essence of functional diagnostics is to analyze the mechanisms that cause changes in the functioning of organs and systems under the influence of various factors. Therefore, in order to objectively and reliably assess the functional capabilities of man, it is necessary to study the reaction (appropriate action) of the organs and systems of his body to any influence. For this purpose, functional tests or tests are used during the functional examination. Cardiorespiratory functional tests characterize primarily the functional abilities of the cardiovascular system, the Stange test also reflects the body's resistance to lack of oxygen. The ability to hold a breath for a long time depends in some way on the functional state and strength of the respiratory muscles. However, when conducting the following tests, it should be borne in mind that they are not always completely objective, as they still largely depend on the volitional qualities of the subject. This in some cases reduces the practical value of these samples.

9.1. Respiratory arrest test during inhalation (Barbell test).

Procedure: The test is to record the time during which a person is able to hold his breath after maximum inspiration. The test is performed in a sitting position. The subject should take a deep (maximum) breath and hold his breath as long as possible. The duration of the break in breathing is counted with a stopwatch. At the moment of exhalation the stopwatch is stopped. Lock time. In healthy but untrained individuals, the time of respiratory arrest ranges from 40-60 seconds. in men and 30-40 seconds. in women. In athletes, this time increases to 60-120 seconds. in men and up to 40-95 seconds. in women.

9.2. Respiratory arrest test during exhalation (Genchi test).

Procedure:
After making normal (not excessive) exhalations, the subject holds his breath. The duration of the break in breathing is marked by a stopwatch. The stopwatch is stopped at the moment of inspiration. Lock time. Respiratory delay time in healthy untrained individuals ranges from 25-40 seconds. in men and 15-30 seconds. - in women. Athletes have significantly higher rates (up to 50-60 seconds for men and 30-50 seconds for women).
Results:

	Result	**Norma**
Barbell test		

(time of respiratory arrest at inspiration), sec.		
Genchi's test (time of respiratory arrest during exhalation), sec.		

9.3. Exercise tests. Martin-Kushelevsky test (20 squats in 30 seconds).

Functional tests with exercise are used mainly to assess the functional state and functional abilities of the cardiovascular system. During these tests, changes in performance after cessation of loading are taken into account. These tests are offered long ago when medicine did not have the equipment which would allow to register various physiological indicators directly during performance of muscular loading. However, even now they have not lost their practical value, because: they allow to qualitatively assess the nature of the reaction during the load; reflect the speed and efficiency of recovery processes; do not require complex equipment and the procedure itself is simple.

Procedure: In the subject before the test determine the initial level of blood pressure and heart rate in a sitting position. To do this, apply the cuff of the tonometer on the left shoulder and after 1-1.5 minutes. (The time it takes for the reflex to disappear when a cuff is applied) measures blood pressure and heart rate. The pulse rate is counted at 10-second time intervals until three identical digits in a row are obtained (for example, 12-12-12). Then calculate the heart rate per minute. Then, without removing the cuff, the subject is offered to perform 20 squats for 30 seconds. (arms should be extended forward). After exercise, the subject sits down and on the 1st minute of the recovery period for the first 10 seconds. he has a pulse rate, and for the next 40 seconds. Blood pressure is measured in the 1st minute. In the last 10 seconds 1st minute and on the 2nd and 3rd minutes of the recovery period for 10 seconds. time intervals again count the pulse rate until it returns to the original level, and the same result must be repeated 3 times in a row.

In general, it is recommended to count the pulse rate to at least 2.5–3 minutes, as there is a possibility of a “negative pulse phase” (ie a decrease below the baseline), which may be the result of excessive parasympathetic nervous system tone or autonomic dysfunction.

If the pulse does not return to baseline within 3 minutes (ie for the period that is considered normal), the recovery period should be considered unsatisfactory and count the pulse in the future there is no qualification. After 3 minutes, measure the last blood pressure.

Record the results of heart rate and blood pressure measurements in the table.

Results:

	BP	**Heart rate**
Initial values before exercise	BP rest. =	Heart rate rest.=
Values after exercise	BP load.1 = BP load. 2=	Heart rate load.1 = Heart rate load.2 = Heart rate load.3 =

9.4 Determining the type of response to exercise

- ✓ To determine the type of reaction of the cardiovascular system, the following parameters are taken into account: Pulse excitability - increase in pulse rate relative to the initial value, noted as a percentage;
- ✓ The nature of changes in blood pressure (BP) - systolic, diastolic and pulse;
- ✓ Time to return heart rate and blood pressure to baseline.

Assess the quality of the cardiovascular system on the load can be calculated by the quality of the reaction (QR):

$$QR = \underline{PL_2\text{-}PL_1}$$

P_2-P_1

where PL_1 – pulse pressure before exercise.
PL_2 – pulse pressure after exercise.
P_1 – pulse before exercise.
P_2 – pulse after exercise.
Pulse pressure is the difference between systolic and diastolic blood pressure.
QR: 0,1-0,2 - irrational reaction; 0.3-0.4 - satisfactory reaction;
0.5-1.0 - good reaction; > 1.0 - irrational reaction.
Using the results of work 36.3, perform the calculation of QR. Evaluate the obtained QR indicator.
Results:_____
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Conclusions: Assessment of what allows you to perform functional tests? _____
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What physiological changes in hemodynamics occur during exercise?_____
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Practical work 10. Research of apical push.

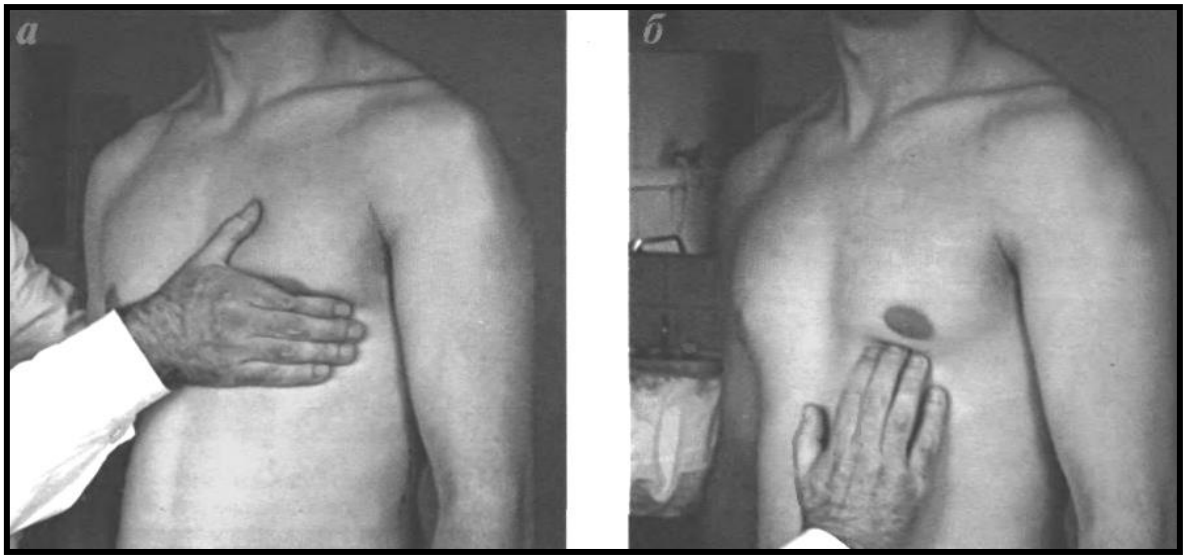
Purpose: to learn to study the apical shock in humans.
Materials and equipment: phonendoscope.
The object of study: human.
The apical shock is a rhythmic local pulsation in the area of the projection of the apex of the heart. It is caused by the push of the apex of the heart into a small area of the chest wall during systole. Detected in healthy people with moderate development of the subcutaneous fat layer. The apical shock occurs due to the work of the heart during ventricular systole, during stress, in the phase of isovolumetric contraction. During this period, both the crescent and atrioventricular valves are closed. Ventricular pressure increases and volume does not change. The increase in pressure leads to a change in the shape of the heart from ellipsoidal to spherical. The longitudinal diameter of the heart decreases and the transverse diameter increases. The apex of the heart is pressed against the inner surface of the chest wall, causing it to bulge - a heartbeat. It refers to the mechanical manifestations of the heart.
Characteristics of a normal heartbeat:

- ✓ Localized in 5 intercostal spaces along the midclavicular line or 1 cm inward from it, on the left.
- ✓ Has a limited area of 1-2 cm2.
- ✓ Is resistant.

- ✓ It is best expressed in people with underdeveloped subcutaneous fat layer and in children.
- ✓ It is better defined not in a direct projection, and at inspection of the left lateral surface of a thorax, especially at a small inclination of a trunk forward.
- ✓ Not determined if it falls on the edge.

Procedure:

1. Expose the chest of the subject.
2. Monitor the presence of heartbeat visually in direct projection and in lateral projection.
3. Determine the location of the apical shock.
4. Palpation to determine the area and resistance of heartbeat.



Results_____

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Practical work 11. Auscultation of heart tones.

Purpose: to learn to study the auscultation of heart tones in humans.

Materials and equipment: phonendoscope.

The object of study: human**.**

Sound phenomena that occur during the work of the heart are called ***heart tones***. At work of heart there are 4 tones: I, II, III, IV. However, during auscultation of the heart we can hear only I and II tones, because III, IV tones are low, quiet, and are rarely heard. In healthy people, two tones are heard: I - systolic (during systole), II - diastolic (during diastole).

- ✓ And the tone occurs during ventricular systole (stress period, asynchronous contraction phase) due to the closure of the atrioventricular valves. And the tone (systolic) has 3 components: valvular, muscular and vascular. The valve component occurs in the phase of asynchronous contraction due to the closure of the atrioventricular valves and their vibration. The muscle component occurs in the phase of isovolumetric contraction due to vibration of the ventricular walls. The vascular component occurs in the rapid expulsion phase due to oscillations of the initial parts of the aorta and pulmonary trunk when they are stretched by blood.
- ✓ II tone occurs during ventricular diastole (relaxation period, protodiastolic interval) due to the closure of the crescent valves. II tone (diastolic) has 2 components: valvular and

vascular. The valve component arises in a protodiastolic interval owing to closing of shutters of crescent valves and their vibration. The vascular component occurs in the phase of isovolumetric relaxation due to vibration of the walls of the great arteries (aorta and pulmonary artery).

- ✓ III tone occurs during ventricular diastole (filling period, rapid filling phase) due to vibration of the ventricular walls.
- ✓ IV tone occurs during atrial systole due to contraction of the atrial myocardium.

To study heart tones use 2 methods:

1. Auscultation (listening).
2. Phonocardiography (graphic recording). Phonocardiography (FCG) allows you to study all tones, while auscultation only I and II tones.

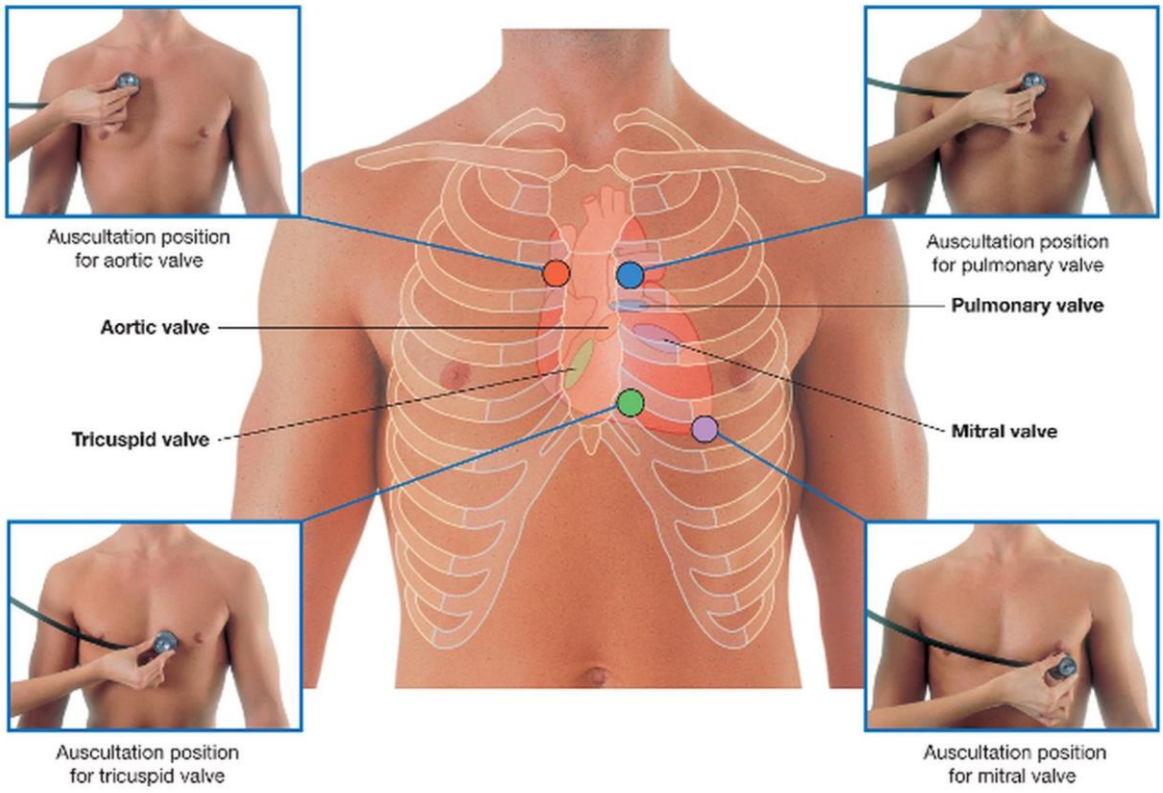
Normally, the first tone is deaf, low, long (0.12 s); II tone - sonorous, high, short (0.08 s).

When auscultating heart tones, the following rules must be followed:

- ✓ The room where the examination is performed should be quiet and warm.
- ✓ The stethoscope should be warm.
- ✓ The experimenter stands to the right of the subject.
- ✓ The tube must be kept in the cutting area.
- ✓ The membrane of the stethoscope is tightly applied to the surface of the body.
- ✓ The tube should not come into contact with clothing or other objects.
- ✓ Listening is performed in different positions of the subject (vertical, horizontal on the back, left, right side).

Perception of tones depends not only on the proximity of the projection of the valves, but also on the oscillations of blood flow. The places of projection of the valves on the anterior chest wall are very close.

As a result of clinical practice the points of the best listening of valves which do not coincide with points of their projection were established (see fig.). The exception is the pulmonary trunk valve, in which the point of listening and projection coincides. The sequence of points of auscultation of heart also has the logic, the increasing numbering is connected with frequency of defeat of the corresponding valve (for example, mitral defects meet more often than others).



The sequence of auscultation of the heart:

1. The first point is the apex of the heart (mitral valve).
2. The second point - 2 interregional right of the sternum (aortic valve).
3. The third point - 2 interregional to the left of the sternum (pulmonary artery valve).
4. The fourth point - at the base of the xiphoid process (tricuspid valve).
5. The fifth point (Botkin-Erb) - an additional point of auscultation of the aortic valve, is heard in 3 interregional drains from a sternum.

Procedure:

1. Expose the subject's chest. Auscultation of the heart should be performed during calm breathing, if necessary, ask the subject to hold his breath on the inhale or exhale or change the position of the body. Noises from the right heart are usually louder in the inhalation phase.
2. Listen to the first tone of the heart. And the tone is heard in 2 points: for the mitral valve - the apex of the heart (5 intercostal spaces along the midclavicular line); for tricuspid - the place of attachment of the xiphoid process to the sternum.
3. Listen to the second tone of the heart. The second tone is heard in 2 points: for aortic valves - 2 intercostal spaces on the right 2 cm outside from the edge of the sternum; for pulmonary artery valves - 2 intercostal spaces on the left 2 cm outside the edge of the sternum.
4. Compare I and II tones, determine their properties.

Results and conclusions: _____

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Practical work 12. Registration of the electrocardiogram.

Purpose: to learn ECG recording

Materials and equipment: electrocardiograph, napkins, cotton wool, 96% alcohol solution, physiological solution.

The object of study: human**.**

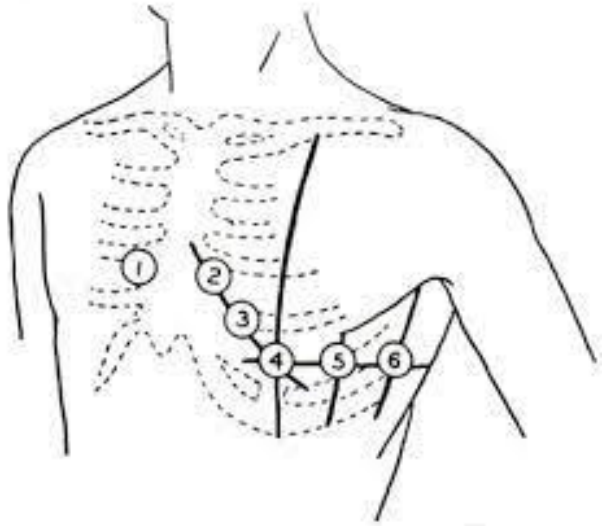
Electrocardiography is a method of graphical registration of changes in the potential difference of the heart that occur during the processes of myocardial excitation. The first recording of an electrocardiogram, a prototype of a modern ECG, was performed by W. Einthoven in 1912 in Cambridge. After that, the method of ECG recording was intensively improved.

Modern electrocardiographs allow both single-channel and multi-channel ECG recording. In the latter case, several different electrocardiographic leads (from 2 to 6-8) are registered simultaneously, which significantly shortens the study period and makes it possible to obtain more accurate information about the electric field of the heart.

Electrocardiographs consist of an input device, a biopotential amplifier and a recording device. The potential difference that occurs on the surface of the body when the heart is excited is registered using a system of electrodes attached to different parts of the body. Electric oscillations are converted into mechanical displacements of the armature of the electromagnet and in one way or another are recorded on a special moving paper tape.

Now use both mechanical recording with a very light pen, to which the ink is fed, and thermal recording of the ECG with a pen, which when heated burns the corresponding curve on a special thermal paper. Changes in the potential difference on the surface of the body that occur during the work of the heart are recorded using different ECG leads. Each lead registers the potential

difference that exists between two specific points of the electric field of the heart in which the electrodes are installed. Thus, the different electrocardiographic leads differ from each other, especially the parts of the body where the potential difference is measured.
Today, the most widely used in clinical practice are 12 ECG leads, the recording of which is mandatory for each electrocardiographic examination of the patient: 3 standard leads, 3 enhanced unipolar leads from the extremities and 6 chest leads.



V1 - the fourth intercostal space on the right edge of the sternum;
V2 - the fourth intercostal space on the left edge of the sternum;
V3 - between V2 and V4;
V4 - in the fifth intercostal space on the left lin. medioclavicularis;
V5 - in the fifth intercostal space on the left lin. axillaris ant .;
V6 - in the fifth intercostal space on the left lin. axillaris med.

Location of ECG electrodes

Conditions for electrocardiographic examination.
ECG is recorded in a room away from possible sources of electrical interference: electric motors, physiotherapy and X-ray rooms, switchboards. ECG recording is usually performed in a supine position, which allows you to achieve maximum muscle relaxation. The couch should be at a distance of at least 1.5-2 m from the wires. The study is performed after 10-15 minutes of rest and not earlier than 2 hours after a meal. The patient should be undressed to the waist, the legs are also free of clothing.

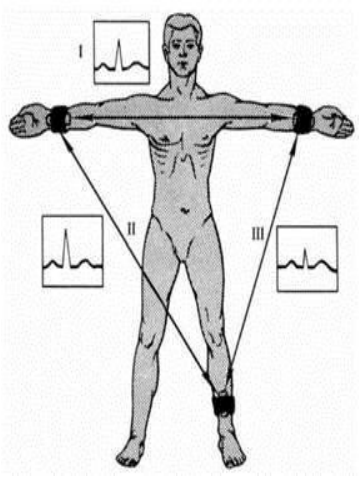
Electrode application.
On the inner surface of the legs and forearms in their lower third with the help of rubber bands impose 4 plate electrodes, and on the chest set one or more (for multi-channel recording) chest electrodes, using a rubber bulb-sucker.
To improve the quality of the ECG and reduce the number of induction currents, it is necessary to ensure good contact of the electrodes with the skin. To do this, you must: 1) pre-degrease the skin with alcohol in places of application of electrodes; 2) at considerable hairiness of skin to moisten places of imposing of electrodes with a soap solution; 3) use electrode paste or abundantly moisten the skin in the places of electrode application with 5–10% sodium chloride solution.
Connecting wires to electrodes.
To each electrode mounted on the limbs or on the surface of the chest, connect the wire coming from the electrocardiograph and marked with certain colors.
The following markings of input wires are generally accepted: right hand - red colors; left hand - yellow; left foot - green, right foot (grounding the patient) - black; chest electrode - white.
In the presence of a 6-channel electrocardiograph, which allows you to simultaneously record the ECG in 6 chest leads, to the electrode V1 connect a wire with a red color on the tip; to the electrode V2 - yellow, V3 - green, V4 - brown, V5 - black and V6 - blue or purple. The marking of other wires is the same as in single-channel electrocardiographs.
Choice of electrocardiograph gain.
Before starting the ECG recording, the same amplification of the electrical signal must be set on all channels of the electrocardiograph. To do this, each electrocardiograph provides the ability to supply a standard calibrated voltage (1 mV) to the galvanometer. The normal gain of each channel

is selected so that a voltage of 1 mV causes a deviation of the galvanometer and the recording system equal to 10 mm. To do this, in the position of the lead switch "0" adjust the gain of the electrocardiograph and record the calibrated millivolt.
If necessary, you can change the gain: reduce if the amplitude of the ECG teeth is too large (1 mV = 5 mm) or increase if their amplitude is small (1 mV = 15 or 20 mm).

ECG recording.

Recording is performed with calm breathing, as well as at the height of inspiration (in lead III). First, the ECG is recorded in standard leads (I, II, III), then in enhanced leads from the extremities (aVR, aVL and aVF) and chest (V1-V6). At least 4 cardiac cycles of PQRST are recorded in each lead. The ECG is recorded, as a rule, at a paper speed of 50 mm · s-1. A lower speed (25 mm · s-1) is used when longer ECG recording is required, for example to diagnose arrhythmias. Immediately after the end of the study, the patient's last name, first name and patronymic, year of birth, date and time of the study are written on a paper tape.

Procedure:



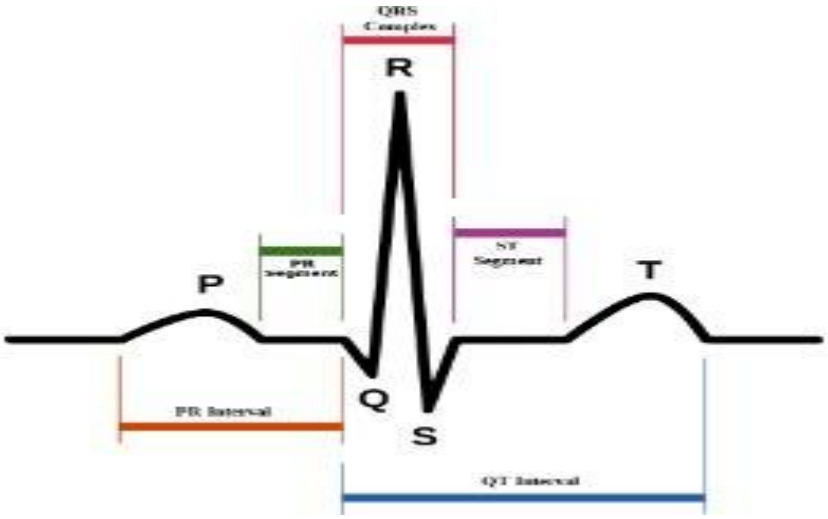
1. Prepare the electrocardiograph to work according to the instructions attached to it.
2. Place the subject on a couch, free the shin and wrist.
3. Degrease the skin with alcohol in the places of application of electrodes.
4. Apply electrodes: right hand - red; left hand - yellow; left foot - green, right foot (grounding the patient) - black; chest electrode - white. To ensure reliable electrical contact between the electrodes and the skin, you can place a gauze napkin or filtered paper moistened with 10% NaCl solution.
5. Turn on the electrocardiograph.
6. Record the calibration signal (1mV = 10 mm), the speed of the tape - 25 mm / s.
7. Record the ECG in I, II and III standard leads. Paste the ECG fragment into the workbook.

Practical work 13. Analysis of the electrocardiogram.

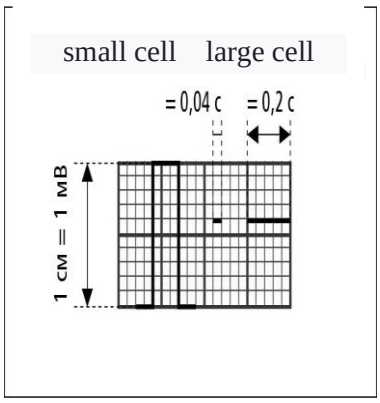
Purpose: to learn ECG analysis
Materials and equipment: electrocardiogram, ruler, pencil, compass.
The object of research: human.
Analysis of any ECG should begin with checking the correctness of the technique of its registration.

Scheme of normal ECG recording

1) deviation up or down from the isoelectric line - teeth P, Q, R, S, T, U; teeth Q + R + S = QRS complex (without R = QS complex);
2) the horizontal line between the teeth U and P or between the teeth T and P, if the tooth U is not detected - is an isoelectric line (isoline);
3) the elements of the line between the P wave and the QRS complex, as well as between the QRS complex and the T tooth are segments PQ and ST;
4) parts of the curve consisting of a segment and a tooth are called intervals PQ and QT.



Teeth, segments and ECG intervals



The ECG is recorded on a millimeter grid, which allows you to perform measurements such as heart rate, duration and amplitude of individual morphological elements of the record.

1) in the case of a standard velocity of electrocardiographic tape 25 mm / s, the segment between the thin vertical lines of the grid corresponds to an interval of 0.04 s (small cell), and between thicker lines - 0.2 s (large cell); at a speed of 50 mm / s - 0.02 s and 0.1 s; 2) calibration of the device: in the standard ECG recording 1 cm = 1 mV, if the voltage is greater or less than 1 cm, then the measurement of the amplitude of the teeth must be adjusted by substituting in the formula: adjusted amplitude of the tooth (in mm) = amplitude of the tooth (in mm) × 10 mm / voltage amplitude (in mm).

To avoid errors in the interpretation of ECG changes, when analyzing each of them should strictly follow a certain decoding scheme.

General scheme (plan) of ECG decoding

I. Analysis of heart rate and conduction:

1. assessment of the regularity of heart contractions;
2. heart rate calculation;
3. determining the source of excitation;
4. evaluation of the conductivity function.

II. Determination of heart rotations around the anteroposterior, longitudinal and transverse axes:

1. determining the position of the electrical axis of the heart in the frontal plane;
2. determining the rotation of the heart around the longitudinal axis;
3. determining the rotation of the heart around the transverse axis.

III. Analysis of the atrial tooth R.

IV. Analysis of the ventricular complex QRST:

1. QRS complex analysis;
2. analysis of the RS-T segment;
3. analysis of the T wave;
4. analysis of the Q – T interval.

V. Electrocardiographic conclusion.

1. Characteristics of ECG teeth. The characteristics of the teeth are: direction, duration, amplitude.

Direction: teeth P, R, T have a positive direction: because the projection of the vector is directed towards the positive lead electrode; the teeth Q, S are negative, because the projection of the vector is directed towards the negative lead electrode. *The amplitude* of the teeth is estimated in relation to the tooth R. In the II standard assignment, the ratio between the amplitudes of the teeth is: T = 1/2 R, S = 1/3 R, Q = 1/4 R, P = 1/8 R.

The amplitude of the R wave is normally 18-22 mm. Appropriate values of the amplitude of the teeth (normal for the patient) are calculated according to the tooth R, the height of which is determined by the ECG.

2. Characteristics of segments and intervals of the ECG. *The characteristics of the segments* are: relation to the isoline; duration (s). *Relation to isoline*: Normally in standard and reinforced unipolar leads the segments are located on the isoline, their displacement up or down does not exceed ± 0.5 mm, in chest leads - (V1 - V3) - not more than 2 mm. *Characteristic of intervals* is their duration.

