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GENERAL PHYSIOLOGY

Methodological development
Educational materials for second year medical students
(22 Healthcare 222 Medicine)

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Educational and methodical recommendations on the subject "Physiology" are designed for the study of physiology by foreign students. The purpose - to provide a list of questions, keywords and terms, questions and answers and examples of MCQs on the system "Krok-1" for individual work and mastering the subject by students in preparation for practical classes in physiology.

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INTRODUCTION

The organization of the educational process in the subject "Physiology" is carried out according to the credit-module system in accordance with the requirements of the Bologna process. The curriculum is structured into 2 modules, which include blocks of content modules.

For each module the student can get a maximum of 200 points, the grade for the subject is set as the arithmetic mean of 2 modules. From each module 120 points can be obtained for current performance, 80 points - for the final module control. For each lesson the student can receive 3 points: 2 points for solving MCQs and 1 point for written task, practical work, answers to questions of the teacher, or solving of situational tasks.

Student assessment scheme:

The maximum score for the subject is **200**
The maximum score for the module is **200**
The maximum score for all classes is **120**, including: **84** points for laboratory classes, **36** points for three Submodules.
The maximum score for the final module control is **80**, including: **50** points for MCQs, **30** points - written task.
The minimum number of points at which a student is allowed to take the final module control is **70** points.

Content

Methodological development №1

The topic: Introduction to physiology.
The number of hours: 2 hours
The class takes place in: education laboratory
The object of learning:
To know: basic methods of physiological research, the concept of function and its regulation, functional system as the basis for the formation of clinical thinking of the doctor.
Be able to: differentiate acute and chronic physiological research methods.
Observe basic safety precautions when working in the physiological laboratory, draw laboratory protocols.

Theoretical questions for self-preparation

1. Methods of physiological research.
2. Basic concepts of physiology (function, physiological process, norm and regulation of the function).
3. Functional system as the basis for the formation of clinical thinking of the doctor.

Key words and terms: mechanism, rule, regulation function, physiological process, functional system, function.

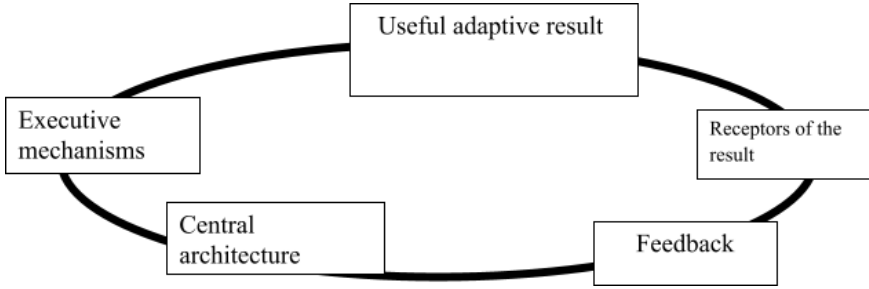
Definitions of key terms and concepts

Normal Physiology is the science that studies the functions of a healthy human body, the underlying physiological processes and mechanisms of their regulation.
Function is a set of interrelated physiological processes that aim to achieve a particular result.
The physiological process is a sequence of physiological events that lead to implementation of functions. Underlying physiological processes are the specific physiological mechanisms.
Mechanism is a way to implement a physiological process.
Regulation of the function is the adaption of this function to current needs of the body. Usually it is achieved by coordinating influence of the nervous and endocrine systems.
Norm is the statistical characterization of the life`s parameters that defines optimal health. It can be the average value of the index or a range of its variations.
Functional system is a selective integration of the various structural elements of the body to ensure some useful result.

Instruments, used in physiological research

1. Devices for stimulation of biological structures (stimuli, irritant electrodes).
2. Devices to record physiological processes that reflect different functions (recorders, taking off electrodes, sensors, amplifiers).

Scheme of functional system



P.K.Anokhin highlighted the main common components for each functional system:

- useful adaptive result as the main system-forming link of the functional system. As a rule, this is the parameter of homeostasis or behavioral reaction;
- receptors of the result;
- afferent feedback, which comes from the receptors of the result in the central regulatory structures;
- executive mechanisms that include somatic, autonomic, endocrine regulatory mechanisms and targeted behavioral responses;
- central architecture, which is a selective association of nerve centers of different levels.