Duration of ECG segments	**Norm (sec)**	*Duration of ECG intervals*	**Norm (sec)**
PQ	0,04-0,10	PQ	0,12-0,2
S-T(RT)	0,09-0,19	QRS	0,06-0,10
T-P	0,24-0,32	QT (RT)	0,36-0,44

2. Analysis of the regularity of heart contractions is evaluated by comparing the duration of the intervals R – R between successively recorded cardiac cycles.

The R – R interval is usually measured between the vertices of the R (or S) teeth. Regular or correct heart rhythm is diagnosed when the duration of the measured R – R intervals is the same and the variance of the obtained values does not exceed ± 10% of the average duration of the R – R intervals. In other cases, an irregular (irregular) heart rhythm is diagnosed.

3. Heart rate calculation. Heart rate is calculated using various techniques, the choice of which depends on the regularity of heart rhythm. With the correct rhythm, heart rate is determined by the formula: heart rate = 60 / R – R, where 60 is the number of seconds per minute, R – R is the duration of the interval, expressed in seconds. It is much more convenient to determine the heart rate using special tables, in which each value of the interval R – R corresponds to a heart rate.

At an incorrect rhythm of an ECG in one of assignments (most often in II standard) it is written longer, than usually, for example within 3–4 s. At a paper speed of 50 mm · s-1, this time corresponds to a segment of the ECG curve 15-20 cm long. Then count the number of QRS complexes recorded in 3 s (15 cm of paper tape), and the result is multiplied by 20. At the wrong rhythm it is possible to be limited also to definition of the minimum and maximum heart rate. The minimum heart rate is determined by the duration of the largest interval R – R, and the maximum heart rate - by the smallest interval R – R. In a healthy person at rest, the heart rate is from 60 to 90 beats / min. An increase in heart rate (> 90 beats / min) is called a tachycardia, and a decrease (<60 beats / min) is called a bradycardia.

4. Determining the source of excitation. To determine the source of excitation or the so-called rhythm driver, it is necessary to assess the passage of excitation through the atria and to establish the ratio of R teeth to the ventricular QRS complexes.

Sinus rhythm. Normally, an electrical impulse that occurs in the sinoatrial node propagates through the atria from top to bottom. The atrial depolarization vector (P) is directed towards the positive electrode II of the standard lead, and positive teeth P are recorded on the ECG in this lead. The positive tooth P is also registered in leads I, aVF, V4 – V6. The excitation of the atria always precedes the excitation of the ventricles, so the positive teeth P in the II lead are registered before each QRS complex. In most cases, in each lead, they have the same shape and are usually placed at the same distance from the QRS complex. In the absence of these signs, various variants of non-sinus rhythm are diagnosed. These include atrial rhythms, AV-rhythm rhythms, ventricular (idioventricular) rhythms, atrial fibrillation, and more.

Atrial rhythm. In cases where the source of excitation is located in the lower atria (for example in the coronary sinus), the electrical impulse in the atria propagates in the opposite direction (bottom up) and the ECG in II and III standard leads are registered negative teeth P, preceding the QRS complex . The interval P – Q (R) may be slightly shortened or unchanged. Since the movement of the excitation wave through the ventricles is not disturbed, unchanged (narrow) QRS complexes are registered, the heart rate is 60–90 beats / min.

Rhythms from the AV connection. If the pacemaker is localized in the AV connection, the ventricles are excited in the usual way - from top to bottom, and the atria - retrograde, from bottom to top. Therefore, normal unchanged QRS complexes and negative P-waves are registered on the ECG. If the ectopic impulse reaches the atria and ventricles at the same time, the P-wave is layered on the QRS complex and is not visible on the ECG. If the ectopic impulse first reaches the ventricles and only then the atria, the negative P wave is placed after the QRS complex. Heart rate at the rhythm of the AV connection is below the frequency of the sinus rhythm and is 40-60 beats / min.

Ventricular (idioventricular) rhythm. If the source of excitation is the conducting system of the ventricles (legs and branches of the His bundle or Purkinje fibers), it is a so-called ventricular (idioventricular) rhythm. Electrical impulses arising in the ventricles are generated at a much slower rate (<40 beats / min). Excitation is carried out on ventricles in an unusual way: it at first covers that ventricle in which there is an ectopic driver of a rhythm, and only then slowly reaches an opposite ventricle. As a result, QRS complexes are expanded and deformed. The excitation does not extend to the atrial myocardium, so there is no constant regular connection of QRS complexes with the P teeth: the ventricles are excited in their slow rhythm, and the atria - in their normal rhythm, the source of which remains the sinoatrial node. Idioventricular rhythm is more often noted at full AV-blockade.

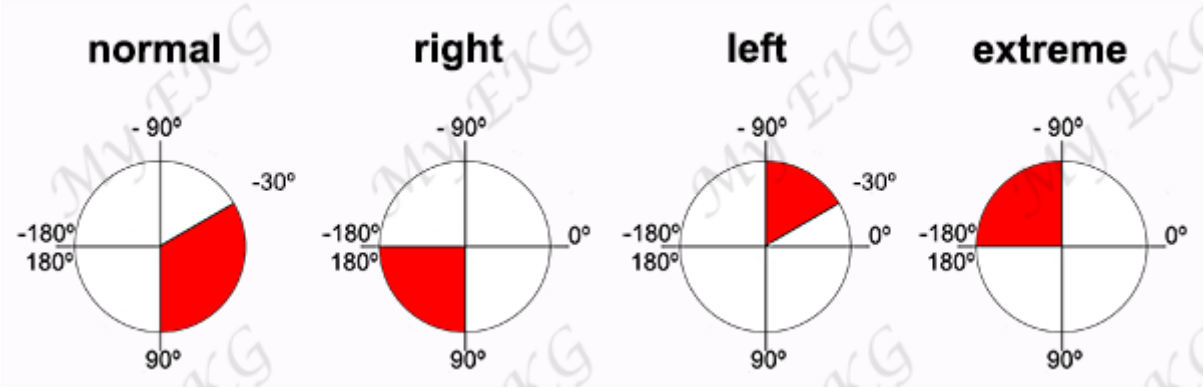
5. Assessment of conductivity. To assess the conductivity measure the duration of the tooth P (time of propagation of excitation through the atria), the interval PQ (R) (time of propagation of excitation through the atria, atrioventricular node, His bundle), QRS complex (time of propagation of excitation through the ventricles). The increase in the duration of these teeth and intervals indicates a slowing of the excitation of the relevant parts of the heart.

6. Determining the position of the electrical axis of the heart.

Electric axis of the heart (EMC): the direction of the EMU is mainly determined by orientation, based on the assessment of the direction of QRS complexes in the leads from the extremities.

Determining the position of the electrical axis of the heart is performed graphically and visually. There are the following options for the position of the electrical axis of the heart:

1) normal position, when the angle α is from +300 to +690;
2) vertical position - angle α from +700 to +900;
3) horizontal position - angle α from +00 to +290;
4) deviation of the axis to the right - the angle α from +910 to +1800;
5) deviation of the axis to the left - the angle α from 00 to -900;



Assessment of the position of the electrical axis of the heart

Registration of work results:

1) Paste obtained in practice № 38 ECG in a workbook.
2) Mark with appropriate marks the type of lead, teeth and intervals.
3) To draw a conclusion about the regularity of heartbeats, localization of the driver's rhythm and conduction; record heart rate, EOS state and angle α, amplitude of ECG teeth.
4) Compare the resulting palms with a typical ECG in the norm.

Results: ECG ANALYSIS

1. Characteristics of ECG teeth.

Direction: _____ teeth have a positive direction, as the projection of the vector is directed towards the positive lead electrode;

the _____ teeth are negative because the projection of the vector is directed towards the negative lead electrode.

Duration:

Teeth	Norma, sec	Data of the researched person	Conclusion
P	0,08-0,1		
Q	0,02-0,03		
R	0,03-0,05		
S	0,02-0,03		
T	0,16-0,24		
U			

Amplitude: The amplitude of the teeth is estimated in relation to the tooth R. In the II standard assignment, the ratio between the amplitudes of the teeth is: T = 1/2 R, S = 1/3 R, Q = 1/4 R, P = 1/8 R. Amplitude tooth R is normally 18-22 mm. Appropriate values of the amplitude of the teeth (normal for the patient) are calculated according to the tooth R, the height of which is determined by the ECG.

Teeth	Normal ratio of teeth	Norm for the investigated person (mm)	Data of the researched person (mm)	Conclusion
P				
Q				
R				
S				
T				
U				

2. ***Characteristics of ECG segments***: Characteristics of segments are: relation to an isoline; duration (s). Relation to isoline. Normally, in standard and reinforced unipolar leads, the segments are located on the isoline, their displacement up or down does not exceed ± 0.5 mm, in the chest leads - (V1 - V3) - not more than 2 mm.

Segments	Norma, sec	Data of the researched person (mm)	Conclusion
PQ	0,04-0,10		
S-T (RT)	0,09-0,19		
T-P	0,24-0,32		

3. ***Characteristics of ECG intervals:***

Intervals	Norma, sec	Data of the researched person (mm)	Conclusion

PQ	0,12-0,2		
QRS	0,06-0,10		
QT (RT)	0,36-0,44		
R-R	0,72-1,0		

4. Calculation of heart rate

With the correct rhythm, heart rate is determined by the formula: heart rate = 60 / R – R, where 60 is the number of seconds per minute, R – R is the duration of the interval, expressed in seconds.
Heart rate = _____. Normally it is 60 - 80 per minute.

5. Determining the duration of the cardiac cycle.

The duration of the cardiac cycle corresponds to the interval R-R. Normally, the duration of the cardiac cycle is 0.72 - 1.0.
Result:_____

6. ECG calculation of the duration of electrical systole and systolic index.

Ventricular systole is determined by the interval Q - T. The normal duration of iQT is determined by the Bassett formula: iQT = √RR x K, where K is a coefficient equal to 0.37 for men and 0.40 for women.
Systolic index (SI) characterizes the ratio of electrical systole to the duration of the cardiac cycle (iR-R).
Normal SI = 40% ± 5%. The calculation is made by the formula: $СП = \frac{iQT}{iR-R} * 100$

According to the Bassett formula iQT = _____

SI =

_____

7. Determination of the direction of the electrical axis of the heart by ECG.

The projection of the mean resultant QRS vector on the frontal plane is called the mean electrical axis of the heart. The location of the electrical axis of the heart is determined in the six-axis Bailey coordinate system, the angle α, which is formed by the electrical axis of the heart and the positive half of the axis I of the standard lead.
There are two methods for determining the electrical axis of the heart: Visual determination of the angle α. Graphic method for determining the angle α.

1. Visual determination of the angle α is a simple and accessible method that allows you to quickly estimate the angle α with an accuracy of ± 100. This method is based on two principles:

a. The maximum positive value of the algebraic sum of the teeth of the QRS complex is observed in the lead, the axis of which coincides with the location of the electrical axis of the heart, parallel to it.
b. A complex of QRS type, where the algebraic sum of the teeth is 0 (R = S or R = Q + S), is written in the lead, the axis of which is perpendicular to the electrical axis of the heart.
1. Graphic method for determining the angle α:
Leads I and III are used to construct the electrical axis of the heart.

- Draw a circle, mark the center.
- Inscribe an equilateral triangle of Einthoven in a circle, mark the axis of the leads.
- Draw a straight line parallel to the lead through the center.
- Draw a straight line parallel to the third lead through the center.
- Determine the algebraic sum of the amplitudes of the teeth Q, R, S in I and III leads.
- Arbitrarily postpone the result obtained from the center on the lines that correspond to the I and III standard leads, taking into account the sign (if the amount is positive to put in the positive half of the axis, if negative - in the negative half).
- From the obtained points lower the perpendiculars to the axes of the leads.

- Find the point of intersection of the perpendiculars and connect it to the center. The resulting line corresponds to the electrical axis of the heart.
- Determine the angle α, which is formed by the electrical axis of the heart and the positive part I of the standard lead.

I = _____ QIII = _____

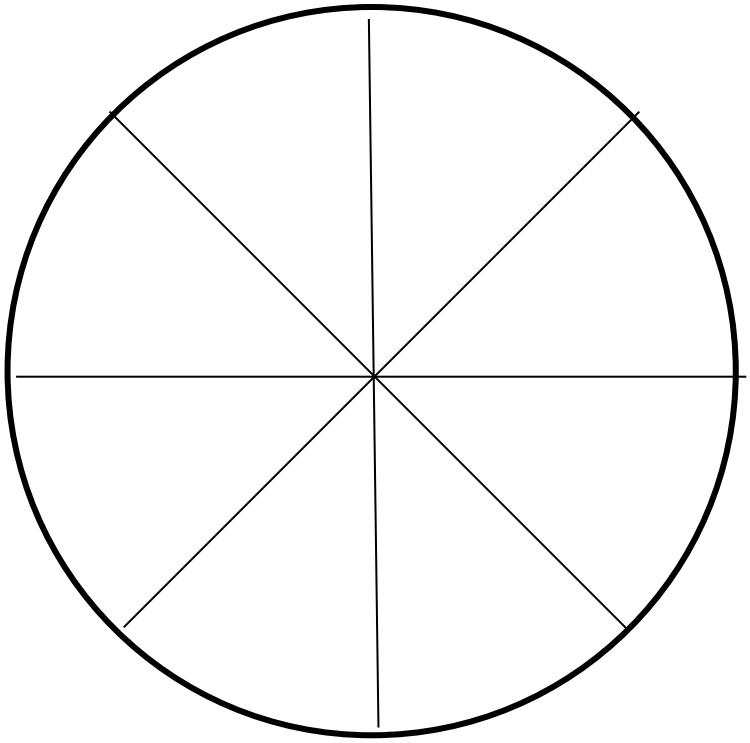
RI = _____ RIII = _____

SI = _____ SIII = _____

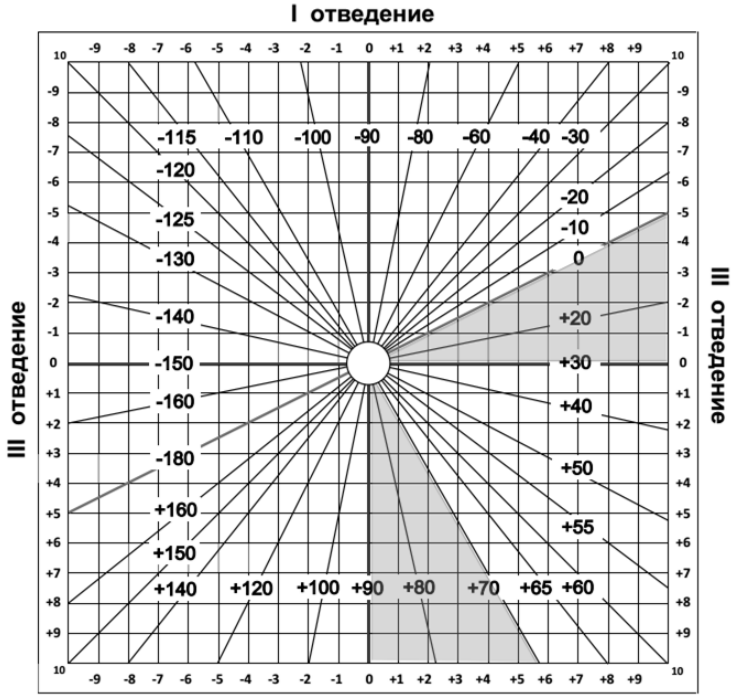
Σ (QRS) I = _____

Σ (QRS) III = _____

Angle α = _____



Normally, the value of the angle α depends on the type of human constitution. In normosthenics α = 30 - 69º, in hypersthenics α = 0 - 29º, in asthenics α = 70 - 90º.
There are special Died tables to find the angle α. Check the value of the found angle α with the data in the table below.



Conclusions on the performed ECG analysis _____
_____
_____
_____
_____
_____
_____

Loading tests in cardiology.

Exercise tests are a common and affordable method of diagnosis and examination of patients with cardiovascular diseases.

Exercise tests are one of the most accessible ways of screening examination and diagnosis of coronary heart disease, risk stratification, assessment of functional status of patients and effectiveness of anti-ischemic therapy.

Practical work 14.1. Orthostatic test (Waldfogel in modification)

Purpose: to learn the technique of performing orthostatic Waldogel test.

Materials and equipment: stopwatch, tonometer, phonendoscope.

The object of research: human.

When a person moves from a horizontal to a vertical position, the hydrostatic pressure changes and the redistribution of blood volume is associated with it. In capacitive vessels alone, 400-600 ml temporarily accumulate. blood. As a result, venous return, central venous pressure, stroke volume, and ATsist. temporarily reduced.

All these changes are compensated by active hemodynamic reactions, which are "triggered" by signals from arterial baroreceptors. At transition of the person from horizontal position to vertical hydrostatic pressure in an aortic arch and a carotid sinus falls therefore impulse from baroreceptors decreases that causes reflex adaptive reactions:

narrowing of resistive and capacitive vessels, increase in heart rate; increased secretion of catecholamines by the adrenal medulla; activation of the renin - angiotensin system; increased secretion of vasopressin and aldosterone;

At transition of the person from horizontal position to vertical: ATsredn. - practically does not change, the central venous pressure - decreases by 3 mm Hg, heart rate - increases by 30%, shock volume - decreases by 40%, the total peripheral resistance - increases by 30%

In the absence of compensatory mechanisms to maintain normal hemodynamics, blood pressure may fall below acceptable levels and the blood supply to the brain is disrupted. Subjective manifestations are dizziness and "darkening of the eyes" (orthostatic hypotension); even loss of consciousness (orthostatic fainting) is possible. Similar phenomena can be observed in completely healthy people at high ambient temperatures. Under these conditions, the tolerance of orthostatic load is reduced, as vasodilation required for thermoregulation prevails over vasoconstrictive reactions that help maintain hemodynamics.

Orthostatic test (Waldfogel test) is a functional test used to assess the regulation of systemic circulation. The test is based on the fact that the tone of the sympathetic division of the autonomic nervous system and, accordingly, the heart rate increases during the transition from horizontal to vertical position.

Procedure:

1. The subject lies on the couch.
2. After being in a supine position for at least 5 minutes, the subject's heart rate is calculated for 15 seconds and the result is multiplied by 4. Thereby determining the initial heart rate for 1 minute. Blood pressure measurements are also performed.
3. Then the subject slowly (for 2-3 sec.) gets up.

4. Immediately after the transition to a vertical position, and then after 3 minutes of standing (ie when the heart rate stabilizes) he again determine the heart rate (for pulse data for 15 sec., multiplied by 4) and perform blood pressure measurements.

Results:

	In the supine position	Immediately after the transition to a vertical position	After 3 minutes in a standing position
BP			
Heart rate			

Evaluation of results: the normal response to the test is an increase in heart rate by 10-16 beats per 1 min immediately after lifting. After stabilization of this indicator in 3 min. standing heart rate decreases slightly, but by 6-10 beats per 1 min. higher than in the horizontal position.

A stronger reaction (increase in heart rate by more than 18 beats / min) indicates increased reactivity of the sympathetic part of the autonomic nervous system, which is characteristic of insufficiently trained individuals.

A weaker reaction is observed in the case of reduced reactivity of the sympathetic part and increased tone of the parasympathetic part of the autonomic nervous system. Weaker reaction, as a rule, accompanies the development of a state of high training.

Hemodynamic reactions are considered *normal* if after 10 minutes. after transition to vertical position:

- BPdiast. - decreases by no more than 5 mm Hg;
- BPsist. - within + 5%;
- Heart rate - increases by an average of 30%;

With hyperdiastolic orthostatic hypotension (80-85% of all pathological abnormalities):

- BPdiast. - increases by more than 5 mm Hg;
- BPsist. - decreases by an even greater amount.

As a result, the amplitude of pressure fluctuations decreases significantly. There is a significant increase in heart rate and a decrease in stroke volume.

Increasing ATdiast. (due to a significant narrowing of resistive vessels) and heart rate in this type of reaction is associated with a significant increase in the tone of the sympathetic nervous system.

With hypodiastolic orthostatic hypotension:

- BPdiast.- decreases;
- BPsist. - decreases;
- BPpulse. - changes slightly;
- Heart rate - almost does not increase;

Changes in blood pressure and heart rate in this type of reaction are due to a weak increase in the tone of the sympathetic nervous system.

Conclusions: conclusions on the evaluation of the regulation of systemic circulation based on the results of the Waldogel test. Compare the results with the normal response to the sample.

_____
_____
_____
_____
_____
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_____
_____
_____

Practical work 14.2. Clinostatic test.

A functional test based on the fact that the tone of the parasympathetic nervous system increases when moving from a vertical to a horizontal position.

The purpose of the work: to learn the technique of performing a clinostatic test.
Materials and equipment: stopwatch.
The object of research: human.
Procedure:
1. The person is offered to rest for five minutes in a standing position.
2. Then the pulse rate is measured.
3. The subject moves to a horizontal position, where the pulse is counted again.
4. **Results:** normative values of the clinostatic test:

Rating	
norm	
Increased tone of the parasympathetic department	
Decreased tone of the parasympathetic department	

Evaluation of results:

Conclusions: Draw conclusions regarding the assessment of the regulation of systemic blood circulation based on the results of the test. Compare the results with the normal response to the sample.

Practical work 15. Test with a load of a 6-minute walk.

Test 3 with a 6-minute walk is used to assess the functional state in heart failure, to compare the state before and after treatment, and to assess the prognosis of the development of complications of cardiovascular diseases. Absolute contraindications for the test: diseases of the musculoskeletal system that prevent the test.
Relative contraindications for a 6-minute walk test:
The initial heart rate is less than 50 beats/min or more than 120 beats/min
Systolic blood pressure is greater than 180 mmHg
Diastolic blood pressure is greater than 120 mmHg.
The purpose of the work: to learn the technique of carrying out a loading test.
Materials and equipment: stopwatch.
The object of research is a person.
Procedure:
1. The patient must walk as far as possible in 6 minutes (corridor of 30 meters) at his own pace, it is possible with stops.
2. Measurement of the traveled distance.
3. Heart rate control before the test and at the end of the test.

Test termination criteria:
- Chest pain
- Pronounced shortness of breath
- Cramps in the lower limbs
- Disturbance of balance
- Dizziness
- Sharp pallor
- Decrease in blood oxygen saturation up to 86%

Parameters of physical activity in patients with chronic heart failure:
- 0 FC more than 551 m distance covered within 6 minutes.
- I FC distance 426-550 m was covered within 6 minutes.
- II FC distance 301-425 m covered within 6 minutes.
- IIII FC distance 151-300 m was completed within 6 minutes.
- IV FC, a distance shorter than 150 m is covered within 6 minutes.

Assessment of treatment effectiveness:
The minimum reliable improvement is an increase in distance of 70 m compared to the previous result.

Conclusions: Make conclusions about the evaluation of the 6-minute walking load test. Compare the results with normal values.

_____
_____
_____
_____
_____
_____

Practical work 16. Bicycle ergometry (treadmill test).

Bicycle ergometry is one of the most important stress tests in cardiology. Bicycle ergometry is used for early diagnosis of coronary heart disease, rhythm disorders, determination of tolerance to physical activity in healthy people, athletes, and children.

Bicycle ergometry is carried out on a special exercise bike - a bicycle ergometer. While the patient is "pedaling", the doctor takes heart function and blood pressure readings.

Advantages of bicycle ergometry over ECG:

Electrocardiography is one of the main diagnostic tests for detecting diseases of the cardiovascular system. An ECG provides a graphical representation of the heart's electrical activity. Standard electrocardiography is done at rest, and this does not give a complete picture of the condition of the heart: after all, it is not clear how it will behave under stress.

Most cardiac problems manifest themselves during the greatest stress: during stress, emotional experiences, physical exertion. An ECG measured at rest depicts the illusion that there is no problem with the heart, although it may be the opposite. For a complete diagnosis of the state of the cardiovascular system, an ECG with stress or stress tests are used. Bicycle ergometry is one of the types of such a stress test. Because during physical exertion, all stress hormones are released: adrenaline, norepinephrine, cortisol, which make the heart beat faster. If normally the heart rate range is 60-80 beats per minute, then during physical exertion it should double.

In order to make the heart work at maximum load, it needs to pump more blood, and the same heart needs more oxygen and nutrients. And it is at the moment of this maximum load on the heart that we determine whether the arteries of the heart supply it with enough blood, recording this on the cardiogram in the form of ischemic changes.

Bicycle ergometric examination is prescribed in the following cases: unusual pain in the heart area, the cause of which is not detected by standard electrocardiography; detection of painless myocardial ischemia; diagnosis of coronary heart disease; evaluation of the effectiveness of coronary heart disease treatment; determination of tolerance to physical exertion in patients with coronary artery disease; determination of the functional class of exertional angina; before starting cardiac rehabilitation; before performing other stress tests, more invasive: coronary angiography, CT angiagraphy, etc.

Preparation for the study:

Report to the doctor about all medications that the patient is taking, even vitamin preparations and medicinal plants too;

2-4 hours before the test, you can not eat or smoke, you can only drink water;

Wear comfortable clothes and shoes;

For men with developed chest hair, it is advisable to remove this cover with hair removal gel;

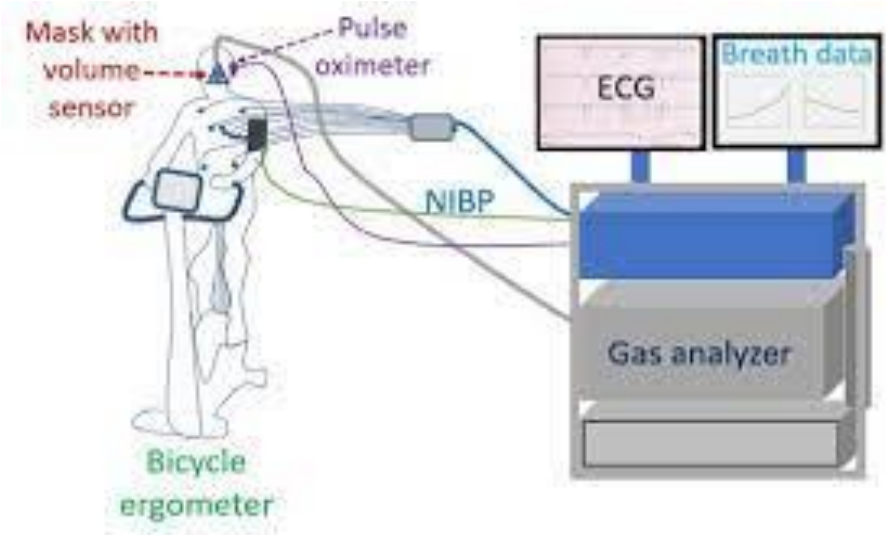
Procedure for the test:

A person sits on a special exercise bike (or stands on a treadmill – a treadmill).

Electrodes are fixed on his chest, which are connected to the ECG machine, and a cuff is put on his forearm to measure pressure.

The doctor asks the patient to pedal at a certain pace, gradually increasing the load every 3-5 minutes to the maximum values relative to the patient's age and weight.

A person's pulse quickens, blood pressure increases, and the sensations are similar to climbing a mountain.



All this time, a cardiogram is recorded, and periodically the doctor measures blood pressure.

These indicators can be used to determine myocardial circulatory disorders, heart rhythm, and blood pressure.

The doctor can stop the procedure ahead of time if he sees that some indicators go beyond critical marks.

At the end of the test, the load will decrease and stop only until all indicators return to their original position.

Indicators to stop the test:

The appearance of chest pain and shortness of breath, especially if it is accompanied by changes in the cardiogram;

Achievement of maximum individual numbers of Watts, heart rate, blood pressure;
The patient's desire for some reason.

Results: blood pressure measurements during the procedure:

Blood pressure measurements	meaning	Blood pressure measurements	meaning
Before the procedure		In the recovery period	
After 3 minutes		After 3 minutes	
After 6 minutes		After 6 minutes	
After 9 minutes		After 9 minutes	
After 12 minutes		After 12 minutes	
After 15 minutes		After 15 minutes	

Evaluation of results:

Conclusions: Draw conclusions about the cardio exercise test procedure. Compare the results of blood pressure before the procedure and in the recovery period.

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Module 4. Physiology of analyzers and HNA

Topic. Sensor systems.

Practical work 17: Research of the somato-sensory analyzer.

Purpose: Research of the somato-sensory analyzer of the person.
Materials and equipment: small ball (or pea), aesthesiometer, ruler.
The object of research: human.

17.1. Aristotle's experiment. This is the illusion of touch, the essence of which is that if you place a small round object (such as a ball) between two crossed fingers (index and middle or other), then a person has a feeling of touch not one but two objects. The illusion is enhanced by a slight sliding of crossed fingers on the object. Aristotle's experiment was described for other parts of the body: lips, tongue, ears. Aristotle's experiment was explained by

the unusualness, artificiality, unnaturalness of the position of the fingers. The causes of illusions of touch are not fully known. At the moment, among the reasons are: the constancy of perception and multichannel perception (the human brain creates an image of the object, using all possible channels of perception, processing information on each of them to obtain a holistic image). It is believed that the illusion may be based on the following explanation: the outer surfaces of two adjacent fingers, almost never touch the same surface at the same time, so the sensations emanating from them are not generalized.

Procedure:

1. Cross the index and middle fingers and roll them a ball (or pea) on a horizontal plane with eyes closed. Normally, there is a feeling that the fingers roll 2 balls. The illusion occurs faster when the eyes are closed.

17.2. Determination of the spatial threshold of tactile sensitivity of human skin.

Tactile sensations carry information about the stimulus and the localization of its influence. In different parts of the body, the accuracy of determining the location of the impact is different. It is characterized by the magnitude of the spatial threshold of tactile sensations. If you touch the skin at two points at the same time, a person will not always feel these touches as separate, if the distance between the points of contact is not large enough, both sensations will merge into one. Therefore, the minimum distance between the points of contact, which allows to distinguish the touch of two spatially different objects, is called the *spatial threshold of tactile sensations*. To determine it, a circular aesthesiometer is used - a compass with sliding legs.

Procedure:

1. The subject is sitting on a chair, he is asked to close his eyes.
2. Aesthesiometer (Weber compass) with the most raised legs touch different areas of the skin (fingertips, palms, outer hand, forearms, back). Make sure that both legs of the anesthesiometer touch the skin at the same time and with the same embossing.
3. Continue to touch different areas of the skin in the prescribed sequence, gradually increasing the distance between the legs of the compass, adding 1 mm each time. At each touch, the subject must answer whether he feels one or two touches.
4. Record at what distance between the legs of the compass and on what part of the skin he first felt a double touch.

Results: spatial threshold of tactile sensations: on the back _____ mm, forearms _____ mm, on the outside of the hand _____ mm, on the palm _____ mm, on the fingertips _____ mm.

Conclusions:_____
_____
_____
_____

Practical work 18: Research of the taste analyzer

Purpose: to study the physiology of the taste analyzer.

Materials and equipment: glass rods, cotton wool, drinking water, a set of solutions for the experiment: 1% sugar, 0.1% calcium chloride, 0.1% salt, 0.1% citric acid, colored pencils (or markers).

The object of research: human.

There are four main flavors: sweet, salty, sour and bitter. All other types and shades of flavors are complex sensations that are perceived as a combination of basic tastes. It is noted that individual papillae of the tongue are associated with the definition of different taste sensations. This explains the unequal sensitivity of different parts of the surface of the tongue and mouth not only to different but also to the same taste stimuli. According to modern scientific ideas, the entire surface of the tongue is able to perceive all the main 4 taste sensations, but some parts of it are more sensitive to the perception of certain taste stimuli and certain taste sensations.

Procedure:

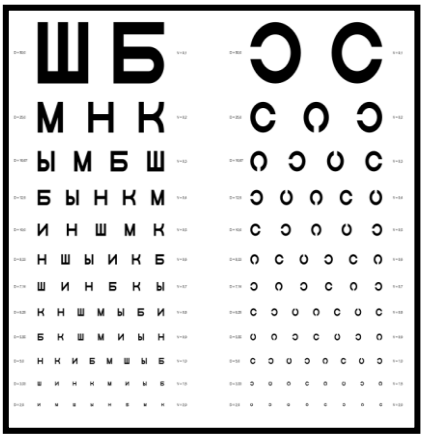
1. Prepare a set of solutions for the experiment: 1% sugar, 0.1% calcium chloride, 0.1% salt, 0.1% citric acid.
2. Wind cotton wool on glass sticks.
3. The subject rinses the mouth.
4. The experimenter gently touches different parts of the tongue with a swab dipped in the working solution. The result is a verbal reaction of the subject about the nature of the sensation.
5. After each test, rinse mouth thoroughly with water. The interval between individual experiments should be more than 2 minutes.
6. Draw a diagram of sensitivity to certain taste stimuli of the subject's tongue.
7. Check the results of observation on 2 - 3 subjects.

Results: _____
_____
_____
_____
_____
_____

Picture (draw a diagram of the predominant sensitivity to certain taste stimuli of individual areas of the subject's tongue. Paint different areas in different colors and the legend of the figure):

Practical work 19. Determination of visual acuity.

Purpose: to study the technique of determining visual acuity.
Materials and equipment: Golovin-Sivtsev table
The object of research: human.



The Golovin – Sivtsev table is a standard table for determining human visual acuity. The table consists of 12 rows of Cyrillic letters and Landolt rings of different sizes. It was developed and proposed by Soviet ophthalmologist Dmitry Sivtsev, a student of Sergei Golovin. The table is used to study the acuity of distance vision. The table has two parts. The right has the image of rings with slots, the left - the letters of the alphabet. The table contains two columns: on the left - "D =" (distance in meters from which the sign is seen by a person with one hundred percent vision), on the right - "V =" (visual acuity, if this series of signs is read from 5 meters). Values of V correspond to the visual acuity studied from a distance of 5 meters. Normal vision (1.0). The study is performed in a room with normal lighting. The table should be illuminated by a lamp that gives diffused light directed at the table. The patient whose vision is being examined sits down at a distance of 5 meters from the table, alternately looking at the table with his left and right eyes, trying to read the letters of the table. Visual acuity is determined by the designation to the right of the line on which the patient distinguishes letters. The tenth line corresponds to normal vision.

Procedure:

1. The table is placed on a well-lit wall.
2. The subject sits at a distance of 5 m from the table.
3. Closing one eye (without pressing on the eyeball), begins to read aloud the letters in lines, starting with the largest.
4. The last line, read without error (or not more than 20% of errors), is an indicator of visual acuity.
5. Repeat step 3 for the other eye.
6. Visual acuity (visus) is determined by the formula V = d / D,
1. where d is the distance from the subject to the table;
2. D is the distance from which this line is correctly read by the normal eye.
7. Record the measurement results.

Example. The subject sees from 5 m the letters that a person with normal vision can read at a distance of 25 m. In this case, V = 5/25 = 0.2 (below normal). Determine the visual acuity of the left and right eyes.

Results: Visual acuity (V):
for the right eye d = _____. D = _____.

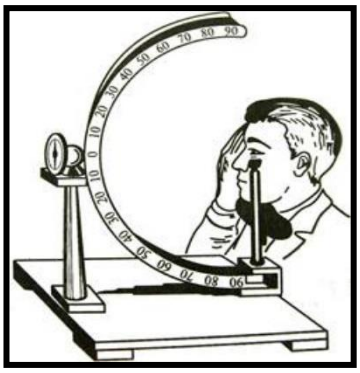
for the left eye d = _____. D = _____.

Conclusions: (make a conclusion about the acuity of your vision):
_____
_____
_____
_____
_____
_____
_____

Practical work 20. Defining the boundaries of the field of view (perimeter).

Purpose: to determine the boundaries of the human field of vision
Materials and equipment: Foster perimeter (ophthalmic desktop perimeter PNR-2), red, green, blue pencils or felt-tip pens.

The object of research: human.

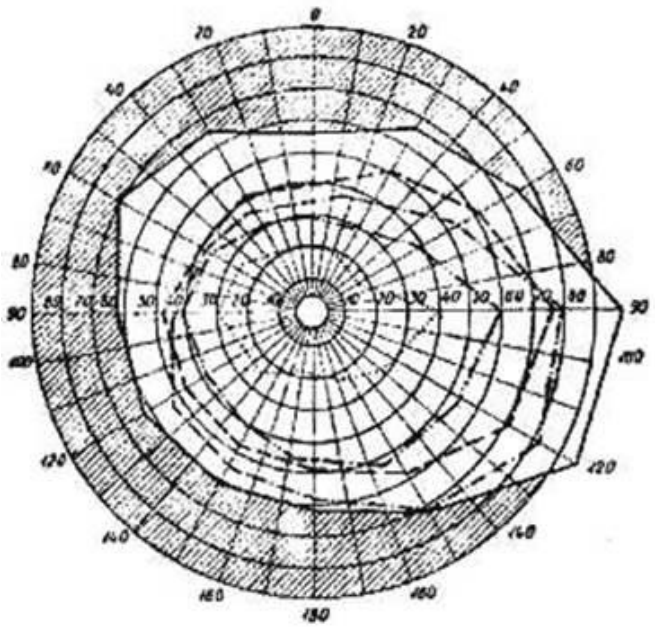


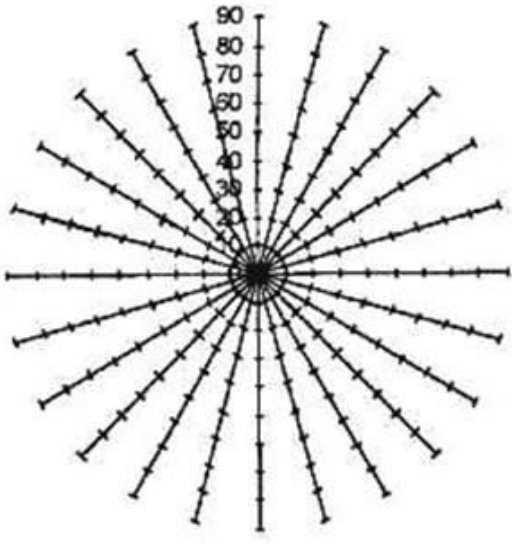
Perimetry - determining the boundaries of the field of view when projecting them onto a spherical surface. The study is performed using the perimeter. The basis of the device is an arc in a half circle, which can be rotated around a horizontal axis. On the outer surface of the arc are divided into degrees. When the perimeter on the inner surface of the arc from the periphery to the center move a special object. The form indicates the boundaries of the field of view in accordance with the testimony of the subject (at the time of the first perception of the object).

Procedure:

1. Foster's perimeter is installed on a table in a well-lit room.
2. The subject is placed with his back to the light source, places his chin on the stand (eyes should be at the level of the lower edge of the sight plate) and the eye fixes a white dot in the center of the perimeter (the second eye is currently covered without pressing on the eyeball).
3. At the first measurement we establish an arc in horizontal position.
4. To measure the boundaries of black and white vision, use a white stamp, slowly moving it along the inner surface of the arc from its outer edge to the center.
5. The subject with a fixed fixed gaze reports when he becomes visible mark. The experimenter points to the corresponding position of the mark on the arc (on a standard form) of the normal field of view.
6. The location of each point is determined twice.
7. Then the field of view is determined on the other side of the arc, after which the perimeter arc is rotated by 90 ° and the corresponding measurements are repeated again.
8. Similarly, determine the boundaries of the field of view, each time rotating the arc by 15 °.
9. A similar experiment is performed with different color brands.

The results of measurements in the form of points are applied to a standard form and connected by lines





Conclusions: Compare the resulting polygon with the normal boundaries of the field of view presented on the control form. Make a conclusion about the relationship between color and black and white fields of view, explain the reasons for the differences. _____

Practical work 21. Mastering exercises for the prevention of visual fatigue

Purpose: mastering exercises to prevent visual fatigue
The object of research: human.

Procedure:

Gymnastics for the eyes (performed standing)

1. Look right and left, actively turning your head, torso and eyes. Repeat 5-6 times.
2. Look up and down, actively raising and lowering the head, watch for balance. Repeat 5-6 times.
3. Rotate the eyes, head clockwise (5-6 times) and counterclockwise (5-6 times).

Exercises to relieve visual fatigue (if necessary, performed sitting)

1. Close your eyes tightly for 3-5 seconds. Then open your eyes for 3-5 seconds. Repeat 6-8 times. Strengthens eyelid muscles, improves blood circulation and relaxes eye muscles.
2. Blink quickly for 1-2 minutes. Helps improve blood circulation.
3. Look at the tip of your nose for 2-3 seconds, then look into the distance for 3-4 seconds. Repeat 6-8 times. Another option is to look at the tip of your own finger, which is at a distance of 30 cm from the eyes, or a mark on the glass and look into the distance.
4. Movement of the eyes to the right and left (6-8 times), up and down (6-8 times), rotation of the eyes clockwise (6-8 times) and counterclockwise (6-8 times). Helps relieve eye muscle fatigue, improves blood circulation.
5. Connect the fingers in the center of the forehead and palms cover the eye sockets, completely blocking the access of light, but the palm does not press the eyeballs (allow free movement for centuries). Carrying out the procedure for 2 minutes allows you to almost completely restore the properties of the "tired" retina.

Results: _____

Practical work 22. Detection of a blind spot of the retina (Marriott experiment).

Purpose: to detect a blind spot on the retina
Materials and equipment: a drawing of Marriott.
The object of research: human.

Procedure:

1. At a distance of 20 - 25 cm from the eyes, place a picture of Marriott.
2. Close the right eye with the palm of your hand and fix the right image with the left eye.
3. Slowly moving or zooming in, notice that the left image disappears at some distance from your eyes.
4. Repeat the experiment, closing the left eye, look at the left eye with the right eye - in this case, the right image disappears.

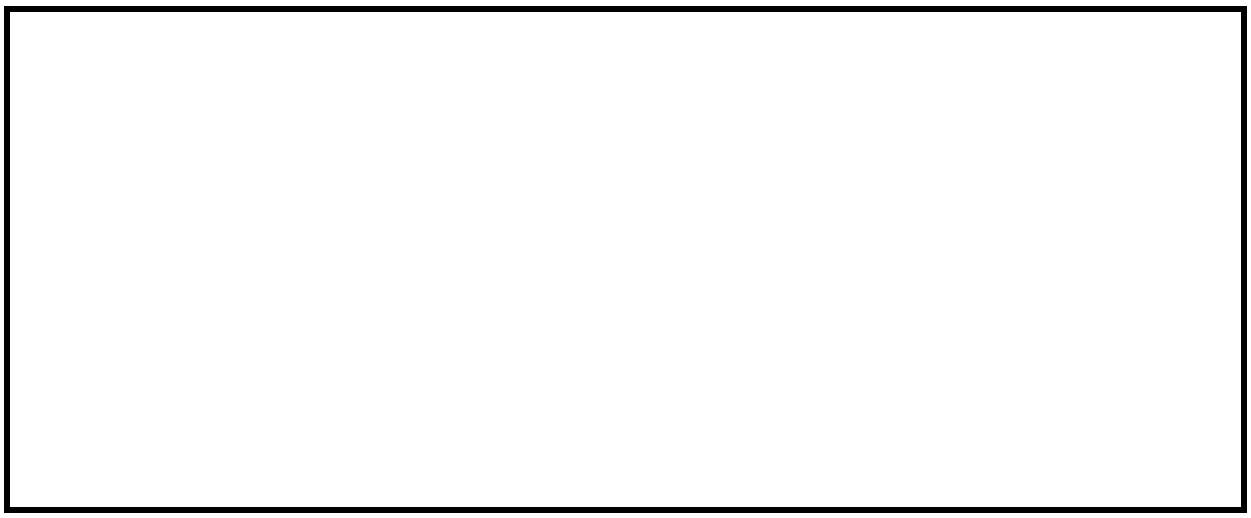
Picture Marriott

The disappearance of one of the drawings is evidence of the presence of a blind spot in the retina. To calculate the diameter of the blind spot use the formula:

$X = a \times b / c$,
where X is the diameter of the blind spot, a is the diameter of the projection of the blind spot on the paper (diameter of the circle or cross), b is the distance from the nodal point to the retina (in an adult - about 17 mm, in a newborn - 11 mm); in - the distance from the figure to the nodal point (in adults the distance from the anterior surface of the cornea to the nodal point is about 7 mm, in the newborn - 5.5 mm). The diameter of the blind spot is normal in an adult is 2 mm.
Conclusion: explain why the found area of the retina does not respond to light stimuli.

_____
_____
_____
_____
_____
_____

Draw a diagram of the image on the retina, mark the location of the blind spot, calculate its diameter.



Practical work 23. Binocular vision.

Purpose: to detect the presence of binocular vision in humans
Materials and equipment: binocular.
The object of research: human.

Procedure: The receptor department of the visual sensory system is a paired organ (two retinas). Therefore, when looking at an object, two monocular images are perceived simultaneously. They are united by the visual system into one merged perception. This occurs only when the image of the object is projected on the so-called corresponding (identical) areas of the retina, which is achieved through the coordinated function of all parts of the oculomotor system - both left and right. The nature of vision is binocular. The image in both eyes is symmetrical, but the field of view of the right eye takes up more space on the right, and the left - on the left. But when we look with two eyes, the objects are not visible in two planes, and the third three-dimensional image. Insert a plate with photographs taken into the stereoscope (binoculars), as seen by the right and left eyes separately. The greater the edge asymmetry, the greater the volume. But there is a limit of asymmetry, at which the central part is clearly visible, and the other image is blurred, doubled.
Results: _____
_____
_____
_____
_____
_____

Practical work 24. Mixing colors.

Purpose: to identify the process of perception and mixing of colors.
Materials and equipment: a circle divided into colored sectors.
The object of research: human.
The human and higher mammalian visual analyzer is capable of color recognition. Color sensation (color sensitivity, color perception) - the ability of vision to perceive and convert light radiation of a certain spectral composition into a sensation of different color shades and tones, forming a holistic sensation There are achromatic vision (analysis of black, gray and white colors) and chromatic (color analysis). Chromatic colors vary in wavelength. Cone photoreceptors are associated with the perception of color tones, which is most pronounced in the area of the macula, where only the cone photoreceptors are located. A number of theories have been put forward to explain the mechanisms of color vision. Among the theories that explain this type of view, the most widespread is the three-component theory. According to this

theory, the eye has three color-perceiving devices that are excited to varying degrees under the action of red, green and blue (blue-violet). The sensation of intermediate colors (orange, yellow, blue, etc.) occurs when different color-perceiving elements are simultaneously stimulated, and depending on the predominance of one or another of them, the sensation will shift towards one of the main colors. Normal color perception is called normal trichromasia, and people with normal color vision are called normal trichromas. At simultaneous irritation of all three types of cone elements of a retina there is a feeling of white color. This is the basis of an experiment with mixing colors.

Procedure: If the circle, divided into sectors, each of which is painted in the corresponding color of the spectrum, rotates around the axis, there is a feeling of white (gray).
Results: _____
_____
_____
_____

Practical work 25. Research of color vision by means of polychromatic tables.

Purpose: to investigate color vision using polychromatic tables.
Materials and equipment: polychromatic tables, ophthalmic screen.
The object of research: human.

Procedure: *Polychromatic tables of Dr. EB Rabkin are intended for differential diagnosis of pathologies of color vision. In these tables on the background of spots of one color there are spots of another color, but the same brightness, saturation, as those that make up the image of a letter or number.*

1. The subject closes one eye with the screen and at a distance of 1 m in front of him is shown consistently all the tables.
2. The subject must report which figure or figure he sees.
3. The researcher must keep a record of all answers according to the table number. Having determined color vision with one eye, proceed to the definition with the other eye.
4. Compare the obtained data. Adequate responses of the subject indicate normal color vision. In violation of the latter, the subject is unable to distinguish numbers or letters.

Results: _____
_____
_____
_____
_____

Practical work 26. Pupil reflex.

Purpose: to investigate the pupillary reflex in humans.
Materials and equipment: ophthalmic screen.
The object of research: human.

Procedure:

1. The subject sits facing the window, closes his eyes with his hand.
2. Alternately, close the second eye of the subject with an ophthalmic screen, then open it.
3. Observe the change in pupil size.

Results: Draw a diagram of the reflex arc of the pupillary reflex.

Conclusions: indicate which department of the CNS is responsible for the implementation of the studied reflex. _____
_____
_____
_____
_____
_____

Practical work 27. Determination of hearing acuity.

Purpose: to investigate the definition of hearing acuity.
The object of research: human.

Procedure:

1. The subject sits at a distance of 6 m from the experimenter, covers one ear with his palm.
2. The experimenter calls whispers words with solid consonants (or numbers).
3. The subject repeats the heard words.
4. If the subject does not hear the words, then reduce the distance to the experimenter by 1 m and closer. The experiment is repeated for the second ear.

Results: _____
_____
_____
_____

Practical work 28. Research of air and bone conductivity of sound.

Air conduction of sounds is a normal physiological process, and bone conduction (through the bones of the skull) is a concomitant process and is of secondary importance for obtaining sound information. Normally, the ratio between the duration of air and bone conduction is 2 to 1. When the sound-conducting apparatus is damaged, the sound of the tuning fork is better heard through the bone.
Purpose: to investigate and compare air and bone conduction of sounds.
Materials and equipment: tuning forks, stopwatches.
The object of research: human.

Procedure:

1. The subject sits down on a chair. Attach the sounding tuning fork to the papillary process with your foot.
2. Record the time during which the subject hears the sound of the tuning fork. This is the duration of bone conduction of sounds.

3. As soon as the sound disappears, transfer the tuning fork to the ear and place at a distance of 0.5 cm from the external auditory canal.
4. Record the time during which the subject hears the sound of the tuning fork. This is the duration of the air conductivity of sounds.
5. To avoid adaptation of the auditory analyzer, during the examination the tuning fork is removed from the ear (up to 50 cm), then again brought closer to it. The tuning fork must be held by the leg without touching its branch, so as not to dampen the amplitude of its oscillations.
6. Note the time during which the subject hears the tuning fork (128 and 512 Hz) in air and bone conduction.

Results:

Ear	*Time of tuning fork, sec*	
	Bone conductivity	*Air conductivity*
	Tuning fork 128 Hz	
Left		
Right		
	Tuning fork 512 Hz	
Left		
Right		

Conclusions: draw a conclusion about the advantages of air conduction over bone and the sensitivity of the hearing aid to sounds of different frequencies _____

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_____
_____

Topic. Higher nervous activity. Physiological bases of behavior.

Practical work 29. Determination of the leading part of the body and the dominant hemisphere.

Purpose: to compile an individual lateral profile - to determine the dominant hemisphere of the brain and the leading part of the body.

Materials and equipment: ballpoint pen, sheet of paper.

The object of research: human.

Individual lateral profile (profile of lateral organization) - an individual combination of functional asymmetry of the hemispheres, motor and sensory asymmetry. Individual lateral profile of a person includes: functional asymmetry of the cerebral hemispheres, motor (arms, legs, face, body); sensory (sight, hearing, touch, smell, taste) asymmetry.

Functional asymmetry of the brain is a complex property of the brain that reflects the difference in the distribution of neuropsychiatric functions between its right and left hemispheres. The

formation and development of this division occurs at an early age under the influence of a complex of biological and sociocultural factors. Functional asymmetry of the hemispheres is one of the reasons for the existence of a certain structure of the psyche in humans. Simplifying the scheme of the individual profile of the functional asymmetry of the hemispheres, we distinguish three main types of brain organization: left hemisphere, right hemisphere and isosceles. Motor asymmetry - a set of signs of inequality of functions of hands, feet, halves of the torso and face in the formation of general motor behavior and its expressiveness. Leading among motor asymmetries is considered manual. Options for asymmetry of the hands: the predominant advantage of the right hand (right hand), left hand (left hand) or the same advantage of both right and left hand (ambidexterity).

Procedure:

1. Take sheets of paper to do some of the work. After passing each task, mark the result by writing it in the appropriate table at the end of the work.
2. Interweaving of fingers. Put your hands together and intertwine your fingers. Note the thumb of which hand was on top. If the left, then mark the letter "R", if the right hand - the letter "L".
3. Rosenbach's test. Take a pencil with your pointed end up in your outstretched hand and hold it upright at eye level. Look at the tip of the pencil as if "aiming". Close one eye first, then the other. When you close which eye, the image shifts more? If when closing the right eye, then write the letter "L" in the table, if the left - "R". If the image is shifted the same, then write "zero".
4. Napoleon's pose. Stand up and cross your arms over your chest. Which hand's brush is on top? If the brush of the left hand - write "R", if the right - "L".
5. Applause. Clap your hands and pay attention to which hand was on top of you. If the left palm - write the letter "R", if the right - the letter "L".
6. Put your foot on your foot. Sit with your foot on your leg. Which leg was on top? If right - write the letter "L", if left - the letter "R".
7. Wink. What eye did you wink at? If the right - "L", the left - "R".
8. Rotation. Get to your feet and rotate slightly around its axis. Which way did you turn? Counterclockwise - "L", clockwise - "R".
9. Strokes. Take a sheet of paper. Now with each hand, not counting, draw in a row a few vertical strokes. Then count the strokes. With which hand did you draw more strokes? If left, mark the letter "R", if right - the letter "L". If the number of lines is the same, then write "zero".
10. Circle. Use your hand to draw a circle on the sheet and finish it with an arrow. If the line is counterclockwise - write "L", clockwise - "R".
11. Count the total number of marks "L" and "R" in the table.
12. Make a calculation according to the formula: (Elp - Erp: 9) x 100%,
    where Elp - the number of marks "L", Erp - the number of marks "R", 9 - the number of tests.

Results:

1.	Intertwining fingers	
2.	Rosenbach's test	
3.	Napoleon's pose	
4.	Put your foot on your foot	
5.	Applause	
6.	Wink.	
7.	Rotation	
8.	Strokes	
9.	Circle	
Total number	**L =**	**R =**

(_____ — _____ : 9) x 100% = _____

Calculate the result:
More than 30% – complete dominance of the left hemisphere.
From 10% to 30% – incomplete dominance of the left hemisphere.
From -10% to + 10% – incomplete dominance of the right hemisphere.
More than -10% – complete dominance of the right hemisphere.
Conclusions: _____
_____
_____
_____
_____

Practical work 30. Research of a condition of short-term visual memory

Objective: To study the state of short-term visual memory.
The object of research: human.
Procedure:
The subject is offered 5 tests (tasks) in turn, each of which requires careful study for a certain amount of time. Then the test is taken away, and the subject on memory reproduces in the notebook the information earlier offered to it. After performing each test, it is necessary to calculate the memory performance, the amount of memory recognition and playback by the formula.

The amount of correctly reproduced information: The amount of information offered x 100%

Test 1. For 40 seconds you need to memorize the following 20 words and their serial numbers, then memorize them:

1) Ukrainian	6) love	11) oil	16) adjective
2) economics	7) scissors	12) paper	17) breakthrough
3) porridge	8) conscience	13) cake	18) soldiers
4) tattoo	9) logic	14) clay	19) candle
5) neuron	10) dictionary	15) standard	20) strawberries

Results: Perform the calculation according to the formula and draw conclusions
_____
_____
_____
_____

Test 2. For 40 seconds you need to memorize the following 20 numbers and their serial numbers, then memorize them:

1) 33	6) 12	11) 99	16) 18
2) 46	7) 86	12) 5	17) 73
3) 12	8) 19	13) 12	18) 17
4) 87	9) 52	14) 83	19) 54
5) 23	10) 22	15) 56	20) 47

Results: Perform the calculation according to the formula and draw conclusions _____
_____
_____
_____
_____

Test 3. Read the text for 60 seconds. It is highlighted in bold and numbered 10 main ideas. Try to play them, keeping the specified sequence.
In 1912, a catastrophe occurred in the Atlantic Ocean. ***The huge passenger ship "Titanic***", which was the first flight from Europe to America, ***collided*** in a fog with a floating ***iceberg*** 1), ***got a hole and began to sink***. 2) "Lower the boats!" the captain commanded. But the boats were

not enough. 3) Only half of the passengers were enough. ***"Women and children to the stairs, men - to put on lifebelts",*** - the second team sounded. The men silently walked away from the board. The steamer slowly ***plunged into the dark cold water***. 5) Here began landing in the last boat. 6) And suddenly a man with ***a face distorted by fear rushed to the stairs***. 7) Pushing women and ***children, he tried to jump into the boat. 8) There was a click - the captain fired from a pistol***. 9) ***The coward fell to the deck dead***. 10) But no one looked in his direction ..