Methodological development №2

The topic: Bioelectric occurrences on the membrane of the excitable cells. Resting membrane potential and mechanisms of its establishment. Action potential and its characteristics.
The number of hours: 2 hours
The class takes place in: education laboratory
The object of learning:
To know: ion channels and their role in the processes of excitability mechanisms of origin. Resting membrane potential, action potential and their physical, physiological characteristics and methods of measurement.
Be able to: paint the schema of the development in time of the action potential,

changes of resting membrane potential during depolarization and hyperpolarization of the cell membrane, interpret the mechanism of the origin of resting membrane potential in different cells.

Theoretical questions for self-preparation

1. Current understanding of the structure and function of cell membranes.
2. Ion membrane channels and their role in the excitability of cell.
3. Ionic gradients of cells and mechanisms of their occurrence.
4. Formation of resting membrane potential. Nernst equation.
5. Action potential and its phases. Ionic mechanisms of action potential.

Key words and terms: excitability, selectivity of channels, activity or passive of channels, local character of channels, functional specificity, electrochemical gradient, sodium-potassium pump of the cell membrane, membrane resting potential, action potential, phase of depolarization, phase of repolarization, phase of afterhyperpolarization.

Definitions of key terms and concepts

Resting membrane potential is the constant potential difference between outer and inner side of the cell membrane, through which the cell can excite under the influence of the stimuli.

Diffusion is the type of passive transport, when ions or molecules are transported without energy consumption due to the difference of electrochemical gradient.

Osmosis is a transport of solvent through the semipermeable membrane to the area of more concentrated solution.

Filtration is transport of fluid through a semipermeable membrane due to gradients pressures.

Active transport is the movement of substances across cell membranes against concentration and electrochemical gradient. It is carried out with special carrier protein and energy compounds (macroergic phosphates).

Endocytosis and exocytosis are the variants of transport, when the architecture of membranes is changed. It happens with energy consumption.

Endocytosis is the introduction of macromolecular particles from the environment into the cell. One of its categories is phagocytosis, the other **- *pinocytosis*.**

Phagocytosis is the transport, when phagocytic cells absorb and digest the microorganisms and the foreign bodies (for example, such mechanism observe in monocytes and granulocytes).

Pinocytosis a way of engulfing the protein molecule by a cell without hydrolysis.

Exocytosis is an emission of macromolecules from cells (for example, emission of neurotransmitter from vesicles to the synapse).

Action potential is a rapid change of the membranes charge that can spread along the

membrane of the excitable cells.

Depolarization is a decrease of the positive charge of the cell's membrane potential on its outer surface.

Hyperpolarization of the membrane is the increase of positive charge on its outer surface.

Control questions and answers on the topic

1. What is the difference between irritability and excitability?
Irritability - is a general property of an alive tissue to change its state under the action of stimulus. Excitability - ability of certain tissues to generate AP.
2. What cell in tissues are excitability and not excitability?
Excitability - a special case of irritability. Excitable tissue cells are able to generate AP and not excitable cells doesn't have the ability to generate AP.
3. What cells are excitable? What cells are not excitable?
Excitable - nerve and muscle, not excitable - epithelial and connective.
4. Define the concept of "stimulus."
Stimulus – is a change in the external or internal environment that perceived by cells and causes a reaction.
5. Two main types of stimuli and their varieties.
Physical - electrical, mechanical, thermal, light; Chemicals – various compounds and gases.
6. The advantages of electric stimuli.
Its versatility, ease of dosage strength, duration, frequency and steepness increase incentives, to switch it on and off.
7. What is the resting membrane potential? What is its value?
The potential difference between the inside and the outside of the cell membrane. Is from 50 to 100 mV.
8. What is the main cause and outcome of RMP?
The different concentration of anions and cations on both sides of the cell membrane is a consequence of different permeability of the membrane for different ions and the active transport of ions by means of ion pumps.
9. How experimentally can be proved the existence of active sodium transport?
By introducing into the cell a radioactive isotope of sodium and its appearance in an extracellular environment (excretion against a concentration gradient). Blocking of ATP synthesis eliminates sodium excretion.
10. Describe the structural and functional organization of the ion potential-dependent channel.
The channel is formed by protein molecules that penetrate the entire thickness of the membrane. It is a "gate" formed by a protein molecule capable to change its conformation under the influence of an electric field (the "gate" is open or closed).

11. Where are (in the intercellular fluid or in the cytoplasm) ions of sodium, potassium, chlorine mainly located? Which is the charge of inner and outsides of the cell membrane?
Ions of sodium and chlorine are located in the intercellular fluid, potassium ions – inside of the cell. The inner side – negative, the external - positive.
12. What are the main anions located in the cell and are important in forming the resting potential. What is the role of these ions?
Glutamate, aspartate, organic phosphate, sulfate. The cell membrane is not permeable for them.
13. Are sodium and potassium ions able to move into the cell and out of the cell actively in resting state? Why these concentration gradients do not break?
Potassium ions move out of the cell, sodium ions move into the cell, because of the constant work of the sodium-potassium pump which carries a number of sodium and potassium ions back, supporting their concentration gradient.
14. What is the reason of permeability of the cell membrane for different ions? What does it depend on?
It is a property of the membrane to pass different substances, including uncharged particles and ions. It depends on the functioning of different channels and their state ("gate" open or closed) on solubility of particles in the membrane, on the size of particles and channels.
15. What determines the conductance of ions across the cell membrane?
The permeability of the cell membrane for the ion, its concentration and electrical gradient.
16. Write the Nernst equation by which you can calculate the value of the equilibrium potential for individual ions?

Nernst equation. $E = 61 \lg \frac{C_1}{C_2}$

where C_1 - concentration of ions inside the cell, C_2- is the ionic concentration outside the cell.
17. Describe the structural and functional organization of ionic potential -dependent channel.
A channel created by protein molecules that penetrate the entire thickness of the membrane, it has a "gate" formed by protein molecules that are able to change their conformation under the influence of an electric field ("target" open or closed).
18. How to prove experimentally the existence of different types of ion channels?
By application of specific blockers of ion channels and thereby preventing the passive movement of the ions into the cell or from the cell, observing the change of the resting potential value.
19. Specify the functional differences between controlled and uncontrolled channels.
Ions pass very quickly through open "gates" of controlled channes and pass - constantly and slowly through uncontrolled (ionic channels).

20. Name specific blockers of sodium and potassium controlled channels.
Tetrodotoxin - for sodium channels, tetraethylammonium - forpotassium.
21. What properties does the cell membrane have?
Ability to change its permeability under the action of the stimulus. It is realized by activation and inactivation of sodium and potassium channels
22. List the main ion-selective channels and their varieties.
For potassium - slow uncontrolled, rapid potential sensitive and calcium dependent. For sodium - slow and fast uncontrolled potential sensitive. For calcium - slow and fast potential sensitive.
23. How and why would change the value of the resting potential if the penetration of the cells membrane be the same for all ions, and the sodium-potassium pump will continue to work?
The resting potential will be significantly reduced due to equalization of the concentration of various ions inside and outside the cell. The potential will be created only by the sodium-potassium pump.
24. Which feature of the cell membrane provides the appearance of the action potential and by which phenomenon it is realized?
The ability to change its permeability under the stimuli. It is realized by activation and inactivation of sodium and potassium channels.
25. Specify the approximate value of the duration and amplitude of the action potential of nerve fibers and skeletal muscle.
The duration is near 1 ms and 10 ms, respectively, the amplitude approximately 100-130 mV.
26. What is an after potential? What types of after potential do youknow?
Slow changes of membrane potential at the end of repolarization, depolarized and hyperpolarized trace potentials.
27. How is the conductivity changed for sodium and potassium ions in excited cells (developing action potentials)? How does this change over time?
Increases for sodium and potassium ions, but initially very fast for sodium and returns to norm, then more slowly for potassium and also slowly returned to norm.
28. What is the activation and inactivation of ion channels?
The rapid increase in cell membrane permeability to ions is called activation, its reduction - inactivation.
29. Movement of which ion and in which direction over the cell membrane provides depolarization phase of the action potential? Is it energy dependent process?
The movement of sodium ions into the cell. Energy is spent.
30. What are the condition and the driving force for sodium entry into the cell in the depolarization phase of the AP?
The condition - increased permeability of the cell membrane to sodium ion, driven force – concentration and electrical gradients.
31. Movement of which ion and in which direction over the cell membrane provides a