Results: _____

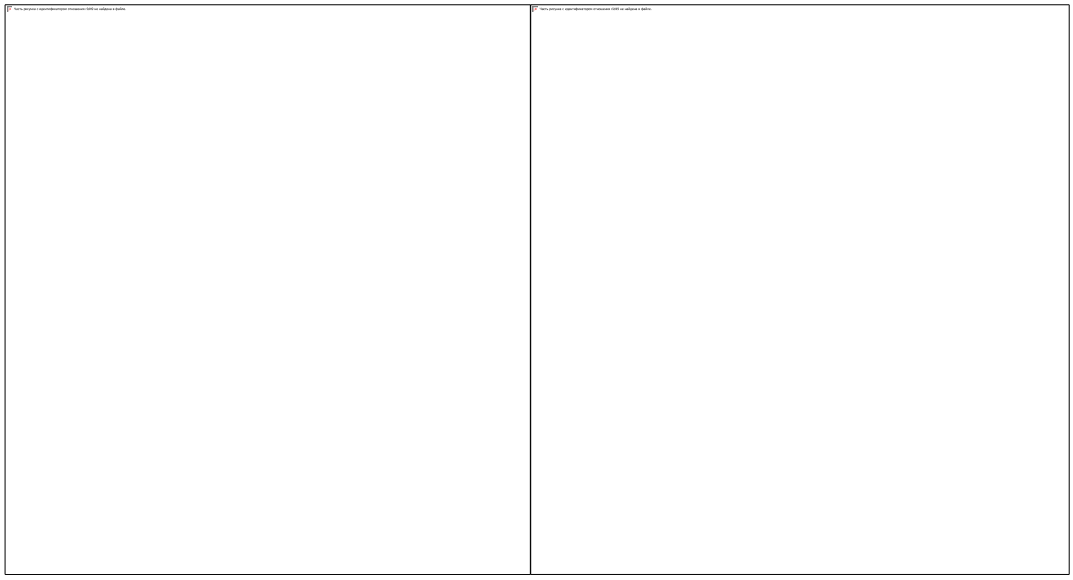
_____

_____

_____

_____

Test 4. Determining the amount of recognition memory. For 20 seconds, consider and memorize the figures in Picture 1, then closing the picture, find these figures among those shown in Picture 2.



Results: _____

_____

_____

_____

Practical work 31. Determination of the type of human GNI by the method of Belov (1971).

Purpose: to master the method of determining temperament by the method of A. Belov.

Materials and equipment: questionnaire to determine temperament by A. Belov test, notebook, pen.

Temperament is an innate stable property of the human psyche, one of the most important structural units of the psychodynamic organization of mental activity, which determines a person's reaction to other people and to the events that occur with it. From a physiological point of view, temperament is due to the type of higher nervous activity of man, which affects the way a person interacts with the outside world. People with pronounced traits of a certain temperament are not so common, most often people have a mixed temperament in different combinations. But the predominance of certain traits makes it possible to attribute a person's temperament to a particular type:

- Choleric – fast, impulsive, unbalanced, prone to sudden mood swings, emotional outbursts. Choleric has a huge capacity for work.
- Phlegmatic – slow, difficult to switch from one activity to another, stable and constant aspirations and moods, stingy on the expression of emotions.

- Sanguine – mobile, lively, easily fails, seeks to change impressions. Has expressive facial expressions. Productive at work when she is interested in him.
- Melancholic – restrained, vulnerable, vulnerable, prone to constant experience of even minor events, shy.

Procedure:

1. Divide a sheet of paper into 4 parts and mark each according to the name of temperament.
2. Subjects are offered 20 qualities that characterize a particular temperament. The subject in the appropriate column puts a sign "+", if it is characterized by one or another trait inherent in the appropriate type of temperament.

You are ***choleric*** if you have:
1) restlessness, fussiness; 2) incontinence, inflammation; 3) impatience; 4) sharpness and straightforwardness in relations with people; 5) determination and initiative; 6) stubbornness; 7) agility in the dispute; 8) intermittent diligence; 9) propensity to risk; 10) indomitability; 11) knowledge of fast, emotional language with confusion of words; 12) imbalance; 13) aggression; 14) intolerance of shortcomings; 15) expressive facial expressions; 16) the ability to act quickly and decide; 17) relentlessly strive for something new; 18) possession of sharp movements; 19) persistence in achieving the goal; 20) tendency to sudden mood swings.
You are a ***sanguine*** if:
1) you are cheerful and upbeat; 2) energetic and active; 3) often do not bring the case to an end; 4) tend to overestimate themselves; 5) able to quickly grasp the new; 6) unstable in interests and inclinations; 7) easily experience failures and troubles; 8) easily adapt to different circumstances; 9) enthusiastically undertake any new business; 10) you quickly lose interest if the case ceases to interest you; 11) quickly join a new job and quickly switch from one job to another; 12) durable and able to work; 13) has a tendency to the monotony of everyday hard work; 14) sociable and responsive, do not feel awkward with people new to you; 15) have a loud, fast, clear language, accompanied by gestures, expressive facial expressions; 16) keep self-control in an unexpectedly difficult situation; 17) always have a cheerful mood; 18) fall asleep quickly and wake up; 19) often uncollected, show haste in decisions; 20) tend sometimes not to delve into the essence of the task, to be distracted.
You are ***phlegmatic*** if:
1) calm and cold-blooded; 2) consistent and meticulous in matters; 3) careful and prudent; 4) know how to wait; 5) silent and do not like to talk in vain; 6) have a calm, even language, with stops, without pronounced emotions, gestures and facial expressions; 7) restrained and patient; 8) bring the case to an end; 9) do not waste energy; 10) adhere to the developed daily routine at home and at work; 11) easily restrain impulses; 12) insensitive to praise and encouragement; 13) are not angry, show a condescending attitude to the "pins" to your address; 14) constant in their relations and interests; 15) slowly get involved in work and slowly switch from one case to another; 16) show the same attitude to all; 17) show neatness and order in everything; 18) with difficulty adapt to the new situation; 19) have endurance; 20) somewhat slow.
You are ***melancholic*** if: 1) you are shy; 2) get confused in a new situation; 3) it is difficult to establish contact with strangers; 4) do not believe in your own strength; 5) easily withstand loneliness; 6) feel depressed and confused by failures; 7) tend to "immerse themselves"; 8) get tired quickly; 9) have a quiet language; 10) unconsciously adjust to the character of the interlocutor; 11) vulnerable to tears; 12) extremely susceptible to approval and condemnation; 13) make high demands on yourself and others; 14) prone to suspicion and obsessive thoughts; 15) painfully sensitive and easily injured; 16) excessively offensive; 17) unfriendly, do not share your thoughts with anyone; 18) inactive and timid; 19) compliant, submissive; 20) seek to evoke sympathy and help from others.

3. Count the total number of "+" in each column. If the number of positive answers in the column, of one type or another is 16-20 - it means that the subject has pronounced features of this type of temperament. If the positive answers are 11-15 - the qualities of this

temperament are inherent to a large extent. If 6-10, then the qualities of this type of temperament are inherent only to a certain extent.

4. Determine the formula of your temperament:

$$FT = (Ch\frac{Ch}{A} \times 100\%) + \left(S\frac{As}{A} \times 100\%\right) + \left(Ph\frac{APh}{A} \times 100\%\right) + \left(M\frac{Am}{A} \times 100\%\right);$$

where, FT - temperament formula;
Ch - choleric temperament;
S - sanguine temperament;
Ph - phlegmatic temperament;
M - melancholic temperament;
A - the total number of advantages for all types;
Ach - the number of pluses in the "choleric passport";
As - the number of pluses in the "sanguine passport";
Aph - the number of pluses in the "phlegmatic passport";
Am - the number of pluses in the "passport of a melancholic".

For example, in the final form, the formula of temperament takes the form:
FT = 35% Ch + 30% S + 14% Ph + 21% M;

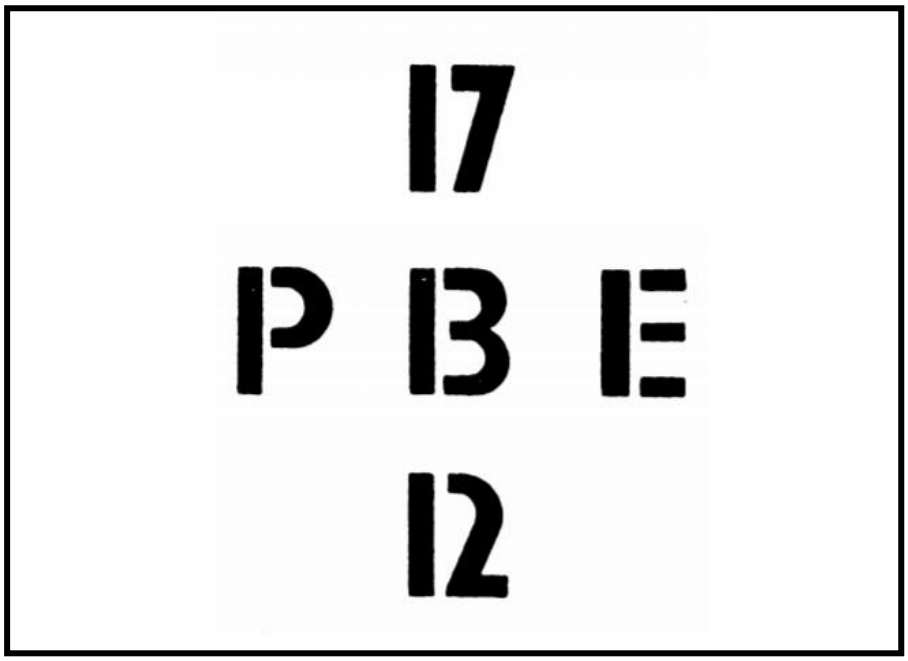
This means that this temperament is 35% choleric, 30% sanguine, 14% phlegmatic, and 21% melancholic.
If the relative result of the number of positive responses from any type of temperament is 40% and above - this type of temperament is dominant,
if 30-39% - the qualities of this type are quite pronounced;
if 20-29% - the qualities of this type are expressed on average,
if 10-29% - the qualities of this temperament are incompletely expressed.

Conclusions: Analyze the data obtained, draw conclusions. _____
_____
_____
_____

Practical work 32. Determining the impact of the goal on the result of human activity

Purpose: to identify the dependence of the result of the activity on the goal.
Materials and equipment: table "letter-number".
Procedure:

1. To work you need to work in pairs with another student.
2. For a short time (1-2 s.) Both show the table "letter-number". The first student in the working pair must memorize the signs (figures) located in the table horizontally. The second student in the working pair must memorize the characters in the table vertically.
3. After completing the task, the students find that, depending on the goal, the same central sign in the table was perceived differently by them.
4. The table is shown again and students explain the results of the experiment.
5. Analyze the data obtained, draw conclusions.



Conclusions: analyze the data obtained, draw conclusions. Explain how the goal affects performance. _____

Module 5. Physiology of the blood system

The general analysis of blood (GAB) is the analysis allowing to estimate the content of hemoglobin, quantity of erythrocytes, color indicator, quantity of leukocytes, thrombocytes. It allows to consider the leukogram and erythrocyte sedimentation rate (ESR). GAB - is one of the most widespread types of researches in clinical practice as at carrying out comprehensive inspection of patients the general picture of blood is demanded, first of all. The share of GAB is about a third of all laboratory tests, its structure includes a quantitative calculation and description of the morphology of the formed elements of the blood. Modern laboratories use automatic hematological analyzers for analysis - devices for determining the qualitative and quantitative indicators of blood. However, in medical institutions on the territory of Ukraine the practice of using methods of microscopic examinations in determining GAB is still preserved. When conducting hematological experiments it is necessary to strictly follow the valid in Ukraine order

of the Ministry of Health of the USSR № 408 from 12.07.1989 "On measures to reduce the incidence of viral hepatitis in the country."

Practical work 33. Collection of capillary blood.

Purpose: to master the technique of capillary blood collection.

Materials and equipment: rubber gloves, 96% alcohol or antiseptic solution, sterile cotton wool, waste material tray, 5% sodium citrate solution, individual plastic tubes, capillary blood collection system, Panchenkov capillary, 3% NaCl solution, 3% acetic acid solution acids.

Procedure: Blood sampling is done in rubber gloves, following the rules of asepsis.

The gloves are treated with a 96% solution of alcohol or other antiseptic before each blood sample. Blood for clinical analysis is taken on an empty stomach from the ring finger of the left hand. If it is not possible to take a blood sample from the specified finger, it is performed from the index or middle finger. The skin of the finger is treated with a sterile cotton swab soaked in a 96% solution of alcohol or other antiseptic, and then wiped with a dry sterile cotton ball. Disposable sterile steel scarifiers are used to pierce the finger. With the left hand, the person taking the blood takes the finger of the patient's free hand, then lightly massage it, pinching the upper phalanx of the finger with the index and thumbs (Pic. A). With the other hand, treat the inner surface of the patient's finger with a cotton ball (gauze) soaked in antiseptic. Dry the finger surface with a dry sterile napkin (cotton ball). Place the used napkin (ball) in the waste material tray. After the skin dries, take a scarifier and make a quick puncture of the skin (Pic. B.).

Place the used scarifier in the container for used scarifiers. Wipe the first drops of blood with a dry sterile cloth (cotton ball), as it contains tissue fluid. Place the used napkin (ball) in the tray for the used material. Here are some ways to draw blood:

a) blood from a finger drips on an individual slide;
b) blood is collected in individual plastic tubes with a small amount of Trilon B;
c) blood is collected by individual sterile microcapillaries (Pic. C.). The sharp end of the microcapillary should be immersed in a drop of blood, and the opposite end should be tilted down slightly. Blood fills the capillary by gravity. At the same time it is necessary to watch that in a capillary there were no air bubbles. The amount of blood taken should match the label on the test tube.

The collected blood is distributed as follows:

1. on a small drop of blood (diameter 0.2-0.3 mm) is applied to 2 slides and with the help of ground glass prepare blood smears.
2. 100 sections of blood capillary Panchenkov added to a test tube with 5% sodium citrate solution (to determine ESR).
3. 0.02 mm of blood capillary Sali is added to test tubes with 3% NaCl solution (to determine erythrocytes), with 3% acetic acid solution (to determine leukocytes), with a transforming solution (to determine) hemoglobin. Press a napkin (cotton ball) with antiseptic solution to the puncture site. Ask to hold a napkin (cotton ball) in the puncture site for 2-3 minutes.

Practical work 34. Hemolysis and its main varieties.

Purpose: to study the main types of hemolysis and the causes and mechanisms of their occurrence.

Materials and equipment: tripod, 3 test tubes, 0.9% saline distilled water, ammonia solution (NH4OH).

Procedure:

1. Install dry clean test tubes in a tripod.
2. Number the tubes in the tripod.
3. Pour 5 ml into the first test tube. saline, in the second pour 5 ml of saline and 5 drops of ammonia (NH4OH), in the third pour 5 ml of distilled water.
4. Add 10 drops of blood to each test tube and mix gently.
5. Evaluate the result in 30 minutes.

6. Enter the observation data in the table.

Results:

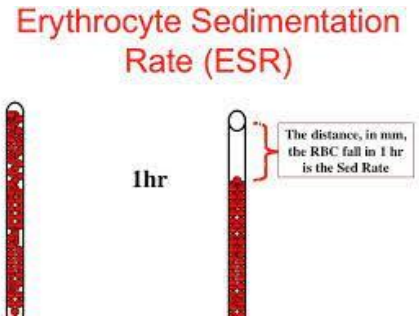
№ test tubes	The contents of the test tube	The presence of hemolysis "+" Or "-"
1	Saline solution 5 ml	
2	Saline solution 5 ml + 5 drops of ammonia	
3	Distilled water	

Conclusions: draw a conclusion about the mechanisms of hemolysis in each case, which took place according to the results of the experiment.

Practical work 35. Determination of erythrocyte sedimentation rate (ESR)

Purpose: to get acquainted with the technique of determining the erythrocyte sedimentation rate (ESR).

Materials and equipment: Panchekov's device, watch glass, sodium citrate solution, pipette, capillary.



Procedure: The device ESR-meter PR-3 (Panchenkov's device) (see fig. On the right) is a support in which special capillaries are fixed in strictly vertical position. They are graduated in mm. The label "0" is located at a distance of 100 mm from the lower end, and the label "B" (blood) is located at the level of "0", the label "R" (reagent) - at the level of 50 mm. In this and subsequent work when collecting blood and reagents use a rubber bulb with a tube of appropriate capillary or pipette diameter.

1. Rinse the capillary with 5% sodium citrate solutions (prevents blood clotting).
2. Gather sodium citrate to the mark "R" and pour it on a watch glass. In the same capillary to collect blood twice to a mark "B".
3. Mix both portions of blood on a watch glass with the available solution of sodium citrate in a ratio of 4:1.
4. Dial the mixture in the capillary to the mark "0" and place it strictly vertically in the tripod.
5. In an hour to fix height in mm of the formed column of plasma in a capillary. This will be the ESR, expressed in mm / h.

ESR cannot be calculated by measuring the amount of plasma formed in 30 min and multiplying the value obtained by 2, as the process of erythrocyte sedimentation occurs unevenly over time.

Results: enter the results in the table.

Sex	**ESR**	
	The value obtained	Norma
man	mm / hour	mm / hour
woman	mm / hour	mm / hour

Conclusions: draw a conclusion about the ESR of the studied blood. Indicate what factors determine and affect ESR. Indicate the main physiological and pathological conditions in which ESR can change significantly. _____

Practical work 36. Study of the content of hemoglobin in the blood by the method of Sally.

Purpose: to get acquainted with the technique of the historical method of determining the content of hemoglobin in the blood by the method of Sally.

Materials and equipment: Sally hemometer, filter paper, 0.1 N hydrochloric acid solution, distilled water, glass rod.

Many methods have been developed to measure hemoglobin in the blood, based on the study of a stained iron-porphyrin complex - heme. One of them is the Sally method. This is the determination of hemoglobin by colorimetric method, based on the following principle: if the test solution is diluted to the same color as the standard solution, the concentration of solutes in both solutions will be the same, and the amount of substances will be given as their volumes. Knowing the amount of substance in the standard solution (16.67 g% hemoglobin, ie 16.67 g per 100 ml), it is easy to calculate its content in the test. The main errors of the Sally method, until recently used in medical practice, are as follows: the effect of plasma proteins on the reaction between hemoglobin and hydrochloric acid, the effect of bilirubin, the color change over time of standard hematin solutions. It gives a number of objective (gradual enhancement of color) and subjective (visual comparison of color) errors. The total error of the Sally method is about 30%.

Procedure: Sally's hemometer (pic.) Represents a support, with three test tubes of identical diameter inserted into it. The two extremes are sealed on top and contain a 1% solution of hematin hydrochloric acid in glycerol containing 16.67 g% hemoglobin. The average is graduated in relative percentages (division from 0 to 140), or gram-percent (division from 0 to 23) and is open. A 20 mm 3 blood pipette ("20" mark), a regular pipette, and a glass rod are added to the device. In the middle tube pour 0.1 N HCl solution to the mark "5". Then, using a graduated pipette, take 20 mm 3 (μl) of blood, and wipe the tip of the pipette with filter paper, blow the blood to the bottom of the tube so that the upper layer of hydrochloric acid was unstained. Without removing the pipette, rinse it with hydrochloric acid from the top layer. After that, the contents of the tube are mixed by tapping its end, and left to stand for 5-10 minutes (the time required for complete conversion of hemoglobin into hematin hydrochloric acid). Then distilled water is added dropwise to the solution (the solution is stirred with a glass rod) until the color of the resulting solution matches the color of the standard. The figure at the level of the lower meniscus will show the content of hemoglobin in the test blood in gram percent (relative percent).

Knowing the value expressed in grams, you can calculate the relative content of hemoglobin in the test blood. [Example: Equality of colors is achieved at 15 g% hemoglobin. Therefore: 15 g% is taken as X, 16.7 g% is taken as 100%. Hence X = (100% '15 g%) / 16.7 g%, where X is the relative hemoglobin content, in%].

In the case of calibration of the tube in relative percentages, it is necessary to calculate the amount of hemoglobin in gram percent. [Example: Equality of colors is achieved at 80. Therefore, the test blood contains 80% of hemoglobin compared to the standard (16.7 mg%), taken as 100%. Formula for calculation: X = (16.7 g% '80%) / 100%, where X is the amount of hemoglobin in the blood, in g%].

Conclusions: draw conclusions about the content of hemoglobin in the blood and its gender differences. _____

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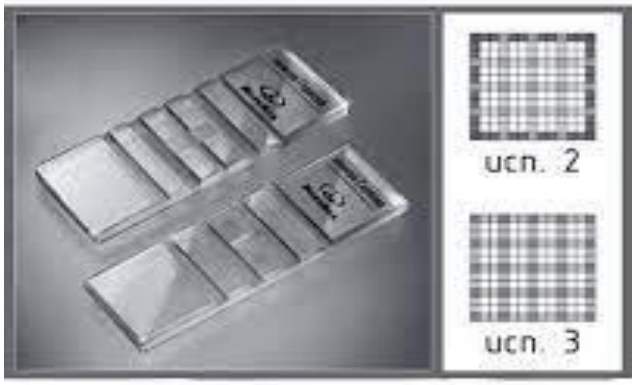
Practical work 37. Calculation of formed elements of blood by means of Goryaev's camera.

Purpose: to get acquainted with the technique of counting the formed elements of blood with the help of Goryaev's camera.



Procedure: Goryaev's chamber - a device designed to count the number of cells in a given volume of fluid. It is usually used to determine the number of formed elements in a blood sample. With the help of Goryaev's camera it is also possible to determine the magnification and size of the field of view of an optical microscope. Proposed by the Russian physician, professor of Kazan University NK Goryaev (1875 - 1943).

Goryaev's chamber is a transparent parallelepiped (slide), with grooves and a microscopic grid. There are four grooves in the middle of the chamber. Narrow areas are formed between them. The middle platform is lower than the lateral ones by 0.1 mm and divided in half by a transverse groove. On both sides of it there are grids, drawing on glass. When superimposed on the side platforms of the cover glass above the grid, a chamber with a depth of 0.1 mm is formed. Goryaev's grid consists of 225 large squares. Every third square is divided into 16 small squares. Such large squares, divided into small ones, are in a grid of 25. The side of a small square is 1/20 mm, the area is 1/400 mm^2, and the volume of space above a small square is 1/400 mm^2 × 1/10 mm = 1/4000 mm^3.

Before counting the shaped elements in Goryaev's chamber, whole blood must be diluted beforehand. To do this, use a special device - a melange., Which has the form of a glass pipette with an ampoule-like extension. In the ampoule is a glass bead for mixing blood. The erythrocyte melange beads have a red bead, and the leukocyte melange beads have a white bead. On a capillary two marks "0,5" and "1,0" are put, and the third label stands for expansion: on melangerers for erythrocytes - "101", for leukocytes - "11". If in a melange for erythrocytes type blood to a mark "1,0" and then pour diluting liquid, bringing the total volume to "101", blood is diluted 100 times. To dilute 200 times the blood should be collected in a melange to the mark "0.5".

Similarly, in the melanger for leukocytes receive a dilution of blood 10 and 20 times. Hypertonic saline solution of 3% in which erythrocytes shrink is used for blood dilution when counting erythrocytes. When counting leukocytes use a 3% solution of acetic acid, methylene blue. Acetic acid destroys the membranes of erythrocytes, while they become invisible and do not interfere with the counting of leukocytes. Methylene blue colors the nuclei of the latter.

The blood of the subject with the help of a pear to collect in the capillary of the erythrocyte melange to the mark "0.5". Wipe the end and walls of the capillary with filter paper and quickly transfer it to a solution for blood dilution - 3% physical solution, which is typed to the mark

"101". Similarly, fill the leukocyte melange - blood to the mark "0.5", and a solution of 3% acetic acid with methylene blue to the mark "11".
In a horizontal position, gently remove the rubber tube from the melange and clamp both ends with your thumb and forefinger and shake it for a minute. Then leave the melange for 10 minutes in a horizontal position.
Erythrocyte count. Normally, the number of erythrocytes in men is 4 - $5.1.10^{12}$, in women - 3.9 - $4.7.10^{12}$
Materials and equipment: microscope, Goryaev's chamber, cover glass, mixer for erythrocytes, 3% sodium chloride solution, 96% alcohol, 2% alcohol iodine solution, cotton wool, rubber pear.
Procedure:

1. Prepare Goryaev's chamber for work: degrease with alcohol and wipe the chamber and cover glass dry; grind the cover glass to the chamber until Newton's rings appear; find under a low magnification microscope grid.
2. 2. Prepare blood for work: put a rubber bulb on the upper hole of the faucet; to the mark of 0.5 to collect blood, remove the excess blood from the capillary spout with a cotton swab; not releasing blood from a capillary, to a mark 101 to type 3% solution of sodium chloride; gently shaking the mixer, mix the solution with the blood in its ampoule (there is a small red bead in it to facilitate mixing). The blood will be diluted 200 times.
3. Fill the chamber with blood: blow the first two drops of solution coming from the capillary into cotton wool; place the next drops of ampoule solution in the chamber. To do this, place the tip of the melange on the edge of the chamber near the cover glass and lightly press on the pear. The solution will go under the cover glass into the chamber and fill it. Wait 1-2 minutes for the erythrocytes to settle to the bottom of the chamber.
4. Count the number of erythrocytes: find the number of erythrocytes in 5 large squares of the grid diagonally. When counting erythrocytes, remember Burker's rule: in small squares, count the cells that are in the middle of the grid square, as well as on its upper and left sides. This is necessary in order not to count twice the erythrocytes contained on the sides of adjacent squares;
5. Calculate the number of erythrocytes in 1 μl of blood by the formula:

E = (a x 4000 x 200) / 1 x5x16

where E is the number of erythrocytes in 1 μl;
a - the number of erythrocytes in 5 large squares of the grid;
5 - the number of large squares;
16 - the number of small squares in one large;
200 - the degree of blood dilution;
1/4000 mm^3 - volume of 1 small square.

To calculate, you can use a simplified formula: ***E = a x 10^4***.

6. Find the number of erythrocytes in 1 liter of blood, for this E x 10^6.

The main sources of errors in the calculation of erythrocytes are: inaccurate blood pipetting; the formation of a clot that absorbs part of the cells and underestimate the result of the study; insufficient mixing of the contents of the test tube before filling the chamber. Improper preparation of the chamber: insufficient grinding of cover glasses; uneven filling of the chamber; formation of air bubbles; counting erythrocytes immediately after filling the chamber, without waiting for 1 minute; counting less than required by the method, the number of squares.
Results:

Blood cells	*Dates*	*Norma*
Erythrocytes	Units/l	Units/l

Conclusions: draw a conclusion about the number of erythrocytes in the studied blood and the ratio of the obtained data to the norm_____
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Leukocyte count.

Materials and equipment : microscope, illuminator, Goryaev's chamber, cover glass, mixer for leukocytes, tripod with test tube, 3% acetic acid solution, 96% ethyl alcohol, cotton wool, rubber pear.

Procedure:

1. Prepare Gorev's chamber for work: degrease with alcohol and wipe dry the chamber and cover glass; grind the cover glass to the chamber until Newton's rings appear; find under a low magnification microscope grid.
2. Prepare blood for work: put a rubber bulb on the upper hole of the faucet; to the mark of 0.5 to collect blood, remove the excess blood from the capillary spout with a cotton swab; without releasing blood from the capillary, to mark 11 to type 3% acetic acid solution; gently shaking the mixer, mix the solution with the blood in its ampoule (there is a small transparent bead in it to facilitate mixing). The blood will be diluted 20 times.
3. Fill the chamber with blood: the first two drops of solution coming from the capillary of the melange, blow on cotton wool; place the next drops of ampoule solution in the chamber. To do this, place the tip of the melange on the edge of the chamber near the cover glass and lightly press on the pear. The solution will go under the cover glass into the chamber and fill it. Wait 1-2 minutes for the leukocytes to settle to the bottom of the chamber.
4. Count the number of erythrocytes: find the number of leukocytes in 100 large, uncharted squares. For accuracy, the calculation should be performed over the entire plane of the grid, starting from the upper left edge; calculate the number of leukocytes in 1 μl of blood by the formula:

   L = (a x 4000 x 20) / 1 x 100 x 16,

   where L is the number of leukocytes in 1 μl;

   a - the number of leukocytes in 100 large squares of the grid;

   100 - the number of large squares;

   16 - the number of small squares;

   20 - the degree of blood dilution;

   1/4000 mm^3 - volume of 1 small square.

To calculate, you can use a simplified formula: L = (a: 2) x 10^2.

5. Find the number of leukocytes in 1 liter of blood, for this L x 10^6.

Results:

Blood cells	*Dates*	*Norma*
Leukocytes	Units/l	Units/l

Conclusions: make a conclusion about the number of leukocytes in the studied blood and the ratio of the obtained data to the norm.

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Practical work 38. Determination of blood color index.

Purpose: to get acquainted with the technique of determining the color index of blood.
Materials and equipment: blood for research
Procedure:
Blood color index - a parameter of blood testing, which expresses the relative content of hemoglobin in one erythrocyte, expressed in extrasystemic units. It shows the ratio of the relative hemoglobin content to the relative number of erythrocytes in the test blood sample.
The relative content of hemoglobin is expressed in% of the conditional norm - 16.7 g / l, which was taken as 100%. The relative number of erythrocytes is also expressed in%, dividing the number found in the test blood by the number of erythrocytes in the blood of a healthy person, followed by multiplication by 100. For example, at $4.2x10^{12}$ / l erythrocytes in men, the relative number of erythrocytes = (4.2x100) / 5.0 = 84%. If the relative hemoglobin content is 70% then CP = 70/84 = 0.83. In adults, CPU = 0.9-1.1. In adolescents and children CP = 0.75-0.85.
Calculate the value of CPU for the test blood sample. Write down the result.
Results: _____
_____
_____
Conclusions: Compare the results with the norm. _____
_____
_____
_____
_____

Practical work 39. Calculation of oxygen capacity of blood (KEK).

Purpose: to get acquainted with the technique of determining the oxygen capacity of the blood (OCB).
Procedure:
Oxygen capacity of blood - the amount of oxygen that can be bound to the blood at its full saturation; expressed as a percentage of volume (% vol.); depends on the concentration of hemoglobin in the blood.
Determining the oxygen capacity of the blood is important for characterizing the respiratory function of the blood.
Given that 1 g of hemoglobin is able to attach 1.34 ml of oxygen (Hüftner's number), the oxygen capacity of the blood (OCB) is calculated by the formula:

OCB = 1.34 x Hb content in the blood (g / l)

At normal hemoglobin content OCB is: 167.5 - 174.2 ml O2 / l - in women,

and 180.9 - 187.6 ml O2 / l - in men.

Using the data obtained in determining the hemoglobin content (Practical work 26), calculate the oxygen capacity of the studied blood.
Record the results of the calculations in the protocol. In conclusions to compare the received size with norm.
Result:

OCB = _____ x _____ = _____

Conclusions: Compare the results with the norm. _____
_____
_____
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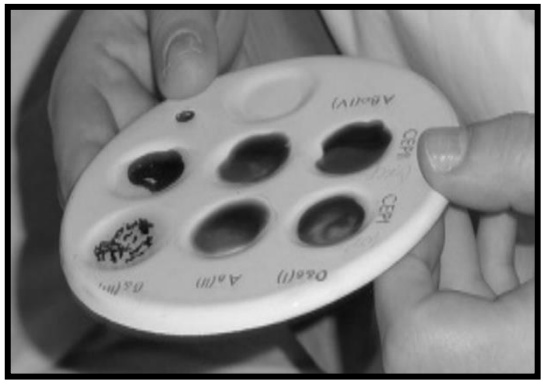
Practical work 40. Determination of blood group of the AB0 system using standard isohemagglutinating test sera.

Purpose: to get acquainted with the technique of determining blood groups of the AB0 system using standard isohemagglutinating test sera
Materials and equipment: a set of standard test sera, a tablet for determining blood groups, a set of glass rods, pipettes; blood test; rubber gloves; containers for waste material; disinfectant solutions, physical solution 0.9%.
Procedure: There are more than 20 systems of erythrocyte antigens. However, the AB0 system and the Rh system are of practical importance, as they are often the cause of severe posttransfusion complications, so they must be considered primarily in blood transfusions. The definition of blood groups is based on the agglutination reaction, ie adhesion. One method of establishing blood type is to determine blood groups by standard serum. Standard sera contain deliberately known agglutinins: groups I, II and III.
Determination of blood groups in patients in medical institutions of Ukraine is regulated by the Order of the Instruction of the Ministry of Health of Ukraine № 164 of 05.07.1999.
Standard sera for blood grouping are produced by special laboratories at the Blood Service. Serums are stored in a refrigerator at a temperature of + (6 ± 2) ° C.
Blood grouping is performed in a well-lit room at a temperature of +15 - +25 C. At low or very high temperatures, panagglutination is possible, ie agglutination with any blood (in all three drops). When using weak sera, pseudoagglutination is possible. In all doubtful cases, the determination of the blood group should be repeated, strictly following the instructions.
1. On a plate for determination of blood groups according to the designation from left to right "0", "A", "B", consistently apply one large drop (0.1 ml) of isohemagglutinating serum.
In clinical practice, to exclude any error and doubt in the results of the study, the blood group is determined (duplicated) simultaneously by two sera of the first, second and third groups from different production series.
2. Using a glass rod, apply next to the recesses (3 recesses) on a drop of test blood. A drop of blood should be 10 times smaller than a drop of serum.
3. Mark the time and with separate clean, dry glass rods for each case mix the blood with the serum in all recesses of the tablet.

4. After mixing all the drops, shake the plate, then for 1 - 2 minutes. left alone and rocked again. Observation of the reaction is carried out for at least 5 minutes, although agglutination begins within the first 10 - 30 s. Observations should be continued for up to 5 minutes, as late agglutination is possible, for example, with erythrocytes of group A2. to exclude false agglutination and to continue supervision within 5 minutes.

Evaluation of results:



The isohemagglutination reaction in each drop can be positive or negative.

In the case of a positive reaction (usually within the first 10 - 30 seconds from the beginning of mixing) in the mixture appear visible to the naked eye small red grains (agglutinates), which consist of glued erythrocytes. Small grains gradually stick together into larger grains, and sometimes into flakes of irregular shape, as a result of which the whey is completely or partially discolored.

In the case of a negative reaction, the liquid remains uniformly colored all the time (5 minutes) and no granularity (agglutinates) is observed in it.

The results of the reaction in drops with sera of the same group (two series) must coincide.

The results of reactions with sera of three groups: 0 (I), A (II) and B (III) can give four different combinations of positive and negative reactions (see table below):

1. If there is no agglutination in any of the cells, then the blood of group I (0).
2. If agglutination in the first and third cells, the blood of group II (A).
3. If agglutination in the first and second groups, the blood of group III (B).
4. If agglutination in the first, second, third cells, the blood of group IV (AB).

The results of the reaction with sera			The test blood belongs to the group
0 (I)	A (II)	B (III)	
-	-	-	0 (I)
+	-	+	A (II)
+	+	-	B (III)

All other combinations are an artifact and indicate an incorrect analysis. To rule out the error, check the blood with serum of group IV, where agglutination should not be.

Results:

The presence of agglutination	1 well	2 well	3 well

Conclusions: will draw conclusions about the group affiliation of the studied blood.

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Practical work 41. Determination of blood group of system AB0 by means of monoclonal reagents anti-A, anti-B.

Purpose: to get acquainted with the technique of determining blood groups of the AB0 system using monoclonal reagents.

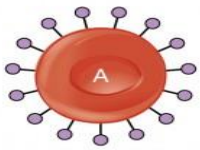
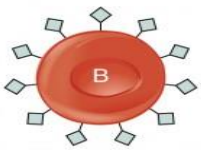
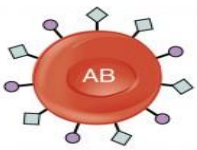
Materials and equipment: a tablet for determining blood groups, a set of glass rods, pipettes; blood test; rubber gloves; containers for waste material; a set of reagents coliclons anti-A, anti-B, Pasteur pipettes, saline.

Procedure: Determination of blood group by anti-A, anti-B super coliclons is a relatively simple method. Coliclons, ie monoclonal antibodies, are used to determine the blood group. Monoclonal antibodies (MCA) anti-A and anti-B are designed to determine human blood groups according to the AB0 system instead of standard isohemagglutinating sera.

Determination of blood groups by the AB0 system in donors and recipients by the cross method includes detection of antigens A and B in human erythrocytes using MCA anti-A and anti-B, detection of isoagglutinins a and b in serum or plasma of test blood standard erythrocytes of all groups. Monoclonal antibodies anti-A and anti-B are produced by two different hybridomas and are a dilute ascitic fluid of mice-carriers of the corresponding hybridoma, which contains specific class M immunoglobulins (IgM), directed against group-specific human A and B antigens. MCA do not have antibodies of other specificity and therefore do not cause nonspecific polyagglutination of erythrocytes. MCA anti-A and anti-B are tested by all common methods of determining blood groups - in parallel with isohemagglutinating sera AB0. The results proved the reliability of blood group determination in the case of monoclonal reagents. Avidity, ie the time of onset of the agglutination reaction, its brightness, in MCA anti-A and anti-B is much higher than in standard sera, especially in the case of weak erythrocyte antigens. Determination of blood group is carried out in a room with good lighting at a temperature of +15 - +25 C. Reagents can not be stored in the open, because in the case of drying the activity of antibodies is reduced. Do not use reagents if they contain insoluble flakes or turbidity. Each reagent uses its own labeled (anti-A or anti-B) pipette.

1. On the tablet to determine blood groups to mark anti-A, anti-B.
2. Using a pipette, apply anti-A and anti-B drops to the areas of the tablet corresponding to the marks.
3. Add one drop of blood to each sample of coliclons to be examined.
4. Observation of the course of reactions with ICA is carried out by light rocking of the plate or tablet for no more than 3 minutes. The result of the reaction in each drop can be positive or negative. A positive result is expressed in the agglutination of erythrocytes. Agglutinates are visible to the naked eye in the form of small red aggregates that quickly merge and form larger flakes up to a large agglutinate. In case of doubt, add a drop of 0.9% saline. In the case of a negative reaction, the drop remains evenly colored, no agglutinates are detected in it. Agglutination with ICA anti-A and anti-B usually occurs in the first 3 seconds.

Blood Type

	A	B	AB	O
Red Blood Cell Type				
Antibodies in Plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in Red blood Cell	 A antigen	 B antigen	 A and B antigens	None
Blood Types Compatible in an Emergency	A, O	B, O	A, B, AB, O (AB^+ is the universal recipient)	O (O is the universal donor)

Results and conclusions: describe the results of the occurrence or absence of agglutination reaction of the test blood with anti-A, anti-B monoclonal reagents. Draw conclusions about the group affiliation of the blood studied. _____

Practical work 42. Determination of rhesus affiliation using anti-D-super test reagent.

Determination of Rh factor in patients in medical institutions of Ukraine is regulated by the Order of the Instruction of the Ministry of Health of Ukraine № 164 of 05.07.1999.

Purpose: to get acquainted with the technique of determining rhesus affiliation using an anti-D-super test reagent.

Materials and equipment: a tablet for determining blood groups, a set of glass rods, pipettes; blood test; rubber gloves; containers for waste material; set of anti-D-super reagents, Pasteur pipettes, saline.

Procedure:

1. On a plate for determination of blood groups to put two drops of test reagent anti-D-super in separate wells.
2. Using a Pasteur pipette, collect the blood to be examined and place a drop of it near the test reagent - a drop of blood should be approximately 10 times smaller than a drop of test reagent).
3. Mix the blood droplets and the test reagent with a glass rod. You need to shake the tablet.
4. Observe the onset or absence of agglutination reaction for 3 minutes.

Evaluation of results:

If the agglutination reaction occurred with anti-D-super, the test blood belongs to rhesus-positive (Rh +)

If the agglutination reaction did not occur with anti-D-super, then the test blood belongs to Rhesus-negative (Rh-). If the result is negative, you need to be monitored by microscopy.

Conclusions: draw conclusions about the rhesus factor of the blood studied.

Practical work 43. Determination of blood clotting time (Mass and Margot method).

Purpose: to get acquainted with the technique of determining the time of blood clotting

Materials and equipment: Petri dish, Pasteur pipette, Vaseline oil, blood for research, 96% alcohol solution, cotton wool, scarifier.

Procedure:

1. Place a drop of Vaseline oil on a Petri dish.
2. Take a capillary blood sample in a Pasteur pipette to the mark of 20 μl.
3. Place the contents of the Pasteur pipette in a drop of Vaseline oil. This moment is the beginning of the experiment. Mark the time.
4. Every 20 seconds, immerse the end of the pipette in a drop of blood, suck it inside and blow back.
5. Count the time when the blood stops being sucked into the pipette, which indicates that blood clotting has occurred.

Results: _____
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Conclusions: _____
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Module 6. Humoral regulation of body functions

Practical work 44. Comparative characteristics of the features of nervous and humoral regulation.

Purpose: Comparative characteristics of nervous and humoral regulation

Procedure: with the help of educational materials to perform a comparative description of the features of nervous and humoral regulation.

Results:

Properties	Humoral regulation	Nervous regulation
Speed of influence on functions.		
Localization of the source of influence.		
Duration of exposure		
Effects on metabolism.		
Chemical intermediaries: a) name b) ways of transport c) mechanism of action.		

Conclusions: _____
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Practical work 45. Characteristics of factors of humoral regulation.

Purpose: To perform a comparative description of the factors of humoral regulation.
Procedure: with the help of teaching materials to perform a comparative description of the factors of humoral regulation.

Results:

	True hormones	Tissue hormones	Metabolic hormones
Places of secretion			
List of factors			

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Practical work 46. Study of pituitary hormones.

46.1. Study of thyroid-stimulating hormone.

Objective: to investigate thyroid-stimulating hormone in the blood using chemiluminescence immunoassay.

Equipment: rubber gloves, 96% alcohol or antiseptic solution, sterile cotton, waste material tray, 5% sodium citrate solution, individual plastic tubes, syringe, needle.

Procedure: Blood sampling is done in rubber gloves, observing the rules of asepsis. Gloves are treated with a 96% solution of alcohol or other antiseptic before each blood draw. The skin of the arm area is treated with a sterile cotton swab soaked in a 96% solution of alcohol or other antiseptic, and then wiped with a dry sterile cotton ball. Make a puncture and draw blood into a syringe. With the other hand, treat the puncture site with cotton wool soaked in an antiseptic. Dry the surface of the finger with a dry sterile cloth (cotton ball). Place the used napkin (ball) in the tray.

Thyroid-stimulating hormone (thyrotropin, TSH) is a reference criterion for laboratory assessment of the functional state of the thyroid gland, synthesized in the thyrotrophic cells of the adenohypophysis. It is with him that diagnostics should begin if you suspect abnormalities in the hormonal activity of the thyroid gland.
Indications for the examination: TSH screening study (recommended for newborns), detection of latent hypothyroidism (an endocrine disease due to which the level of synthesis of thyroid hormones decreases), control study for detected hypothyroidism, control study for detected diffuse toxic goiter (1.5-2 years 1-3 times a month), delayed mental and sexual development in children, cardiac arrhythmias, myopathy (a group of neuromuscular diseases, which lead to gradual muscle atrophy and degeneration).
The research method is chemiluminescence immunoassay (CLIA) - a type of kinetic method for determining ions and chemical compounds by the intensity of chemiluminescence or the sum of the glow.

Biomaterial of the study - Blood (serum)
How to properly prepare for the test
Fasting (8-12 hours of fasting); For children under two years of age, fasting for 2-3 hours is possible. During the day, exclude physical and emotional stress, overheating and hypothermia,

sleep disorders, air travel, instrumental research methods (ultrasound, X-ray, etc.), physiotherapeutic procedures, massage, alcohol and medication (the latter - only in consultation with a doctor).

Age	TSH level , mU/liter
4 days - half a year	0,73–4,77
Half a year - 14 years	0,7–4,17
14 – 19 years	0,47–3,41
After 19	0,4–4,0

Conclusion:

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Practical work 46.2. Follicle-stimulating hormone research.

Objective: to investigate the level of FSH in the venous blood of the test subject

Equipment: rubber gloves, 96% alcohol or antiseptic solution, sterile cotton, waste material tray, 5% sodium citrate solution, customized plastic tubes.

Procedure: Blood sampling is done in rubber gloves, observing the rules of asepsis. Gloves are treated with a 96% solution of alcohol or other antiseptic before each blood sampling. The skin of the arm area is treated with a sterile cotton swab dipped in a 96% solution of alcohol or other antiseptic, and then wiped with a dry sterile cotton ball. Make a puncture and draw blood into a syringe. With the other hand, treat the puncture site with cotton wool soaked in an antiseptic. Dry the surface of the finger dry sterile napkin (cotton ball). Place the used napkin (ball) in the tray.

Follicle-stimulating hormone (follitropin, FSH) is a peptide hormone that affects the functioning of the gonads: in girls, it stimulates the synthesis of estradiol granulosa cells, participates in stimulating the growth and maturation of follicles until they reach maturity and are ready for ovulation. One of the first laboratory indicators of the onset of puberty (puberty) in children is an increase in the concentration of FSH at night. At the same time, the response of the gonads increases and increases sex hormone levels.

Indications for the examination: premature sexual development; delayed sexual development.

In girls: menstrual irregularities; anovulation; premature ovarian failure; abnormal uterine bleeding; amenorrhea; polycystic ovary syndrome and hirsut syndrome; hormone-secreting pituitary tumors.

In boys: subfertility (unsuccessful attempts to conceive after one year of regular sexual activity without the use of contraceptives.), abnormal spermogram indicators.

Method: Chemiluminescence immunoassay

Measuring range: 0.3 - 400

Unit of measurement: Units per liter

Biological material	Delivery terms	Container	Volume
Venous blood serum	24 years. at a temperature of 2 to 25 degrees Celsius	Vacutainer with dispensing gel	3.5 milliliters

Significance of FSH test results

The concentration of follicle-stimulating hormone in the female body depends on the phase of the menstrual cycle. The norm during the follicular phase is 3-14.4 mIU/ml (mIU/ml), during ovulation - 5.8-21 mIU/ml, during the luteal phase - 1.2-9 mIU/ml. If a woman goes through menopause, the FSH level rises to 21.7-153 mIU/ml.

For men, reference values (corresponding to the norm) are values in the range of 0.7-11.1 mIU/ml.

Conclution_____

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Practical work 47. Study of thyroid hormones.

Objective: to determine and quantify thyroid hormones in serum.

Materials and equipment: reaction vessel, protein buffer solution, lumenometer, small columns with cation exchange resin, paper chromatography.

Object of study: blood serum.

47.1.Thyroxine.

Thyroxine is the main hormone that synthesizes the follicular cells of the thyroid gland.

With increased secretion of thyroxine, hyperthyroidism develops. Extreme hyperthyroidism is called Graves' disease and can lead to heart failure. A lack of hormone or hypothyroidism at an early age can lead to cretinism, and at a more mature age to myxedema.

The level of free thyroxine in the blood is measured in picomol per liter (pmol/l or pmol/l), and a concentration of 10.3 to 24.5 pmol/l is considered normal.

Procedure.

The free T4 assay (FRT4) is a two-step enzyme-linked immunosorbent assay. 1.Thyroxine (T4) monoclonal antibodies coupled to biotin, sample, protein buffer solution, and streptavidin-coated solid phase are added to the reaction vessel.

2.During this first incubation, the anti-T4 antibody bound to biotin binds to the solid phase and free T4 in the sample.

3.After incubation in the reaction vessel, the materials bound to the solid phase are held in a magnetic field, while the unbound materials are washed out.

4. Next, a protein buffer solution and triiodothyronine (T3)-alkaline phosphatase conjugate are added to the reaction vessel.

5.T3-alkaline phosphatase conjugate binds to vacant anti-T4 binding sites
antibodies with vacant binding sites.

6.After incubation in the reaction vessel, the materials bonded to the solid
phases are held in a magnetic field, while unbound materials are washed out. 7.Then, Lumi-Phos™ 530 chemiluminescent substrate is added to the vessel and
The light generated by the reaction is measured using a luminometer.

Light production is inversely proportional to the concentration of free T4 in the sample. The amount of analyte in the sample is determined by the stored multi-point calibration curve.

Conclusions: What level of free thyroxine can we see? What does this indicate?

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47.2.Triiodothyronine

Triiodothyronine (T3) is one of the two main thyroid hormones, whose main function is to regulate energy (mainly oxygen uptake by tissues) and plastic metabolism in the body. Total triiodothyronine is the sum of two fractions: bound and non-bound to plasma proteins.

An increased level of free T3 may indicate the development of serious pathologies of the thyroid gland: Graves' disease, gland cancer, diffuse toxic goiter, thyrotoxicosis, chronic liver disease, etc.

A decrease in the level of triiodothyronine can be in the presence of autoimmune diseases of the thyroid gland (autoimmune thyroiditis), hypothyroidism, subacute and acute thyroiditis, adrenal gland diseases, after surgery, in case of severe systemic diseases, severe exhaustion, physical overload, etc.

The normal human serum T3 concentration is approximately 0.2 μg/100 mL; the mean ±SD 31 of normal serum was 220 ±27 ng/100 mL.

Procedure.

The fundamental approach to measuring T3 in human serum consists of the following steps:

1. Venous blood sampling;
2. Removal of thyroid hormones from human serum using small columns with cation exchange resin;
3. Separation of T3 from T4 completely by downward paper chromatography with improved solvent system;
4. Quantification of eluted T3 by displacement method.

Conclusion. What level of triiodothyronine can we observe? What does this indicate?

47.3. Calcitonin

Calcitonin is a hormone synthesized by the parafollicular cells of the thyroid gland in humans. Its biological function is to regulate the metabolism of calcium and phosphorus ions.

Reference values of calcitonin levels for men are less than 11.4 pg/ml, for women – less than 8 pg/ml.

The calcitonin test is primarily used to diagnose C-cell hyperplasia and medullary thyroid cancer (MTC), to assess the effectiveness of breast cancer treatment, and to monitor patients for recurrence.

If too much calcitonin is found in the blood, it may be a sign of a type of thyroid cancer called medullary thyroid cancer (MTC). High levels can also be a sign of other thyroid conditions that may put you at a higher risk of contracting the thyroid gland.

Procedure.

1. Taking a venous blood sample with a volume of 4 ml. We collect it in a test tube to separate the serum from the patient
2.Centrifugation at 3000 rpm for 10 min., and half for analysis.
3. Serum calcitonin levels are measured by chemiluminescence immunoassay (CHLIA).
4. Serum calcitonin levels were determined using a fully automated Siemens IMMULITE® 2000 chemiluminescence immunochemiluminescence detector with the specified reagents (detection limit 2–2000 pg/ml).
Conclusions. What calcitonin levels can we observe? What does this indicate?

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Practical work 48. Study of pineal hormones.
48.1. Determination of blood melatonin.

The purpose of the work: to learn about the method of determining the level of melatonin in the blood serum, the consequences of hypo- and hyperfunction of the pineal gland, the effect of melatonin on the body and determining its optimal norm depending on the time of day, the value of low and high levels in the blood and their causes.
Materials and equipment: a set of standard DRG reagents, a spectrophotometer
Object of study: blood (serum)

48.1 Melatonin

Melatonin (N-acetyl-5-methoxytryptamine) is the main hormone of the pineal gland, a derivative of N-acetylserotonin, an intermediate metabolite of serotonin. Melatonin, in addition to the pineal gland, is produced by the retina of the eye and the mucous membrane of the gastrointestinal tract. The maximum values of melatonin in the blood are observed between midnight and 4 o'clock in the morning. The regulation of melatonin secretion is controlled mainly by the sympathetic nervous system with the help of norepinephrine. Areas that have a high affinity for melatonin are found in the human hypothalamus. Most melatonin is metabolized in the liver and excreted in the urine. Melatonin is an antagonist of the melanocyte-stimulating hormone of the pituitary gland against melanophores - cells that cause pigmentation of the skin.
In addition, melatonin is involved in the regulation of blood pressure, the functions of the digestive tract, and the functioning of brain cells. One of the main actions of melatonin is to regulate sleep. Insufficiency of melatonin secretion by the pineal gland leads to increased production of FSH and, consequently, to follicle persistence, polycystic ovaries, and general hyperestrogenism. Against this background, the following can develop: uterine fibromatosis, dysfunctional uterine bleeding. Hyperfunction of the pineal gland induces hypoestrogenism, frigidity.

Order of work:
To determine the level of melatonin, it is customary to use enzyme-linked immunosorbent assay. These reactions are based on the use of antibodies (less often antigens) conjugated with enzymes that are able to ensure the transformation of an uncolored substance (the so-called chromogen) into a stained one.
1. Introduction of a solution containing antigen into the cells of the microchamber (antigen sorption).
2. Washing from unadsorbed antigen.
3. Addition of antigen-specific antibodies.
4. Washing from antibodies that have not bound to the antigen.

5. Addition of a ligand capable of binding to the antibodies of the substance to which the enzyme is covalently attached.
6. Washing from non-antibody-bound ligand.
7. Addition of chromogen - a substance that changes color under the action of the ligand of the enzyme that is part of the composition.
8. Measuring the intensity of staining with a spectrophotometer.

Table 1. Results of melatonin levels in the blood

Indicator	Result	Norm
Мелатонін нмоль/л	14,7	Rank:7.9-15.0 Day:< 4.9 Evening (22:00-00:00):8,0-19,0 Night: 52,3-149,4

Conclusions: During the analysis of this study, answer the question: At what time of day does the melatonin in the blood reach its highest value and why? What non-pathological factors can affect the value of indicators when analyzing melatonin levels?

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Practical work 48. 2. Determination of blood serotonin.

The purpose of the work: to learn about the method of determining the level of serotonin in the blood serum, the effect of serotonin on homeostasis and metabolism of the body, the importance of reference indicators and factors that can affect their variability, the causes of the increase and decrease in serotonin in the blood and their medical significance.
Materials and equipment: Formed blood elements were precipitated with a 10% solution of trichloroacetate acid. Biological impurities were removed by extraction with diethyl ether from an acidic environment and by TLC method. Chromatographic analysis was performed on a microcolumn chromatograph with a multi-wavelength UV spectrophotometric detector on a column with an inverse phase C.

Object of study: blood (serum).
48.2 Serotonin.
Serotonin, or 5-hydroxytryptamine, is a common neurotransmitter in the body, belonging to the group of monoamines, and a hormone. Monoamines also include catecholamines, norepinephrine, and dopamine. The precursor for the synthesis of serotonin is the essential amino acid L-tryptophan, the main source of which is food proteins. It is formed in serotonergic neurons, the pineal gland, as well as enterochromaffin cells of the gastrointestinal tract. 95% of serotonin in the human body is localized in the intestines, it is the main source of blood serotonin. In the blood, it

is found mainly in platelets, which capture serotonin from plasma, neurons contain only 1–2%. It stimulates smooth muscle contraction, has a vasoconstrictor effect, regulates blood pressure, body temperature, breathing, and has an antidepressant effect. According to some reports, it can be involved in allergic reactions, since it is synthesized in small quantities in mast cells. Serotonin is involved in many integral bodily functions, such as eating behavior, sleep, circadian rhythms, memory, learning, behavior, pain perception. Diseases such as depression and schizophrenia are associated with impaired metabolism and the implementation of serotonin as a means of controlling physical and mental functions.

In particular, its participation in the management of the synthesis, reservation and excretion of adrenocorticotropic hormone, prolactin and growth hormone has been proven. Serotonin can be converted into melatonin (a hormone of the pineal gland), which regulates daily and seasonal changes in the body's metabolism and is involved in the regulation of reproductive function.

Determination of the concentration of serotonin in the blood in clinical practice is used in the diagnosis of carcinoid tumors.

In oncological pathologies, the content of serotonin in the serum is increased by 5-10 times. A large number of its metabolic products are found in the urine. A single serotonin test is not enough to make an accurate diagnosis. Therefore, a number of other studies are prescribed for the reliable determination of tumor markers. In addition to these pathologies, medullary thyroid cancer, dumping syndrome, acute myocardial infarction, and prolonged depression can cause an increase in the concentration of the hormone.

A decrease in serotonin is characteristic in the presence of Down syndrome, Werlhoff's disease and other pathologies. As a rule, the study of serotonin is carried out in combination with the determination of the excretion of the metabolite serotonin (5-NIAA) in the urine.

Order of work:

To determine the level of serotonin in the blood, it is customary to use high-performance liquid chromatography (HPLC). This is an effective method for analyzing organic samples with complex compounds. The process of sample analysis takes place in two stages – separation of the sample into its constituent components and detection and measurement of each component.

1. Separation takes place due to a special chromatographic column, which is a tube filled with sorbent
2. A liquid (eluent) of a certain composition is fed through a chromatographic column at a constant rate.
3. A precisely measured sample dose is added to this stream. The components of the sample, due to their different affinity for the column sorbent, move along it at different speeds and reach the detector at different intervals.
4. The quantification of each of the components is calculated based on the magnitude of the analytical signal measured by a detector that is connected to the output of the chromatographic column.

Table 1. Results of serotonin levels in the blood

Serotonin	Women	Men
Reference indicators	80-450 ng/mL	70-270 ng/mL

Conclusions: What non-pathological factors can affect the result of a serotonin test? What do serotonin values in the blood that are too low and too high indicate?

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Practical work 49. Research on sex hormones.

The aim of the work was to determine and quantitatively study sex hormones in blood serum.
Materials and equipment: Methanol, acetonitrile, n-hexane and ethyl acetate, formic acid, Ammonium acetate and sodium carbonate, mass spectrometer, liquid chromatography column.
The object of study is blood serum.

Testosterone.

Testosterone is the male sex hormone; By biochemical nature, it is a steroid. Testosterone is produced mainly in the testicles, but also (to a lesser extent) in the placenta and adrenal glands (the cortical substance of the adrenal gland). In men, about 10 mg is formed per day, in women - 0.4 mg of the substance. In the blood, testosterone circulates in an inactive form in complex with β globulin. Testosterone stimulates the development of male genitalia and secondary sexual characteristics (in particular, facial hair growth, coarsening of the voice, baldness) and also promotes bone growth.
An increase in the level of free testosterone in men can be a consequence of: viriliazing adrenal gland; androgen resistance. In women: hirsutism; syndroi polycystic ovaries.
A decrease in the level of free testosterone in men may indicate hypogonadism, erectal disflux. Yes, in all of them with antidepressant therapy and cytochrome P450 deficiency

Procedure:
Isotope dilution method for the determination of testosterone in human serum using a tandem of liquid chromatography and isotope dilution mass spectrometry.
Take a venous blood sample
Serum was balanced with an isotope internal standard and treated with an acidic buffer to release hormones from their binding proteins.
Lipid fractions from the acidic buffer solution were isolated using ethyl acetate and n-hexane. The organic phase was evaporated and reduced in a basic buffer solution.
Polar impurities of n-hexane extraction were removed.
Quantitative determination of total testosterone in blood serum was carried out by ultra-efficient liquid chromatography with tandem mass spectrometry in the mode of monitoring multiple reactions with positive electrospray ionization.
Table 1. The norm for the amount of testosterone (may differ for different age groups):

Testosterone	Men	Women
Total Testosterone	8.64-29.0 nmol/L	0.29-1.67 nmol/L
Free Testostrn	15-50 pg/mL	Up to 9 pg/ml

Conclusions. What testosterone levels can we observe? What does this indicate?
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49.2. Estradagiol.

Estradiol is a female sex hormone belonging to the group of estrogens and is the most active of them. Estradiol is produced from the male sex hormone testosterone in women in the adrenal cortex, in the ovarian follicles (vesicles in which the egg matures) and the placenta, in men - in the seminal vesicles, adrenal cortex and body tissues. Estradiol is responsible for: the formation and development of the organs of the female reproductive system, the development of secondary sexual characteristics, the adjustment and regulation of the menstrual cycle, the growth of the egg, the preparation of the reproductive organs for pregnancy, stress resistance, and the maintenance of youthful skin. In men, this hormone is responsible for spermatogenesis.

Increased estrogen levels in women can be the result of estrogen-producing tumors of the ovaries and adrenal glands, cirrhosis of the liver, hyperthyroidism, and premature sexual development. In men, hormone-producing tumors of the testicles and adrenal glands, delayed sexual development.

Reduced estrogen levels in women can be a consequence of physiological and early menopause, premature ovarian failure (primary and intragenic), gonadotropin resistance syndrome, gonadal agenesis, hypopituitarism of various etiologies

Procedure:

In this paper, we will use a newer and more efficient research method, namely liquid chromatography with tandem mass spectrometry (LC–MS (/MS)).

Take a venous blood sample

The sample solution containing the analytes is pumped through the stationary phase (column RX) by a mobile phase proceeding under high pressure.

After elution from the RX column, the drain is sent to the mass spectrometer. The mass spectrometer for the LC-MS (/MS) system has an ionization source in which the runoff from the RC column is sprayed, dissolved and ionized, creating charged particles.

Charged particles migrate under high vacuum through a series of mass analyzers (quadrupole) using electromagnetic fields.

In a collision cell, selected ions with a certain mass/charge are fragmented into product ions (or daughter ions) by collision with an inert gas.

The third quadrupole is used to target specific fragments of product ions.

The resulting isolated product ions are quantified using an electron multiplier.

Table 2. The norm for the amount of estradiol:

Phase	Zhinky	Men
Фолікулярна фаза	12.5-166.0 pg/ml	7.63-42.6 pg/ml
Lute phase	43.8-211.0 pg/ml	
Ovulatory phase	85.8-498.0 pg/ml	
Postmenopause	Up to 54.7 pg/ml	

Conclusions. What level of estradiol can we observe? What does this indicate?

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Progesterone

Progesterone is an endogenous steroid and progestogenic sex hormone that affects the menstrual cycle, pregnancy and embryonic development in humans and other species. Progesterone causes changes in the endometrium, preparing it for embryo implantation. It contributes to the preservation of pregnancy at all stages, inhibiting the activity of the smooth muscles of the uterus, maintaining the tone of its cervix, blocking the development of follicles in the ovaries, providing immunological changes in the uteroplacental space favorable for pregnancy. It belongs to a group of steroid hormones called progestogens and is the main progestogen in the body. It is also a key metabolic intermediate in the production of other endogenous steroids, including sex hormones and corticosteroids, and plays an important role in brain function as a neurosteroid. It is produced in organisms of both sexes in the ovaries and testicles, respectively. A small amount of it is produced by the adrenal glands.

An increase in progesterone levels may result from dysfunctional uterine bleeding with prolongation of the luteal phase; some types of secondary amenorrhea; dysfunction of the fetoplacental complex; delayed maturation of the placenta; impaired excretion of progesterone in renal failure

Decreased progesterone levels, chronic inflammation of the internal genital organs; follicle persistence; anovulatory dysfunctional uterine bleeding; placental insufficiency; the threat of termination of pregnancy of endocrine genesis; true carrying; intrauterine growth retardation of the fetus.

Procedure:

Take a venous blood sample

Serum was balanced with an isotope internal standard and treated with an acidic buffer to release hormones from their binding proteins.

Lipid fractions from the acidic buffer solution were isolated using ethyl acetate and n-hexane. The organic phase was evaporated and reduced in a basic buffer solution.

Polar impurities of n-hexane extraction were removed.

Quantitative determination of progestrium in blood serum was carried out by ultra-efficient liquid chromatography with tandem mass spectrometry in the mode of monitoring multiple reactions with positive electrospray ionization.

Table 3. The norm of the amount of progesterone

Phase	Zhinky	Men
Фолікулярна фаза	0.2-1.5 ng/mL	0.2-1.4 ng/mL
Lute phase	0.8-3.0 ng/mL	
Ovular phase	1.7-27 ng/mL	
Postmenopause	0.1-0.8 ng/mL	

Conclusions. What level of progesterone can we observe? What does this indicate?

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Practical work 50. Research on stress factors.

50.1. Blood glucose test.

Objective: To detect the concentration of glucose in blood plasma.

Materials and equipment: test tubes, micropipettes, water bath, refrigerator, set of reagents: picric acid, caustic sodium 10%, reference tables.

Object of study: human blood.

Performing a functional test: blood is taken from a person to determine the amount of fasting blood glucose. Then the subject is given 100 ml of tea to drink, in which 50 g of glucose is dissolved. After that, blood is taken for examination every next 30 minutes. The obtained results are displayed in the form of a curve, plotting on the abscissa axis - time, and on the ordinate axis - the amount of glucose in the blood in mg %. This curve will show:

Baseline fasting glucose. 2.The rate, degree and increase in blood glucose levels after sugar load. 3. The time and nature of the decrease in this level of starting substances.

Progress: take two test tubes No. 1 and No. 2. 1.9 ml of distilled water is poured into the first tube. 1 ml of blood is collected with a micropipette and released into the test tube No. 1, washed with water of the same tube several times. Then 1.0 ml of 1-2% picric acid solution is added to the tube. The contents of the tube are thoroughly mixed and filtered through small filters, which are moistened with distilled water (in test tube No. 2). 1 ml of distilled water is poured into test tube No. 1 and poured onto the same filter. 2 ml is taken from the filtered liquid with a pipette and this liquid is transferred to a dry, clean test tube No. 3. Then add 0.1 ml of a 10% NaOH solution, boil in a water bath for 3 minutes. Next, the tubes are cooled and the colors of the liquids are compared with the colors of the reference table in daylight, standing with their backs to the window.

If there is 100 mg% of glucose in the blood, it is yellow

125 mg% glucose – light orange color

150 mg% glucose – dark orange

200 mg% glucose – orange-brown

250 mg% glucose – brown with blackish color

300 mg% glucose is dark brown in color.

Since 0.1 ml of blood was taken, multiply the results by two. If the color of the liquid in the test tube is more intense than one strip and less intense than the adjacent strip, then take the average value between those indicated on both strips.

Results:

Blood glucose concentration:

Punch Number	Value, mg%
1 (fasting)	
2 (30 min) after drinking glucose solution	
3 after 60 minutes	
4 after 90 minutes	

Conclusions:

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50.2. Blood insulin test.

Examination of the hormone insulin of the pancreas
Objective: to investigate the preparation for the study of the hormone insulin of the pancreas, methods of blood collection and immunochemiluminescence method for determining insulin.
Equipment: For blood sampling: a pillow for blood sampling, a special needle for blood sampling, a vacuum syringe container for blood sampling, a knitted tourniquet, antiseptic wipes.
For laboratory diagnostics of the hormone: a rack for test tubes, polymer tubes with a screw cap, a desktop tripod for automatic dispensers, a laboratory microevaporator, a vortex, a laboratory shaker, a multifunctional refrigerant centrifuge and an angled rotor.

The object of the study is venous or capillary blood.
Insulin is a hormone secreted by the pancreas and is responsible for maintaining blood glucose levels. It plays an important role in carbohydrate metabolism and is also involved in lipid metabolism. The level of glucose in the blood is regulated by the level of insulin in the blood: with a low level of insulin in the blood, the level of glucose in the blood increases, which leads to the development of a disease – diabetes mellitus; With elevated insulin levels, blood glucose levels decrease, leading to hypoglycemic coma and even death. The values of normal insulin levels in the blood for healthy people are in the range of 2.3 - 26.4 mIU/ml. Lower values are a sign of insufficient insulin production by the pancreas, while higher values indicate hyperinsulinemia.
Indications for prescribing a blood test to detect the level of insulin in the blood:
Diagnosis of different types of diabetes mellitus;
Diagnosis of hypoglycemic conditions;
Diagnosis of insulinoma (tumor of the pancreas);
Diagnosis of the degree of insufficiency and absolute need for insulin.
Carbohydrate metabolism disorders.

Preparation for insulin testing:
Before blood sampling, the patient is forbidden to eat for 12 hours (this is agreed with the doctor who prescribed the test). Also, it is necessary to stop taking medications that can affect the result of the study during the day.

Methods of collecting venous blood:
Syringe method:

A special needle is put on a closed venous blood collection system (vacuum syringe containers), and a puncture of the vein is performed;
By pulling the plunger, the vacuum syringe container is filled with blood. After filling with blood, the syringe container is disconnected from the needle, after which the needle itself is removed. If blood sampling is performed several times, then in this case the needle is not removed from the vein, but the syringe containers are changed.
At the end of the blood draw, the syringe container is closed and set aside for further laboratory testing.
Vacuum method:
Puncture of the vein with a special needle is performed;
A vacuum syringe container without a plunger is attached to the needle. In this way, the container is filled with blood under the action of a vacuum;
After filling the container, it is detached from the needle and closed, and then the needle itself is removed.
Progress:
We collect blood by syringe or vacuum method.
We transport it to the chemiluminescent laboratory.
Biomaterial for the study: venous blood serum. **Tube type**: vacunizer with distribution gel, 3.5 ml. **PreA Treatment Before Transport:** Store the centrifuged tube in the refrigerator. **Delivery terms:** temperature from 2 to 8 degrees, 24 hours.

or

Biomaterial for the study: capillary blood serum. **Tube type:** microvet (serum), 500 µl. **PreA Treatment Before Transport:** Store the centrifuged tube in the refrigerator. **Delivery terms:** temperature from 2 to 8 degrees, 24 hours.

We conduct a laboratory test of insulin.

Test method: chemiluminescence immunoassay.

Measuring range: 0.5 – 1500

Unit of measurement: milliunits per liter.

We evaluate the results.
Reference values:

Age	Results	Women Men
0 -130 years		3 – 25 µIU/mL

Results:_____

Conclusion:

_____
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50.3. Blood glucagon test.

Objective: to study the main hormones of the pancreas (insulin, glucagon), their functions, biological role, norms of indicators in the blood, determination of their level in the blood using chemiluminescence immunoassay, methods of chemiluminescence immunoassay.

Equipment: capillary blood, venous blood, test tubes, tripod, syringes, container, centrifuge.

II. Glucagon is a single-stranded polypeptide with a molecular weight of 3,485 Da, containing 29 amino acid residues. It is synthesized in pancreatic α cells as an inactive precursor of preproglucagon, which, after cleavage of the N-terminal signal sequence of amino acids, is converted to proglucagon, and after the action of proteases, to glucagon.

Glucagon test. Preparation of the patient: fasting for 8 hours, exclude fatty foods. You can drink water. Do not smoke for 30 minutes. Coordinate with the doctor the use of insulin, glucocorticoids, amino acids, catecholamines.

Diagnostic direction: Assessment of the state of carbohydrate metabolism Indications for prescribing Differential diagnosis of diabetes mellitus resulting from glucagonoma from other types of diabetes. Additional examination for MEN syndrome - 1 to detect glucagonoma. Assessment of the general degree of loss of pancreatic tissue mass.

Marker for assessing the functional activity of pancreatic alpha cells. Clinical relevance Diagnosis of glucagonoma. Assessment of the overall degree of weight loss of pancreatic tissue.

Composition of indicators: **Method:** Chemiluminescence immunoassay

Measuring range: 0.5 - 1500

Unit of measurement: nanograms per liter.

Evaluation of results: - M and F > 209.

Chemiluminescence diagnostic method is a medical and biological method for diagnosing various pathological conditions and diseases of the body, which is based on the results of a comprehensive study of the processes of regulation of free-radical oxidation (BPO) by the method of chemiluminescence of biological material. The study of chemiluminescence of biological objects shows its connection with free-radical oxidation in the body, which occurs without the participation of enzymes due to the reduction of molecular oxygen to its active forms: superoxide anion radical, hydroxyl radical. The main source of these compounds is the autooxidation of lipids, mainly unsaturated fatty acids, in which free radicals are released that interact with oxygen to form peroxides. Chemiluminescence measurement is carried out in natural conditions without the need for special preparation of material for the study. To measure chemiluminescence, the chemiluminescence unit HLM-003 is used.

The material for the study is: 1) Diluted whole blood (optimal dilution - 1:22);

2) Isolated cell fractions. Other variants of blood dilution, according to various authors, are 1:9, 1:21, 1:40, 1:100, 1:200, however, an increase in luminescence intensity is observed up to a dilution of 1:22 due to a decrease in the optical density of the solution, and with further dilution it decreases due to a decrease in the concentration of phagocytic cells in it. The lack of use of whole blood is the antioxidase activity of plasma, which distorts the results of the study.

Obtaining an isolated fraction of cells can be carried out by precipitation or centrifugation (using neutrophil granulocytes as an example):

A) 1 ml of polyglukin is added to 5 ml of blood from the ulnar vein with heparin. The mixture is incubated for 30 minutes at 37° to accelerate erythrocyte precipitation. The resulting leukocyte supernatant is washed twice in Hanks' solution without phenolic red for 10 min at 400 g. Supernatant is drained, the remaining neutrophil granulocytes are diluted in 1 ml of Hanks' solutions and a suspension is obtained. The number of neutrophil granulocytes in the Goryaev chamber is counted.

B) 2 ml of blood from the ulnar vein into centrifuge tubes, mixed well with 80 ED of heparin and 1 ml of polyglukin, incubate the mixture for 25 minutes at 37°C and 30 minutes at room temperature, after which the leukocyte supernatant is transferred to clean centrifuge tubes and washed three times in Hanks' solution without phenolic red for 5 minutes at 1500 rpm. At the

end of the third centrifugation, the supernatant is removed, and the remaining cells are diluted in 2 ml of Hanks' solution. Leukocyte counting is carried out in the Goryaev chamber: 200 μl of a 10% acetic acid solution with a 0.25% trypan blue solution is added to 20 μl of the leukocyte mixture. After counting, the cells are brought with Hanks' solution to a concentration of 2 * 106 /ml.

Results:_____

Conclusions:

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50.4. Studies of adrenaline and norepinephrine.

50.4. Practical work "Determination of blood adrenaline".

Objective: To detect adrenaline and its concentration in blood plasma, to determine that the indicator is very variable depending on the situation and condition of a person.

Materials and equipment: a set of standard reagents from the company
DRG, Spectrophotometer, Chromatography-Mass Spectrometer.

Equipment. The work was performed on a liquid chromatograph Waters 590 with an amperometric detector (NPO "Khimavtomatika") (working electrode material - carbon glass), Ascentic C18 column (5 μm, 4.6 x 250 mm). Electrophoretic determination was carried out on the capillary electrophoresis system "KAPEL 105" (SPF Lumex LLC) with a spectrophotometric detector, unmodified quartz capillary total length – 60 cm, effective length – 50 cm, inner diameter – 50 μm. For sample preparation the Supelco Preppy system with the KNF LaboPort diaphragm pump was used.

Reagents. For the preparation of the buffer electrolyte, the mobile phase and the sample preparation, the following were used: glacial acetic acid (c.p.), triethanolamine (TEA) (c.m.), hydrochloric acid, conc. (h.p.), sodium hydroxide (h.c.), aqueous ammonia (h.c.), sodium octyl sulfonate (Sigma), acetonitrile (for HPLC, Merck), chloroacetic acid (Sigma), sodium dihydrogen phosphate (Sigma), sodium carbonate (Sigma), ethylenediaminetetraacetic acid (EDTA) (Sigma), aluminum oxide (acidic) (Sigma), Supelco DSC-SCX SPE solid-phase extraction cartridges and bidistilled water obtained using the "Aquarius" system).

Object of study: Daily urine, blood serum.

Characteristics of adrenaline: Adrenaline or epinephrine is a hormone secreted by the adrenal medulla and partly by the cells of the chromaffin system. According to the chemical structure, adrenaline is a 3,4-dihydroxy derivative of phenylethylamine. It is part of the group of physiologically active substances — catecholamines. Also, this is the drug "Adrenaline/Epinephrine", which is referred to as adrenergic drugs (adrenomimetics).

It accelerates and increases the heartbeat, causes constriction of blood vessels, which causes an increase in blood pressure, causes relaxation of the smooth muscles of the bronchi and digestive system, and increases metabolism. In medical practice, a solution of adrenaline hydrochloric acid salt is administered subcutaneously (and sometimes intravenously or intracardially) in case of deep circulatory disorders (hemodynamics), which occur in diseases of the cardiovascular system, collapse, some types of shock (including anaphylactic), allergic diseases, asthmatic attacks, and some poisonings.

In a calm state, adrenaline is produced in a person, but in much smaller quantities than under stress. The concentration of catecholamines in the blood changes significantly during the day, which is

associated with emotional and physical influences, therefore, to assess the hormonal status of the adrenal medulla, it is better to use indicators of daily excretion of catecholamines in the urine and total metanephrines (more stable than catecholamines). In women, the release of epinephrine and norepinephrine increases during the luteal phase of the menstrual cycle and then decreases during ovulation.

An adrenaline test is most often used:

- If a chromaffin catecholamine-producing tumor (pheochromocytoma, neuroblastoma) is suspected, as well as to clarify its localization, and then control after surgical treatment of the neoplasm;
-As an auxiliary study to determine the state of the central nervous system and the sympathetic part of the autonomic nervous system in case of their damage (mental and neurological diseases, panic attacks, migraine, vascular tone dysregulation, congestive heart failure, etc.);
-In order to diagnose arterial hypertension, clarify the hormonal prerequisites for its development and monitor treatment.

Detection method: High-performance liquid chromatography.

Progress: Pheochromocytoma is a hormonally active tumor of catecholamine-producing cells of the sympathoadrenal system. In most cases, these tumors are surgically removed, after which the catecholamine content is significantly reduced, and the symptoms and complications associated with the tumor are alleviated or disappear

1. Obtaining blood plasma. A sample is taken into an EDTA vacutainer to prevent catecholamine oxidation. The plasma is separated by centrifugation within 15 minutes after the sample is taken and then immediately frozen at -20 0C plastic vessels.
2. The method consists in conducting a chromatographic study, in which the original thin-layer chromatography is used. After the distribution of norepinephrine and adrenaline on the Silufol plates, the presence of hormones in UV radiation is determined. Quantification of adrenaline and norepinephrine content is determined by spectrophotometric method after iodine oxidation.

A blood test reveals the amount of the hormone at the time of taking the test, while a urine test reveals the amount of the hormone for the previous 24 hours.

Results:

The concentration of adrenaline is normal depending on age:

Age	Reference values, pg/ml
2-11 days	36.0 - 400.0
Day 11 - 4 months	55.0 - 200.0
4 months - 1 year	55.0 - 440.0
1-2 years	36.0 - 640.0
2-3 years	18.0 - 440.0
3-18 years	18.0 - 460.0
> 18 years old	10.0 - 200.0

Conclusions:

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50.5. Practical work "Determination of blood norepinephrine".

Objective:To determine the level of norepinephrine concentration in the blood and why it increases.

Materials and Equipment: The 3-CAT ELISA Fast Track kit is a solid-phase competitive enzyme-linked immunosorbent assay on microplates. The three catecholamines are epinephrine (epinephrine), norepinephrine (norepinephrine), and dopamine.

Object of study: blood plasma

Characteristics of norepinephrine: Norepinephrine is a hormone of the adrenal medulla and a neurotransmitter. In women, it stimulates uterine contractions, in men it increases peripheral vascular resistance and systolic and diastolic pressure. Norepinephrine is a biogenic amine that, along with adrenaline and dopamine, belongs to catecholamines. Unlike adrenaline, which, for the most part, exhibits hormonal activity, norepinephrine is a mediator that plays transmitter role in adrenergic synapses of the CNS and PNS. In the human brain, noradrenergic neurons are found mainly in the areas of the blue spot, the hippocampus, and a large part of the cerebral cortex. The functional role of norepinephrine as one of the main mediators of the central nervous system is associated with maintaining the level of activity of neuropsychiatric reactions, the formation of cognitive and adaptive processes. Marker of differential diagnosis of catecholamine-secreting tumors of adrenal and extraadrenal localization and differential diagnosis of hypertension. It makes it possible in a difficult and dangerous situation to pull yourself together and believe in yourself and solve a problem that, as it seemed at first glance, has no solution. Thus, it provides a sense of relief in a stressful situation. But when its level is reduced, it affects the person's condition.

Norepinephrine deficiency can have the following symptoms:

-depression;
-Constant fatigue;
-Bipolar disorder;
-Pain syndrome in muscle fibers;
-Headaches.

An increased concentration of the neurotransmitter contributes to the appearance of the following signs:

-High blood pressure;
-anxiety;
-Panic attacks;
-Sleep disorder;
-Manic-depressive psychosis;
-Parkinson's syndrome.

Detection method: Enzyme-linked immunosorbent assay.

Progress: The duration of action of circulating catecholamines is short, so blood sampling for this study should be carried out at the time of vivid clinical manifestations (hypertensive crisis, etc.). With pheochromocytoma, the secretion of catecholamines increases tens, sometimes hundreds of times. In hypertension, the level of catecholamines in the blood is at the upper limit of normal or increased by 1.5-2 times.

The 3-CAT ELISA Fast Track kit is a solid-phase competitive enzyme-linked immunosorbent assay on microplates. The three catecholamines, epinephrine (epinephrine), norepinephrine (norepinephrine), and dopamine, are extracted by cis-diol-specific affinity gel, acylated, and enzymatically modified. The antigen is immobilized on the surface of the wells of the microplate (solid phase). Modified standard analytes contained in the control and basic samples and immobilized in the solid phase of measurement at a limited number of binding sites for unique antiserum antibodies. In the presence of a complex of detected unbound antigens and unbound antigens, the antibody is removed by washing. Antibodies bound to the solid-phase immobilized analyte detect conjugates of anti-rabbit antibodies to IgG with peroxidase. TMB is used as a substrate. The amount of analyte to be determined in certain samples is calculated from a calibration curve plotted from the concentration density in standard concentrations

Functional purpose Diagnostic enzyme-linked immunosorbent (ELISA) in vitro test system for determining the amount of adrenaline (epinephrine), norepinephrine (norepinephrine) and dopamine in blood plasma and urination.

Results: Norepinephrine.

Age	Reference value	
	Women nmol/day	Men nmol/day
1-3 years	31,0 – 50,0	27,0 – 49,0
4-7 years	29,0 – 106,0	35,0 – 88,0
8-11 years	77,0 – 146,0	12,0 – 90,0
12-15 years	115,0 – 274,0	75,0 – 175,0
16-18 years	75,0 – 97,0	99,0 – 126,0
Over 18 years old	20,0 – 240,0	20,0 – 240,0

Procedure:

Enzyme-linked immunosorbent assay (ELISA) can be used to determine the level of catecholamines in the blood. These reactions are based on the use of antibodies (less often antigens) conjugated with enzymes that are able to ensure the transformation of an uncolored substance (the so-called chromogen) into a stained one.

The progress of the work is joint:

1. Introduction of a solution containing antigen into the cells of the microchamber (antigen sorption)
2. Washing from unadsorbed antigen.
3. Addition of antigen-specific antibodies
4. Washing the cell from antibodies that have not bound to the antigen.
5. Addition of a ligand capable of binding to antibodies of a substance to which it is covalently attached by enzymes.
6. Washing the cell from antibodies that have not bound to the ligand.
7. Addition of chromogen, a substance that changes color under the action of an enzyme that is part of the ligand.
8. Measurement of color intensity using a spectrometer.

Indicator	Result	Norm
Адреналін пг/мл		10-85pg/ml
Norepinephrine pg/mL		95-450 pg/mL

Therefore, the results of the enzyme-linked immunosorbent assay showed that _____

Conclusions:

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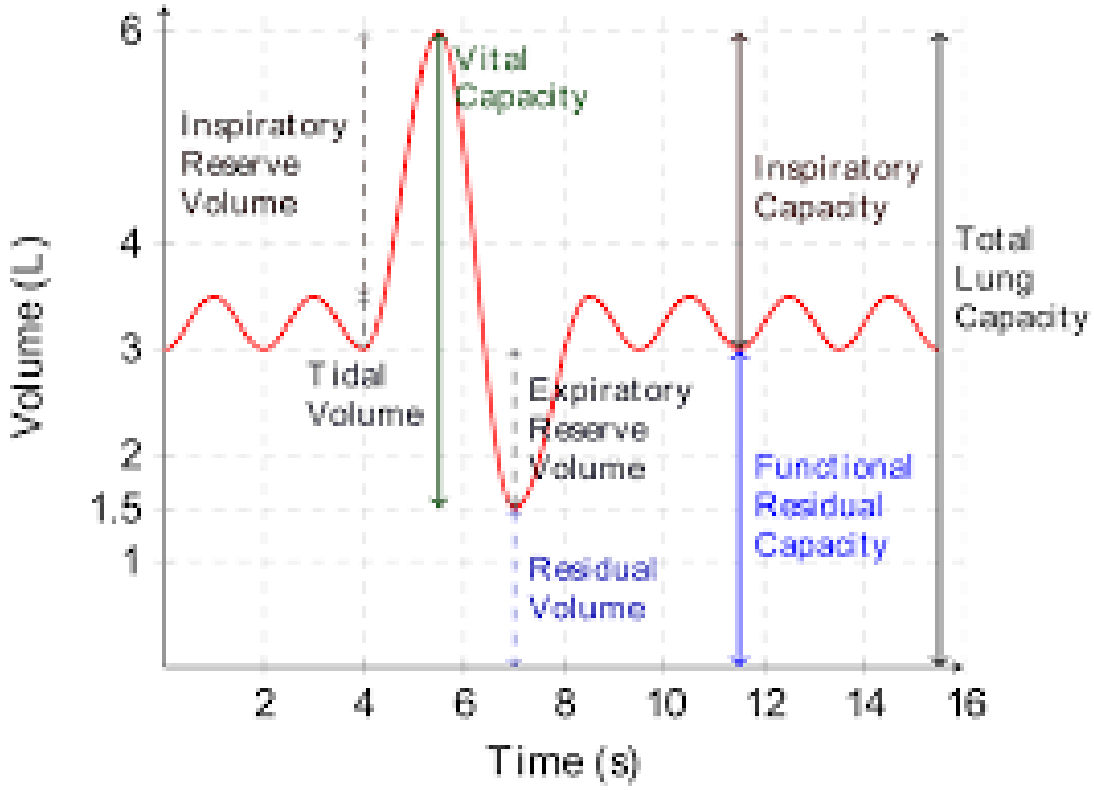
Module 7. Physiology of the respiratory system.

Practical work 51. Determination of lung volumes. Spirometry.

Purpose: to learn the technique of spirometry - to determine lung volume.
Materials and equipment: dry spirometer, wipes, cotton wool, 96% alcohol solution.
The object of study: human.
Spirometry is a method of studying the functions of external respiration, which involves measuring the volume and velocity of respiration. Spirometry helps to effectively determine the lungs' ability to receive, hold and use inhaled air. Such calculations are done using a spirometer. Basic spirometry is performed to determine the vital capacity of the lungs, its components and to assess forced exhalation. Spirometry is the main functional study of the respiratory system. Assessment of lung function is used to diagnose and monitor most chronic respiratory diseases.
Before spirometry, the person to be spirometry should avoid:
1) smoking tobacco or e-cigarettes 1 hour before the study (due to the risk of bronchospasm).
2) use of psychoactive substances (eg alcohol) 8 hours before the study.
3) intense physical activity 1 hour before the study (risk of bronchospasm).
The person should also not eat a large portion of food for 2 hours before the study, as well as wear clothing that does not restrict the movement of the chest and abdomen.
Spirometry is usually well tolerated and rarely (approximately 5 / 10,000) causes significant side effects - most often syncope or presyncope and arrhythmias that go away on their own and do not require special treatment.
Procedure:

1. The person to whom the spirometry will be performed sits sideways to the table.
2. Use a dry spirometer, which is an air turbine that rotates a jet of exhaled air. The rotation of the turbine is transmitted to the arrow of the device, which moves on a scale and indicates the amount of exhaled air. The scale with marks from 0 to 6,5 is fixed in a cover of the device together with which it can turn on the case of the device for movement of an arrow to zero position before each measurement.
3. Cover the spirometer, set the arrow to zero.
4. Wipe the mouthpiece of the spirometer with a cotton ball soaked in alcohol.
5. On the inlet tube of the device put on a disinfected mouthpiece, which is then clamped with his lips.
6. Determine the following lung volumes, the results are recorded in the table.
    a) Respiratory volume (RV). After a few calm inhales and exhales, perform 5 calm exhalations into the spirometer. We inhale through the nose. The total volume of exhaled air is divided by 5.
    b) Exhalation reserve volume (ERV). After a calm exhalation through the nose, make the maximum possible exhalation into the spirometer. At the same time we clamp a nose with fingers, or a special clothespin that air did not leave through it.
    c) Vital capacity of the lungs (VCL). After a few calm inhales and exhales, take the deepest possible breath and then the deepest possible exhalation into the spirometer. Perform VCL measurements in different positions - sitting, standing, lying down.
    d) Reserve volume of breath (RVB). From the value of VCL established during measurement we calculate the sum RV and ERV.
7. Measurement of all the listed lung volumes is repeated after physical activity (30 squats).



Result:

Pulmonary volumes, l.	With calm breathing	After exercise
RV		
ERV		
RVB		
VCL		

VCL standing _____ ml **VCL** sitting _____ ml **VCL** lying _____ ml

Determine the normative indicator of **VCL** by the formula:: **VCL** (l) = 2.5 x height (m).

VCL = 2.5 x _____ = _____ (l).

Conclusions: compare the value of VL measured by a spirometer with the corresponding VEL found by the formula. Explain the differences in the indicators of VL obtained during the work.

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Practical work 52. Calculation of minute volume of breath, alveolar ventilation, coefficient of pulmonary ventilation.

Purpose: to learn the method of calculating the minute volume of respiration, alveolar ventilation, pulmonary ventilation.
Materials and equipment: results of practical work №41, stopwatch,
The object of study: human.

Procedure: Calculate the frequency of respiratory movements (BPM) at rest for 1 minute.

BPM = _____ / minute

Using the data obtained after the work № 41, will determine the following indicators:
1. Minute tidal volume (MTV) - the amount of air entering the lungs in 1 minute. Determined by the formula: MTV = RV x BPM.
where, RV - respiratory volume , BPM - respiratory rate

MTV = _____ x _____ = _____

2. Alveolar ventilation. Lung ventilation depends on the ratio of the volume of air renewed for each respiratory cycle and the volume of air contained in the lungs. But part of the inhaled air does not reach the alveoli and remains in the airways. Due to the presence of "dead space" alveolar ventilation differs from pulmonary: from 500 ml of air to the alveoli does not reach 150 ml. That is, for each respiratory cycle to the alveoli receives about 350 ml of air, which is about 1/7 of all air contained in the alveoli. Naturally, the deeper the breath, the more intense the alveolar ventilation, because on the one hand, with deeper exhalation, less air remains in the lungs, and on the other - with forced breathing, the respiratory volume increases significantly.
Alveolar ventilation (AM) characterizes the ventilation of the alveoli: AV = (RV - DS) x BPM.
where, RV - respiratory volume, BPM - respiratory rate
DS - dead space, equal to an average of 140-150 ml

AV = (_____ - 150) x _____ = _____

3. The coefficient of pulmonary ventilation (CLV) is the part of the air that is exchanged in the lungs during each breath: CLV = (RV - DS): FRC.
where, RV - respiratory volume, DS - dead space, equal to an average of 140-150 ml., FRC - functional residual capacity - the amount of air that remains in the lungs at the end of exhalation: FRC = ERV + RLV; RLV- residual lung volume - about 1500 ml

FRC = _____ + 1500 FRC = _____

RLV = (_____ - 150): _____ RLV = _____

Conclusions: Draw conclusions about the calculations of minute tidal volume, alveolar ventilation, pulmonary ventilation rate.

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Practical work 53. Assessment of the state of elasticity of lung tissue (Christie's test).

Purpose: to assess the state of elasticity of lung tissue.
Materials and equipment: results of practical work №41, dry spirometer, napkins, cotton wool, 96% alcohol solution.
The object of research: human.

Procedure:

1. Using a dry spirometer to determine the VCL at once (or use the indicators obtained in the course of practical work № 41).
2. Using a dry spirometer to determine RV, ERV, RVB (or use the indicators obtained in the course of practical work № 41).
3. Find VL as the sum of separately measured RV, ERV, RVB.
4. Compare the value of VCL, measured simultaneously and the value that is the sum of RV, ERV, RVB. A deviation of ± 7-15% is considered normal.

Results and conclusions:

VCL measured = _____ VCL calculated = _____
_____
_____
_____
_____
_____

Practical work 54. Assessment of the width of the small bronchi and the tone of the bronchial muscles (Votchala-Tiffno test).

Purpose: to assess the width of the small bronchi and the tone of the bronchial muscles.
Materials and equipment: results of practical work №41, dry spirometer, napkins, cotton wool, 96% alcohol solution.
The object of research: human.
The Votchala-Tiffno test is a functional test for assessing tracheobronchial patency by measuring the volume of air exhaled after maximal inspiration in the first second of forced exhalation. Next, calculate the percentage of this volume to the vital capacity of the lungs (norm 70-80%). The test is performed in obstructive diseases of the bronchi and lungs. The test is used to assess the width of the small bronchi and the tone of the bronchial muscles.
Procedure:

1. Using a dry spirometer to determine the VCL at the normal rate of respiration (or use the indicators obtained in the course of practical work № 41).
2. Using a dry spirometer to determine the VCL at the fastest forced expiration.
3. Compare the value of VCL, measured at normal respiration rate and the value obtained by the fastest forced expiration. A deviation within ± 300 ml is considered normal.

Results and conclusions:

VCL rest = _____ VCL force. = _____
_____
_____
_____
_____

Module 8. Physiology of the digestive system.

Practical work 55. Study of physicochemical properties of saliva.

Purpose: to study the physicochemical properties of saliva.
Materials and equipment: human saliva, 10% acetic acid solution, tripod with test tube, litmus paper.
The object of research: human.
A person produces 0.5-2 liters of saliva daily, its pH varies from 5.25 to 8.0. The viscosity and mucous properties of saliva are due to the presence of mucopolysaccharides (mucin). Mucin - the most important organic component of saliva, which ensures its viscosity, promotes the adhesion of food particles and the formation of food lumps, prepares it for swallowing.
Procedure:

1. Determine the pH of saliva. Place a drop of saliva on litmus paper and determine the pH.
2. Qualitative test for mucin. Collect 1-2 ml of saliva in a test tube and add a few drops of dilute acetic acid. Saliva loses its viscosity and viscosity, as mucin precipitates as a white precipitate.
3. Record the results and draw a conclusion.

Results and conclusions: _____
_____
_____
_____
_____
_____

Practical work 56. The role of bile in the digestive process.

Purpose: to determine the effect of bile on fats.
Materials and equipment: tripod with test tubes, bile, liquid vegetable oil, filter paper, distilled water, 0.5% solution of baking soda.
The object of research:human**.**
Procedure:

1. To study the emulsification of bile fats:
    a. in test tube 1 pour 3 ml of distilled water;
    b. in a test tube 2 - 3 ml of a solution of baking soda;
    c. in a test tube 3 - 3 ml of distilled water and a few drops of bile.
2. Add 7 drops of vegetable oil to each test tube and shake vigorously.
3. In one of the test tubes a white "milk" is formed - a fat emulsion.
4. After 10-15 minutes, examine the contents of all tubes and make sure that the emulsion is stable, as the boundaries between the layers are not planned. Use test tube 1 as a control.
5. To establish the effect of bile on fat filtration, the following must be done. Put paper filters in small funnels. Moisten one of the filters with bile and the other with water. Put the funnels in test tubes in a tripod and pour 10 ml of vegetable oil into each.
6. After 30-45 minutes, determine the amount of filtered fat in both tubes. The oil will pass quickly through the filter treated with bile, and will remain in the funnel moistened with water.

Conclusions: Describe the role of bile in digestion and explain why fat penetrates freely through a filter soaked in bile. _____
_____
_____
_____
_____
_____

Module 9. Physiology of metabolism and energy. Thermoregulation.

Practical work 57. Determining the appropriate value of the basic exchange.

Purpose: to determine the value of the basic exchange
Materials and equipment: tables of calculation of the basic exchange.
The object of research: human.
The value of the basic metabolism (M) is the minimum amount of energy needed to carry out vital processes of the body (physiological, biochemical, functioning of organs and systems). This value depends on gender, age, body weight, health status of the individual and correlates with the ratio of body surface to its volume.
The values of proper exchange obtained during the work are basic and are used to perform the following practical work of this section.
Procedure:

1. Measure the growth of the subject in a standing position. To measure the length of the body in the "standing" position, the subject stands on the rack "slim", touching the vertical bar of the height meter with his heels, buttocks, shoulders, nape; the head should be in such a position that the line connecting the outer corner of the eye and the earlobe would be on the line, horizontal floor.
2. Measure body weight. To weigh correctly, it is carried out without shoes and with a minimum amount of clothing.
3. Determine the appropriate value of the basic exchange using the following Harris-Benedict tables. To do this, you need to find two numbers: the first - by height and age, the second - by body weight. The sum of these numbers will be the value of the proper basal metabolism (kcal / day), characteristic of the age, height and weight of the subject. In modern conditions, it is mainly expressed in kilojoules (kJ). Therefore, the sum of the numbers found using the tables must be multiplied by a factor of k = 4.19.

Tables of Harris - Benedict

Table: the number of calories according to height and age for men 16-26 years. (number A)

Height, cm	Age, years										
	16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
144	605	593	556	568	–	–	–	–	–	–	–
148	648	633	620	608	–	–	–	–	–	–	–
152	685	673	661	648	634	619	613	605	598	592	586
156	725	713	698	678	661	639	633	625	618	612	605
160	761	743	726	708	690	659	652	645	638	632	625
164	794	773	775	738	721	679	672	665	658	652	645
168	820	803	785	768	745	699	692	685	678	672	665
172	840	828	806	788	760	719	712	705	698	692	685
176	860	843	825	808	788	739	732	725	718	712	705
180	880	863	845	828	808	759	752	745	739	732	725
184	903	883	865	848	830	779	772	765	758	752	745
188	920	903	885	868	850	799	792	785	779	772	765
192	940	923	906	888	871	819	812	805	799	792	785

Table: the number of calories according to height and age for women 16-26 years. (Number A).

Height, cm	Age, years										
	16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
144	178	171	166	162	–	–	–	–	–	–	–
148	206	201	197	192	188	178	170	167	161	156	152
152	221	215	210	206	198	183	178	174	169	164	160
156	235	229	224	220	209	190	186	181	176	172	167
160	250	243	239	234	219	198	193	188	184	179	174
164	263	255	250	246	229	205	200	196	191	186	182
168	276	267	263	258	239	213	208	203	199	194	189
172	289	279	274	270	249	220	215	211	206	201	197
176	302	291	287	282	259	227	223	218	213	209	204
180	315	303	298	294	268	235	230	225	221	216	211
184	318	313	309	304	277	242	237	233	228	233	219

Table: Dependence of energy consumption on body weight. (number B).

Men				**Women**			
Weight, kg.	**calories**	**Weight, kg.**	**calories**	**Weight, kg.**	**calories**	**Weight, kg.**	**calories**
46	699	**78**	1139	**45**	1085	**76**	1382
48	727	**79**	1153	**46**	1095	**77**	1391
50	754	**80**	1167	**47**	1105	**78**	1401
51	768	**81**	1180	**48**	1114	**79**	1411
52	782	**82**	1194	**50**	1133	**80**	1420
53	795	**83**	1208	**51**	1143	**81**	1430
54	809	**84**	1222	**52**	1152	**82**	1439
55	823	**85**	1235	**53**	1162	**83**	1449
56	837	**86**	1249	**54**	1172	**84**	1458
57	850	**87**	1263	**55**	1181	**85**	1468
58	864	**88**	1277	**56**	1191	**86**	1478
59	878	**89**	1290	**57**	1200	**87**	1487
60	892	**90**	1304	**58**	1210	**88**	1497
61	905	**91**	1318	**59**	1219	**89**	1506
62	918	**92**	1332	**60**	1229	**90**	1516
63	933	**93**	1345	**61**	1238	**91**	1525
64	947	**94**	1459	**62**	1248	**92**	1536
65	960	**95**	1373	**63**	1258	**93**	1545
66	975	**96**	1387	**64**	1267	**94**	1554
67	988	**97**	1400	**65**	1277	**95**	1565
68	1002	**98**	1414	**66**	1286	**96**	1574
69	1015	**99**	1428	**67**	1296	**97**	1585
70	1029	**100**	1442	**68**	1305	**98**	1594
71	1043	**101**	1455	**69**	1315	**99**	1605
72	1057	**102**	1469	**70**	1325		
73	1070	**103**	1483	**71**	1331		
74	1084	**104**	1497	**72**	1344		
75	1098	**105**	1510	**73**	1353		
76	1112	**106**	1524	**74**	1363		
77	1125	**107**	1538	**75**	1372		

Results: Height = _____ cm. Body weight = _____ kg.

Number A = _____ Number B = _____

Basic metabolism (kcal / day) = number A + number B
Basic metabolism = _____ (kcal / day)

Conclusions: draw conclusions explaining why the value of proper basal metabolism depends on anthropometric data (height, body weight), as well as age and sex. _____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Practical work 58. Determination of deviation from the proper value of the basic exchange by Reed's formulas and nomogram.

Purpose: to determine the deviation of the value of the basic exchange by the formulas and nomogram of Reed.
Materials and equipment: tonometer, phonendoscope, stopwatch, ruler, colored pen or pencil.
The object of research: human.
It is known that in the conditions of the basic exchange 9-10% of energy of ATP are spent on the works carried out by heart. This gives grounds to establish the relationship between the parameters that characterize the function of the heart (heart rate, blood pressure), and the total energy expenditure of the body. This relationship can be most clear if the body is in standard conditions for determining basal metabolism. On the basis of numerous parallel studied parameters of hemodynamics and values of the basic exchange Reed empirically established and quantitatively expressed in the form of a formula dependence between indicators of measured functions. The coefficients used in this formula allow to calculate the percentage of deviation from the appropriate values of the basic exchange. This is quite convenient, because it is with this value that the assessment of the state of basal metabolism is performed (deviation ± 10% is considered normal).
Procedure:
1. At the subject in a supine position in the conditions of muscular rest to make three times measurement of arterial pressure - systolic (BPsyst.) and diastolic (BPdiast.). Next, measure your heart rate by heart rate. The interval between measurements should be 1 -2 minutes. For further calculations it is necessary to use the minimum values obtained during the measurements.
2. Calculate the value of pulse pressure (PP) by the formula: PP = BPsyst. - BPdiast.
3. Substitute the results into the Reed formula:

The percentage of deviation = 0.75 x (heart rate + 0.74 x PP) - 72.

Example, if heart rate = 76 per minute,
blood pressure (systolic) = 120 mm Hg,
blood pressure (diastolic)= 80 mm Hg,
the pulse pressure PP = 120 - 80 = 40 mm Hg.
Substitute the obtained data into the Reed formula:
Percentage of deviation = 0.75 x (76 + 0.74 x 40) - 72 = 7.2.
Deviation from norm to ± 15% is considered normal.

4. Instead of calculations, you can use the Reed nomogram (see figure on the right). Find the measured pulse value on the left scale and the pulse pressure on the right. Connect the found points with a line by applying a ruler. Draw a line with a colored pen or pencil. The point of intersection of the line with the middle scale shows the percentage deviation of the main exchange.
5. Record the results.
Results:

Heart rate = _____ / minute

BPsyst. = _____ mm.rt.st.

BPdiat. = _____ mm.rt.st.

Deviation = 0.75 (___ + 0.74 x ___) - 72 = _____%

Conclusions: Compare the data calculated by the Reed formula with the values of the appropriate ground exchange calculated in the previous practical work №47. Explain the possible reasons for the differences. Why on indicators of activity of system of circulatory system it is possible to draw conclusions about the basic exchange?

Practical work 59. Determination of daily energy consumption by time-table method.

Purpose: to determine the daily energy consumption using the time-table method.

Materials and equipment: table of total energy consumption. The object of research is a person. Timing-tabular method is the simplest and fastest method of approximate determination of human energy consumption. To do this, first timed the distribution of the daily time budget for individual operations and a chronogram of the day, and then on special tables, which show the energy cost of individual operations (labor, household and others), calculate energy costs for individual activities and for the day as a whole . This method can be used to determine the needs of the body as an organized contingent of the population and for a specific (individual) person. The table below presents data developed on the basis of determining energy expenditure in different states of the body (sleep, wakefulness, eating, etc.) and various types of its activities: work (study), physical education and sports, various forms of economic activity and more. The numbers that characterize the energy consumption in different conditions and at different levels of activity, take into account both the level of basal metabolism and the amount of work allowance, ie characterize the total energy consumption in a particular situation.

Table: Total energy consumption for different activities (including basic exchange)

Type of activity	Energy consumption per 1 kg of body weight, Kcal / minute	Type of activity	Energy consumption per 1 kg of body weight, Kcal / minute
Sleep	*0,0511*	Reading silently	*0,0230*
Run	*0,1780*	Physical training	*0,0648*
Conversation sitting	*0,0252*	Cycling	*0,1285*
Standing conversation	*0,0262*	Swimming	*0,1190*
Housework	*0,0530*	Playing football	*0,1190*
Personal Care	*0,0329*	Playing basketball	*0,2042*
Putting on and taking off clothes and shoes	*0,0281*	Care of the room, furniture, appliances	*0,0402*
Rest standing	*0,0264*	Energetic Dancing	*0,1614*
Rest sitting	*0,0229*	Skiing	*0,2086*
Rest lying down (without sleep)	*0,0183*	Aerobics	*0,312*
Shower	*0,0570*	Climbing the stairs up	*0,540*
Meals sitting	*0,0236*	Driving a car	*0,0154*
Working at a computer	*0,028*	Going by car	*0,0112*
Conversation without gestures	*0,0369*	Babysitting	*0,0360*

Walking on the asphalt road (4-6 km / h)	*0,0626*	Pet care	*0,0300*
Work in the garden	*0,135*	A walk with a dog	*0,048*
Cooking	*0,0330*	Seminar classes	*0,0250*
Purchase of goods, products	*0,0450*	Listening to lectures	*0,0243*
Dusting	*0,0411*	Work in the laboratory standing	*0,0360*
Washing-up	*0,0343*	Working in the laboratory sitting	*0,0250*
Ironing of linen	*0,0320*	Preparation for classes	*0,0250*
Work in the field	*0,0690*	Break between classes	*0,0258*
Boating	*0,233*	Mental work sitting	*0,0250*
Washing by hand, washing windows	*0,0642*	Board Games	*0,0126*
Vacuuming	*0,048*	Walk	*0,0516*
Travel in public transport	*0,0267*	Yoga	*0,100*

Procedure:
1. Time one of the most stereotypical days (24 hours), during which the duration of different activities is known (using the table above).
2. Find the numerical values of energy consumption per 1 kg of body weight per unit time.
3. Multiply the values found by the duration of this activity and the body weight of the subject. You will get the amount of energy consumption over a period of time. Make similar calculations for each activity and sleep during the day.
4. Find the sum of all quantities. The result roughly reflects the daily energy expenditure of the subject.

Results: The results of the work should be presented in the form of a table.

№	Activity	Activity time, min.	Energy consumption kcal / year	Energy consumption for the entire period of activity
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				
21.				
22.				
23.				
24.				
25.				
26.				
27.				
Total:				

Conclusions: Make a conclusion about the appropriateness of your energy consumption to the nature of the activity. Compare the obtained data with the energy costs of different professions.

_____
_____
_____
_____
_____
_____

Practical work 60. Basics of nutrition. Compilation of the daily diet according to the tables.

Purpose: to learn how to compile a daily diet.

Materials and equipment: tables.

The object of research: human.

Balanced diet as a properly organized provision of the body with nutritious and tasty food that contains the optimal amount of various nutrients necessary for its development and functioning. As a result of studying the body's needs for energy and nutrients, physiological norms of nutrition have been developed based on the following principles.

1. The energy value (caloric content) of the diet should correspond to the body's energy expenditure. It should be borne in mind that the digestibility of food is about 90%, ie the energy value of the diet should be 10% higher than the body's energy needs. The body's energy expenditure is determined by the level of basal metabolism and the amount of working allowance. The working allowance, in turn, depends on the nature of employment.

Nutrition standards for the population are enshrined in the order of the Ministry of Health of Ukraine dated 03.09.2017 №1073 "On approval of the norms of physiological needs of the population of Ukraine in basic nutrients and energy"

Depending on the severity of work, the entire population is divided into five (men) or four (women) occupational groups:

Physical activity groups	Coefficient of physical activity	Approximate list of specialties
I - workers mostly mental work, very light physical activity	1,4	Researchers, humanities students, programmers, controllers, teachers, dispatchers, console workers and others
II - workers engaged in light work, light physical activity	1,6	Tram, trolleybus drivers, conveyor workers, packers, seamstresses, workers in the electronics industry, agronomists, nurses, nurses, communications workers, service workers, sellers of manufactured goods and others
III - workers of average hard work, average physical activity	1,9	Locksmiths, adjusters, adjusters, machine operators, drillers, bus drivers, surgeons, textile workers, shoemakers, railway workers, food sellers, watermen, apparatchiks, metallurgists-blacksmiths, workers of chemical plants and others
IV - workers of hard physical labor, high physical activity	2,2	Construction workers, drill assistants, tunnelers, the vast majority of agricultural workers and machine operators, milkers, vegetable growers, woodworkers, metallurgists and foundries and others
V - workers of especially heavy physical work, very high physical activity	2,5	Machine operators and agricultural workers in the sowing and harvesting periods, loggers, concrete workers, masons, diggers, loaders of non-mechanized labor and others

In each of the groups there is a differentiation by age. Pregnant women and children with children 1 - 6 months and 7 - 12 months are allocated as additional groups. For them the additives to the group norms corresponding to their labor activity are specified.

2. Nutrients that come with food must be balanced with each other, ie be in certain proportions; in particular, for proteins of fats and carbohydrates, as a rule, the proportion should be observed: 1: 1,2: 4,6.
3. At least 55% for adults and 60% for children protein should come from animal products whose proteins contain a complete set of essential amino acids.
4. To meet the body's needs for unsaturated fatty acids, at least 30% of fats must be of vegetable origin.
5. The need for vitamins should be met by including in the diet of vegetables and fruits (preferably fresh), rye bread and bread made from wholemeal flour (B vitamins).
6. Food should be sufficient in volume and contain so-called ballast substances: fiber and pectin. These substances are not absorbed and used for human energy and plastic needs, but perform a number of important physiological functions: provide timely formation of satiety, adsorb toxins, normalize the microflora of the digestive system, stimulate its peristalsis.
7. The frequency of meals should be optimal: with three meals breakfast should be 35% of daily calories, lunch - 45%, dinner - 25%; with four meals breakfast - 25%, second breakfast (or lunch) - 15%, lunch - 35%, dinner - 25%. In the first half of the day should be dominated by meat, in the second - dairy and vegetable.

8. The situation should promote digestion: appearance, smell, taste of food should promote allocation of "appetizing" juice.
9. The optimal ratio of proteins, fats and carbohydrates (by weight) in the daily diet is 1: 1: 4.
10. The recommended content in the diet of animal proteins relative to the total amount of protein: for children - 60% or more, for adults - 50% or more.
11. The recommended protein content relative to the energy value (caloric content) of the daily diet for children - about 15% of calories, for adults - about 13% of calories; fat content - about 30% of calories.
12. The recommended content of vegetable fats in the diet is 20% of the total amount of fats. The recommended content of polyunsaturated and monounsaturated fatty acids in the diet is about 10% and 10% of the caloric content of the daily diet, respectively.
13. When calculating the nutritional value of the average daily sets of food products, the following values of generalized losses are used: for protein - 11%, fat - 12%, carbohydrates - 10%.

It should be noted that these principles are only indicative and are mainly used in the organization of food for large contingents of people in the same conditions.
Often the set of products and the nature of food are determined by national traditions, religious dogmas, availability of products, the nature of natural and climatic factors.

1) Using the table above, determine the norm of physiological needs for nutrients and energy appropriate for your age and professional group.
2) Make an individual daily diet, balanced in energy, protein, fat and carbohydrates, using the tables below. Currently, energy expenditures of all groups have decreased as the share of manual labor has decreased, the caloric content of the diet of urban residents should average 2000-2500 kcal / day.
3) All data on the caloric content of selected foods in the form of a table. In the column "product name" indicate the name of the dish, and then list the products included in it. The table ends with the final numerical data characterizing the daily diet.
The work is time consuming and time consuming, so it is recommended to do most of it as homework. In the practical lesson, the analysis of the diet and the formation of a conclusion about its compliance with the basic principles of nutrition.

Назва продукту	Protein, %	Fats, %	Carbohydrates, %	Energy value of 100 g of product, kcal kJ
1	2	3	4	5
Grain, bread, pasta				
Rye bread	5,5	1,0	44,5	189
Wheat bread	8,6	1,4	48,5	226
Wheat loaf	7,4	2,9	45,9	249
Sweet foaf	10,3	2,0	51,0	282
Wheat flour, high sort	10,8	0,9	73,6	354
Pasta, high sort	12,3	1,1	67,3	330
Buttery pastries	7,6	4,5	60	297
Cookie	10,4	1,3	68,7	312
Crackers	11	1,3	73	330
Wheat crackers	11,2	1,4	72,4	331
Groats				
Oatmeal	11,9	6,9	63,9	344
Pearl barley porridge	9,3	1,1	72,4	324
Buckwheat porridge	12,6	3,3	66,5	328
Semolina porridge	11,3	0,7	73,3	324
Millet	12,0	2,8	70,4	332
Barley porridge	9,3	1,5	70,7	243
Rice	7,3	2,5	74,4	346

Pea	23,0	2,0	59,0	249
Bean	22,3	1,7	58,4	307
Soy	34,9	1,7	30,8	393
Oat flakes	13,1	6,2	65,7	355
Corn porridge	8,3	1,2	75	325
Lentil	24,8	1,1	53,7	310
Meat, sausages, eggs, fish, seafood				
Meat pork	14,6	33,0	-	354
Fatty pork	11,4	49,3	-	487
Beef	18,9	12,4	-	186
Veal	19,7	1,2	-	90
Rabbit meat	20,7	12,9	-	198
Mutton	16,3	15,3	-	202
Chicken	18,2	18,4	-	240
Goose meat	9,0	27,8	-	300
Turkey meat	13,6	10,1	-	150
Duck meat	13,8	8,9	-	139
Horsemeat	20,2	7	-	143
Brisket	7,8	47,6	-	475
Sausage p / k	17,4	28,9	-	340
“Moscow sausage”	21,0	40,5	-	463
“Sausage Servelat”	28,2	27,5	-	360
“Krakow sausage”	16,2	44,6	-	466
Smoked loin	10,5	47,2	-	467
“Medical sausage”	13,7	22,8	-	260
Dairy sausages	12,3	25,3	-	277
Canned beef	20,5	10,4	-	176
Canned pork	16,9	15,4	-	206
Beef stew	16,8	18,3	-	232
Ham	12,9	26,6	-	300
Boiled ham	14,3	25,6	-	288
Quail eggs	11,9	13,1	0,6	168
Chicken eggs	12,7	11,5	-	156
Carp	16,0	3,6	-	96
Pike	18,8	0,7	-	82
Bream	17,1	4,1	-	104
Mackerel	18,0	9,0	-	152
Scad	18,5	5,0	-	119
Chum salmon	21,14	7,3	-	138,2
Salmon	21	15,5	-	222
Atlantic herring	24,6	12,4	-	217
Pacific herring	16,4	13,9		195
Grainy caviar	26,2	15,8	-	256
Catfish caviar	31,6	13,8	-	258
Flounder	16,1	2,6	-	88
Crucian	17,7	1,8	-	87
Smelt	15,5	3,2	-	91
Pollock	15,9	0,7	-	70
Capelin	13,4	11,5	-	157
Nototenia marble	14,8	10,7	-	156
Sea bass	17,6	5,2	-	117
River perch	18,5	0,9	-	82
Sturgeon	16,4	10,9	-	164
Halibut	18,9	3	-	103

Carp	18,4	5,3	-	121
Saira	18,6	20,8	-	262
Salaka	17,3	5,6	-	121
Tuna	22,7	0,7	-	96
Catfish	16,8	8,5	-	144
Sterlet	17	6,1	-	320
Eel sea	19,1	1,9	-	94
Hake	16,6	2,2	-	86
Squid	18	0,3	-	75
Shrimp	28,7	1,2	-	134
Mussels	9,1	1,5	-	50
Rapani	16,7	1,1	-	77
Smoked cod	20,7	22,9	-	290
Fats				
Butter	0,6	82,5	-	781
Sandwich margarine	0,5	82	1,2	744
Lard	1,9	87,4	-	821
Sunflower oil	-	99,9	-	929
Margarine	0,5	82,0	0,4	766
Mayonnaise	3,1	67	2,6	627
Dairy products				
Cow's milk	3,2	3,6	4,7	67
Cheese from cow's milk	17,9	20,1	-	260
Fatty cheese	14,0	18,0	2,3	225
Low-fat cheese	18,0	0,6	2,5	86
Soft cheese	17	11,3	23,9	257
Kefir is fatty	3,3	3,7	3,0	67
Processed cheese	22,1	18,2	-	268
Natural yogurt	4,3	2	6,2	60
Condensed milk with sugar	7,2	8,5	56	315
Cream 10%	3	10	4	118
Cream 20%	2,8	20	3,6	205
Sour cream 10%	3	10	2,9	116
Sour cream 20%	2,8	20	3,2	206
Sour cream 30 %	2,4	30,0	2,3	302
“Russian cheese”	23,4	30	-	371
“Dutch cheese”	26,8	27,3	-	361
“Swiss cheese”	24,9	31,8	-	396
Marinated vegetables				
Cabbage	5,8	2,3	-	17
Cucumbers	0,7	0,4	-	8
Tomatoes	0,9	0,9	-	11
Fresh vegetables				
Eggplant	0,6	0,1	6,8	24
White cabbage	1,8	-	6,1	28
Cauliflower	2,5	-	2,2	29
Red cabbage	1,5	-	5,2	27
Young potatoes	1,7	-	17,8	80
Potatoes from XI to I months.	1,5	-	15,8	71
Potatoes till III months.	1,4	-	14,7	66
Potatoes from III till VI months	1,2	-	12,6	56
Red carrots until January 1	1,3	-	6,4	33
Carrots from January 1	1,1	-	6,0	29
Beet	1,7	-	10,7	48

Ground cucumbers	0,8	-	3	15
Greenhouse cucumbers	0,7	-	1,8	10
Sweet green pepper	1,3	-	4,7	23
Red sweet pepper	1,3	-	5,7	27
Radish	1,9	-	8,4	34
Tomatoes are ground	0,6	-	4,2	19
Greenhouse tomatoes	0,6	-	2,9	14
Watermelon	0,7	-	9,9	38
Green peas	5,0	-	13,4	75
Melon	0,4	-	4,5	25
Artichoke	1,3	-	3,8	59
Zucchini	0,4	-	2,5	12
Green onions	1,3	-	4,3	22
Parsley (greens)	3,7	-	8,1	45
Parsley (root)	1,5	-	11	47
Spinach	2,9	-	2,3	21
Onions	1,7	-	9,5	43
Squash	0,6	-	4,1	19
Celery (greens)	-	-	2,0	32
Salad	1,1	-	1,5	11
Pumpkin	0,3	-	4,4	19
Dill	1,8	-	5,6	30
Asparagus	1,9	0,1	3,2	21
Horseradish	1,6	-	10,4	49
Garlic	5,1	-	16,5	89
Fruits and berries				
Apricots	0,9	-	11,3	46
Cherry	0,8	-	11,8	49
Sea buckthorn	0,9	2,5	5,0	52
Pear	0,4	-	12,2	42
Plum	0,8	-	10,4	43
Apple	0,4	-	11,9	46
Grape	0,6	-	18,1	69
Blackberry	2,0	-	7,3	33
Strawberry	1,8	-	12,1	41
Raspberry	0,8	-	10,8	41
Black currant	1,0	-	11,0	40
White currant	0,3	-	7,8	40
Red currants	0,5	-	7,2	43
Rose hips are fresh	1,6	-	28,2	101
Orange	0,7	-	6,3	33
Banana	0,9	-	13,4	60
Lemon	0,4	-	1,8	21
Tangerine	0,6	-	6,4	32
Peach	0,8	-	9,4	44
Pomegranate	0,9	-	11,8	52
Pineapple	0,4	-	11,8	48
Fig	0,7	-	13,9	56
Dogwood	1	-	9,7	45
Dates	2,5	-	72,1	281
Persimmon	0,5	-	15,9	62
Mulberry	0,7	-	12,7	53
Grapefruit	0,9	-	7,3	35
Cranberry	0,7	-	8,6	40

Gooseberry	0,7	-	9,9	44
Blackthorn	1,5	-	8,3	45
Rowan chokeberry	1,5	0,1	10,9	52
Bilberry	1,1	-	8,6	40
Strawberry wild	0,5	-	4,8	28
Quince	0,6	-	8,9	38
Dried fruits and nuts				
Dried apricots	5,2	-	66,4	302
Raisins	1,6	-	63,8	273
Dried pear	3,0	-	68,5	303
Prunes	1,7	-	48,8	218
Dried apples	1,5	-	50,4	220
Hazelnut (forest)	8,6	26,2	4,0	294
Hazelnut	16,1	66,9	9,9	704
Almond	18,6	57,7	13,6	645
Walnut	13,8	61,3	10,2	648
Peanut	26,3	45,2	9,7	548
Sunflower seeds	20,7	52,9	5	578
Mushrooms				
Mushrooms	4,3	-	0,1	27
White mushrooms	4,2	0,4	2,3	126
Brown mushrooms	0,9	0,7	3,4	19
Yellow mushrooms	2,2	1,2	4,6	20
Desserts and sweets				
Milk ice cream	3,2	3,5	22,5	137
Ice cream	4,2	15,0	20,4	240
Eskimo creamy	3,2	20,4	19,7	284
Sugar	-	-	99,9	410
Chocolate candies	2,9	10,7	76,6	396
Honey	0,4	-	81,3	335
Marshmallow	0,8	0	78,3	299
Peanut halva	16,7	30,4	43,2	545
Cake	7,0	17,1	62,9	446
Jam	-	-	66,7	274
Dark chocolate	5,4	35,3	52,6	540
Milk chocolate	6,9	35,7	52,4	547
Waffles with fruit fillings	3,2	2,8	80,1	342
Waffles with fatty fillings	3,4	30,2	64,7	530
Puff pastry with cream	5,4	38,6	46,4	544
Puff pastry with apple	5,7	25,6	52,7	454
Cake with fruit filling	4,7	9,3	84,4	344
Gingerbread	4,8	2,8	77,7	336
Almond cake	6,6	35,8	46,8	524
Drinks				
Coffee with milk	-	-	-	187
Cocoa	16,4	18,7	35,1	385
Black tea, without sugar	-	-	0,3	1
Orange juice	0,7	0,1	13,21	60
Tomato juice	1	0,1	2,9	18
Apple juice	0,5	0,1	10,1	46
Cherry juice	0,7	-	12,2	53
Beer	0,6	-	4,8	37
Red wine tables	0,2	-	0,2	71

Carbonated drink, soda cream, lemonade, etc.	-	-	13,31	51
Cola, with caffeine	0,07	0,02	9,56	38
Bread kvass	0,2	-	5,2	27

Results: Table: Set of food products

Product name	**The amount of product**	**The content in the taken quantity of a product, g**			**Energy value**
		Proteins	**Fats**	**Carbohydrates**	
Breackfast					
Total					
Lunch					
Total					
Dinner					
Total					
Total per day					

Conclusions: Assess the compliance of your diet with the principles of nutrition. Make an ideal diet for the week, using information about daily energy expenditure and the principles of compiling a diet. Draw a conclusion. _____

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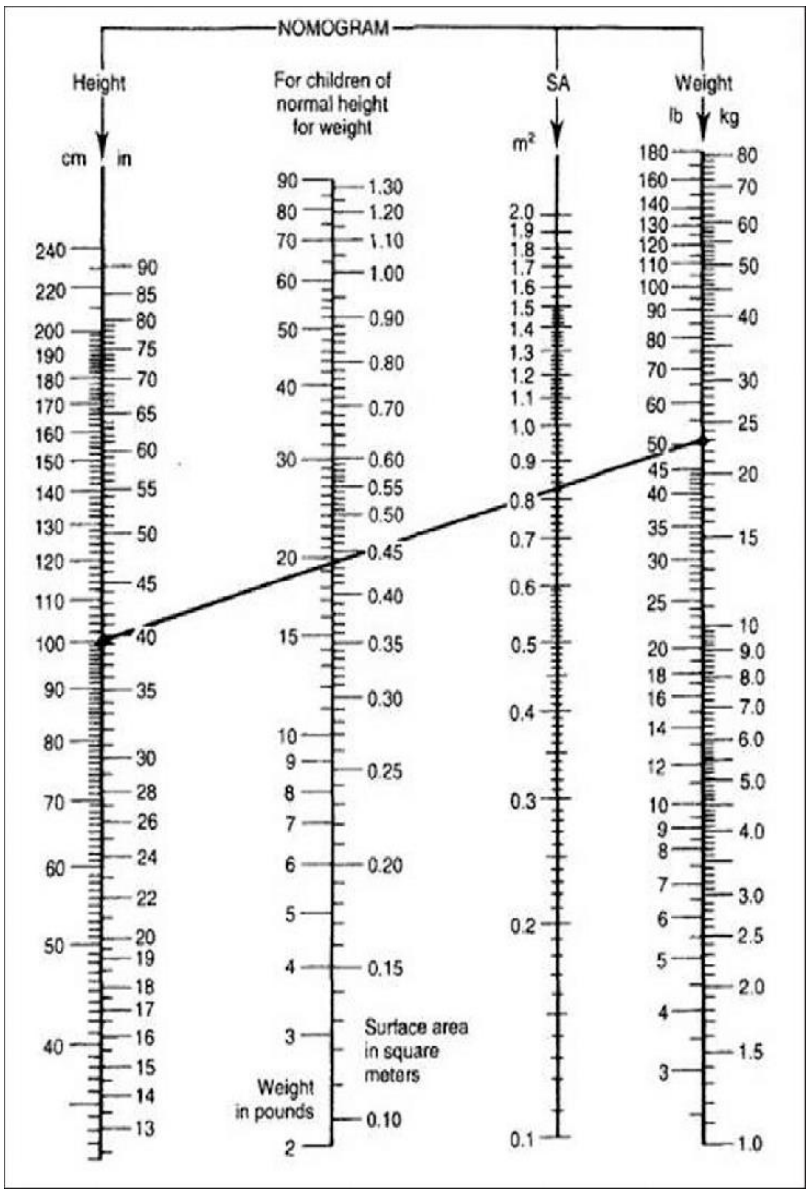
Module 10. Physiology of the excretory system

Practical work 61. Determination of glomerular filtration rate (GFR).

Purpose: to learn to determine the rate of glomerular filtration.
Materials and equipment: nomogram to determine the surface area of the body.
The object of research: human.
The glomerular filtration rate (GFR) shows the amount of urine produced in the kidneys per unit time. It is usually expressed in ml / min. This is a very important indicator, because it can be used to assess the ability of the kidneys to perform their primary function.
GFR is determined by the volume of filtrate entering the initial nephron of both kidneys in 1 min. The method is based on determining the clearance.
Clearance - the rate of purification of plasma from this substance in 1 minute. when passing it through the kidneys. Today, in clinical practice, creatinine clearance is most often determined to assess glomerular function.
GFR is measured in ml for 1 min. per 1.73 m2 of body surface, and quantitatively it corresponds to the clearance of the substance from which the plasma is purified only by filtration.
Clearance is found by the formula: **Cin. = (Win .: Pin.) × V**,

de Cin. - inulin clearance,
Uin. - the concentration of inulin in the urine,
Pin.- concentration of inulin in blood plasma,
V - the amount of urine ml / min

Normal GFR range, adjusted for body surface area:
men under 40 years - 100 -130 ml / min / 1.73m2
women under 40 years - 90 - 120 ml / min / 1.73m2.
children under 2 years, both sexes - 110 ml / min / 1.73 m2 (measured by inulin clearance)
With age, GFR gradually decreases, and after 40 years, the rate decreases annually by approximately 0.4 ml / min - 1.2 ml / min.
Procedure:
Task 1. Calculate GFR in a man aged 33 years (height 175 cm, body weight 72 kg), if after the introduction of inulin, its concentration in plasma is 0.04 mmol / l, in urine - 0.85 mmol / l. Urine is excreted 5 ml / min.
Task 2. Calculate GFR in a man aged 47 years (height 178 cm, body weight 75 kg), if after the introduction of inulin, its concentration in plasma is 0.044 mmol / l, in urine - 0.72 mmol / l. Urine is excreted 4 ml / min.
Task 3. Calculate GFR in women aged 26 years (height 160 cm, body weight 54 kg), if after the introduction of inulin, its concentration in plasma is 0.05 mmol / l, in urine - 0.76 mmol / l. Urine is 3.3 ml / x2.
Task 4. Calculate GFR in a man aged 38 years (height 180 cm, body weight 78 kg), if after the introduction of inulin, its concentration in plasma is 0.21 mmol / l, in urine - 12.6 mmol / l. Urine is excreted 1 ml / min.



Nomogram to determine the surface area of the body.

The values of the body surface area are found at the point of intersection of the line that connects the indicators of growth (on scale I) and weight (on scale III), with the scale II.

Results: _____

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Conclusions: Draw conclusions about the definition of GFR and its importance in clinical practice _____

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Practical work 62. Research of tubular reabsorption.

Purpose: to learn the study of tubular reabsorption.

Materials and equipment: nomogram to determine the surface area of the body.

The object of research: human.

Tubular reabsorption is the process of absorption by tubules of cells and transport into the intercellular fluid and capillaries of the kidneys of substances necessary for the body from primary urine.

The amount of tubular reabsorption of substances is determined by the difference between their number in the primary and final urine. The amount of tubular reabsorption of water (RH_2O) is determined by the difference between the glomerular filtration rate (Cin) and the amount of final urine and is expressed as a percentage relative to GFR.

RH_2O = (Cin. - V): Cin.) × 100%. Normally, the amount of reabsorption is 98 - 99%.

The functions of the proximal tubules are assessed by the value of the maximum reabsorption of glucose (Rmax.gl.), increasing its concentration in blood plasma to a limit significantly exceeding the threshold.

R max.gl. = Cin. × Pgl. - Angle. × V,

de Cin. - GFR, Pgl. - the concentration of glucose in blood plasma,
Angle - the concentration of glucose in the urine,
V - minute diuresis.

Normally Rmax.gl. in men it is 34.7 mmol / l per 1.73 m2 of body surface. After 40 years, it decreases by 7% every 10 years of life.

Procedure:

Task 1. Calculate RH_2O in a man aged 32 years (height 1706 cm, body weight 70 kg), if the concentration of endogenous creatinine in plasma is 0.21 mmol / l, in urine - 10.7 mmol / l. Urine is excreted 1 ml / min.

Task 2. Calculate the rate of maximum glucose reabsorption in women aged 42 years (height 165 cm, body weight 65 kg), if the GFR is 15 ml / min., The concentration of glucose in plasma is 22.2 mmol / l, in urine - 111 mmol / l. Urine is excreted 5.2 ml / min.

Task 3. Calculate the rate of maximum reabsorption of glucose in a man aged 44 years (height 180 cm, body weight 82 kg), if the GFR is 16 ml / min., The concentration of glucose in plasma is 19.1 mmol / l, in urine - 94, 2 mmol / l. Urine is excreted 5.4 ml / min

Results:

Conclusions: Draw conclusions about the determination of tubular reabsorption.

Practical work 63. Research of tubular secretion.

Purpose: to learn the study of tubular reabsorption.
Materials and equipment: nomogram to determine the surface area of the body.
The object of research: human.

Tubular secretion is an active process carried out by enzyme systems of membrane transport in the proximal nephron. The value of the maximum tubular secretion is determined by the difference between the amount of substance in the primary and final urine:

$$\mathbf{S\ max. = V \times U - C \times P \times a,}$$

where S max. - maximum tubular secretion,
V - minute diuresis,
U - the concentration of the substance in the urine,
C - the glomerular filtration rate,
P - the concentration of the substance in blood plasma,
a - the part of the substance contained in the plasma that is not bound to proteins.

To assess the secretion in the proximal tubules determine the secretion of paraaminohypuric acid (PAA), or diotrast or drugs of the penicillin group.

$$\mathbf{S\ max._{PAA} = V \times U_{PAA} - Cin. \times P_{PAA} \times a,}$$

where a = 0.8.

Normal S $max._{PAA}$ = 6.78 +1.37 mmol / s or 79.9 + 6.7 ml / min. on 1.73 m^2 of body surface.
Procedure:
Task 1. Calculate the value of the maximum secretion of PAG in women aged 48 years (height 167 cm, body weight 65 kg), if the concentration of PAG in plasma is 2.06 mmol / l, in urine - 115 mmol / l. Urine is excreted 4 ml / min. The value of glomerular filtration is 100 ml / min.

Task 2. After the introduction of diotrast, its concentration in blood plasma is 15.8 mmol / l, in urine - 392.4 mmol / l. The concentration of iodine in plasma does not depend on the level of proteins - 0.73. Calculate the maximum secretion of iodine in humans, the body surface area of which is 1.73 m^2, the value of glomerular filtration - 120 ml / min., The amount of urine - 3 ml / min.
Result: _____

Conclusions: Draw conclusions about the determination of tubular secretion.

ADDITION

Tables of laboratory indicators

General blood test

Indicator	Norma
Erythrocytes	MEN: 4,0 – 5,0 * 10^{12}/l
	WOMEN: 3,9 – 4,7 * 10^{12}/l
Hemoglobin	MEN: 135 – 180 g/l
	WOMEN: 120 – 140 g/l
Color indicator	0,85 – 1,15
Reticulocytes	0,2 – 1%
Platelets	180,0 – 320,0 * 10^9/l
Leukocytes	4,0 – 9,0 * 10^9/l
Basophils	0 – 0,065 * 10^9/l (0-1%)
Eosinophils	0,02 – 0,30 * 10^9/l (0,5 – 5,0%)
Stick nuclear neutrophils	0,04 – 0,30 *10^9/l (1-6%)
Segmental neutrophils	2,0 – 5,50 *10^9/l (47 – 72%)
Monocytes	0,09 – 0,60 * 10^9/l (3 – 11%)
Lymphocytes	1,2 – 3,0 *10^9/l (19 – 37%)
Erythrocyte clotting rate (ECR)	MEN: 2-10 mm/h
	WOMEN: 2-15 mm/h
Hematocrit	MEN: 40-48%
	WOMEN: 36-42%

Biochemical analysis of blood

Total protein	65 – 85 g/l
Albumins	35 – 50 g/l (52 – 65%)
Globulins:	23 – 35 g/l (35 – 48%)
α_1 - globulins	2 – 4 g/l (4,2 – 7,2%)
α_2 – globulins	5 – 9 g/l (6,8 – 12%)
β – globulins	6 – 11 g/l (9,3 – 15%)
γ - globulins	11 – 15 g/l (15 – 19 %)
Anlutination factor	1,2 – 2,0
Immunoglobulins:	
IgD	0 - 0,15 g/l
IgG	50 – 112,5 μmol / l
IgM	0,6 – 2,5 μmol / l
IgA	5,6 – 28,1 μmol / l
IgE	0,3 – 30 nmol / l
Bilirubin:	
general	8,5 – 20,5 μmol / l
free (indirect)	1,7 – 17,11 μmol / l
bound (direct, conjugated)	0,86 – 5,1 μmol / l
Lipids (total content)	5 – 7 g/l

Triglycerides	0,59 – 1,77 μmol / l
Total cholesterol	2,97 – 8,79 μmol / l
Lipoproteins:	
Very low density (prebetalipoproteins)	1,5 – 2,0 г/л (0,63 – 0,69 μmol / l)
Low density (beta-lipoproteins)	3 – 4,5 г/л (3,06 – 3,14 μmol / l)
High density (alpha - lipoproteins)	1,25 – 6,5 г/л (1,13 – 1,15 μmol / l)
Chylomicrons	0 – 0,5 г/л (0 – 0,1 μmol / l)
Blood glucose	3,3 - 5,5 μmol / l
Glycated (glycosylated) hemoglobin	4 – 7%
Blood iron	8,53 – 28,06 μmol / l
Blood potassium (plasma)	3,8 – 5,2 μmol / l
Blood sodium (plasma)	138 – 217 μmol / l
Blood calcium (plasma)	0,75 – 2,5 μmol / l
Magnesium (plasma)	0,78 – 0,91 μmol / l
Blood chlorides	97 – 108 μmol / l
Residual nitrogen (non-protein)	14,28 – 25 μmol / l
Urea, whey	3,33 – 8,32 μmol / l
Creatinine	53 – 106,1 μmol / l
Creatine	MEN: 15,25 – 45,75 μmol / l
	WOMEN: 45,75 – 76,25 μmol / l
Uric acid	MEN: 0,12 – 0,38 μmol / l
	WOMEN: 0,12 – 0,46 μmol / l
Lactate dehydrogenase (LDH)	< 7 μmol /(hour/l)
Aldolase	0,2 – 1,2 μmol /(hour/l)
Alpha-amylase (diastose) of the blood	12 – 32 g/(hour/l)
Aspartate aminotransferase (AST, AST)	0,1 – 0,45 μmol /(hour/l)
Alanine aminotransferase (ALT, ALT)	0,1 – 0,68
Cholinesterase	160 – 340 μmol /(hour/l)
Alkaline phosphatase	0,5 – 1,3 μmol /(hour/l)
Creatine kinase	0,152 – 0,305 μmol /(hour/l)
Creatine phosphokinase (CPK), serum	До 1,2 μmol / (hour/l)
Lipase	0,4 – 0,30 μmol /(hour/l)

Coagulogram

Prothrombin index	80 – 100%
Plasma recalcification time	60 – 120 c
Thrombosis	IV – Vl evels
Thrombosis	5,9 – 11,7 μmol / l
Fibrinogen B	negative
Fibrinolytic activity	183 – 263 min.
Plasma tolerance to heparin	3 – 6 (7 – 11) min.
Lee White's blood clotting time	5 – 10 min.
Duration of bleeding according to Duke	till 4 min.

Blood clot retraction	44-65% (index retraction 0,3 – 0,5)

Indicators of acid-base status

pH, arterial roof	7,4
pH, arterial roof	7,35
Spill in carbon dioxide, Pco_2:	
Arterial shelter	40 mmHg.
Venous roof	46 mmHg
Voltage o_2, Po_2, arterial blood	75-105 mmHg
Excess (deficit) of bases (BE)	+-2,3 μmol / l
General buffer bases of explosive blood	45-50 μmol / l
Standard bicarbonate (B):	
Arterial blood	24 μmol / l
Venous blood	26 μmol / l
Genuine bicarbonate (AB)	27 μmol / l

Other blood counts

Cortisol, serum	230 – 750 nmol / l
Osmolality, serum	275 – 295 μmol /kg
Parathyroid hormone, serum	42,6 +- 9,31 nmol / l
Somatotropic hormone	0 – 118 nmol / l
Thyroid hormone, serum or plasma	128 +- 28 nmol / l
Thyroxine (T4), serum	65 – 155 nmol / l
Triiodothyronine (T3), serum	1,77 – 2,43 nmol / l
Ferritin, serum	MEN: 96 +- 7,63 mkg/l
	WOMEN: 45,5 +- 4,58 mkg/l
a1- seromucoid	12,47 – 31,75 μmol / l
Thymol test	till 5 unit
Sialic acid	550 – 790 mg/l
C is a reactive protein	negative
Antistreptohyaluronidase (ASG)	250 unit
Antistreptolysin - 0 (ASL - 0) 250 IU	250 unit

Daily energy consumption of the adult population without physical activity

Body weight kg	**Age**			
	18-29 years	**30-39 years**	**40-59 years**	**60-74 years**
MEN (basic exchange)				
50	1450	1370	1280	1180
55	1520	1430	1350	1240
60	1590	1500	1410	1300
65	1670	1570	1480	1360
70	1750	1650	1550	1430
75	1830	1720	1620	1500
80	1920	1810	1700	1570
85	2010	1900	1780	1640
90	2110	1990	1870	1720
WOMEN (basic exchange)				
40	1080	1050	1020	960
45	1150	1120	1080	1030
50	1230	1190	1160	1100
55	1300	1260	1220	1160
60	1380	1340	1300	1230
65	1450	1410	1370	1290
70	1530	1490	1440	1360
75	1600	1550	1510	1430
80	1680	1630	1580	1500

Daily need of adults, proteins, fats, carbohydrates and energy (women)

Group	Ind.	Age (years)	Energy, kcal	Proteins, g		Fats,g	Carbohydrates, g
				total	including animals		
I	1,4	18-29	2000	61	30	62	300
		30-39	1900	59	29	60	280
		40-59	1800	58	28	58	240
II	1,6	18-29	2200	66	34	70	326
		30-39	2150	65	32	70	315
		40-59	2100	63	32	66	313
III	1,9	18-29	2600	76	40	80	394
		30-39	2550	74	39	83	377
		40-59	2500	72	38	80	373
IV	2,2	18-29	3050	87	46	90	473
		30-39	2950	84	45	85	462
		40-59	2850	82	43	85	439
In addition to the norm according to physical activity and age							
Pregnant			+350	30	20	12	30
Breathfeeding (1-6 month)			+500	45	34	13	50
Breastfeeding (7-12 month)			+450	40	26	14	40

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Електронне навчальне видання комбінованого використання
Можна використовувати в локальному та мережному режимі

Шерстюк Сергій Олексійович
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ФІЗІОЛОГІЯ ЛЮДИНИ

Практикум

для самостійної роботи студентів медичного факультету 2-го року навчання з дисципліни «Фізіологія» спеціальності 222 «Медицина»

(Англ. мовою)

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