phase reversal AP? Will there be spent energy at the same time?
The movement of sodium ions into the cell. Energy is not consumed.
32. What is the condition and the driving force for sodium to enter the cell in the reversed phase of the AP?
The condition –is an increased penetration of the cell membrane for sodium and the driving force- the concentration gradient.
33. In which phases of the action potential and what influence provides the concentration gradient on the entrance of sodium into the cell?
Promotes entry of sodium in the depolarization phase and in the ascending part of reversion.
34. Movement of which ion and in which direction through the cell membrane provides the downward part of the action potential? Will there be spent energy at the same time?
The movement of potassium ions from the cell. Energy is not consumed.
35. What is the reason and the driving force of the outflow of potassium ions from the cell during its excitation?
The reason is the increased cell membrane permeability to potassium ions, the driving force - the concentration and electrical gradients.
36. What force provides potassium ions out of the cell and prevents it in the repolarization phase of the AP?
Concentration gradient provides exit potassium out of cells, electric gradient prevents it.
37. What force provides potassium ions out of a cell and the same time prevents it in a repolarization phase of AP?
Concentration gradient provides exit potassium out of cells, electric gradient prevents.
38. List the characteristics of local potential. How does excitability of the tissue change during this process?
The local potential is capable to summation, the value is determined by the power of the subthreshold stimuli, the excitability increase.
39. List the properties of the spreading excitation (AP). What stimuli cause the local response and the action potential?
AP can spread, does not summate, the value does not depend on the strength of the stimulus. Local potential (graded potential) arises under the influence of subthreshold stimuli, and the action potential - under the influence of threshold or supra-threshold stimuli.
40. How does the increasing phase of the AP and its amplitude change under the influence of different concentrations of sodium channel blockers?
As the concentration of blockers increases, the amplitude of the AP decreases until its complete disappearance.

Examples of MCQs

1. Due to action of electric current on the excitable cell there appeared depolarization

of its membrane. Movement of what ions through the membrane caused depolarization?

a) Na+
b) HCO3-
c) Ca2+
d) Cl-
e) K+

2. Rest potential of a cell equals -80 mV. At what stage of action potential did the membrane potential equal +30 mV?

a) Reverse polarization
b) After hyperpolarization
c) After depolarization
d) Depolarization

3. A19-year-old woman with a history of diplopia and paresthesia is diagnosed with multiple sclerosis (MS). MS is a demyelinating disease characterized by a failure of nerve conduction. Immersion of an affected limb in a cold bath restores nerve conduction in many of these patients. The explanation often cited for this effect is that cold increases the duration of the action potential. Which of the following best explains why increasing the duration of the action potential can restore nerve conduction in patients with MS?

a) The amount of sodium entering the nerve with each action potential increases
b) The capacitance of the nerve fiber membrane is increased
c)The duration of the refractory period is increased
d)The potassium conductance of the membrane is increased
e) The membrane potential becomes more positive

4. Which of the following is true regarding the sodium gradient across the nerve cell membrane?

a) It is used as a source of energy for the transport of other ions
b) It is a result of the Donnan equilibrium
c) It is significantly changed during an action potential
d) It is an important determinant of the resting membrane potential
e) It is maintained by a Na+/Ca2+ exchanger

5. A fireman suffers extensive burns, resulting in a fluid and electrolyte imbalance. Which of the following conditions will produce a decrease in the magnitude of a nerve membrane action potential?

a) Hypernatremia
b) Hyperkalemia
c) Hypokalemia
d) Hyponatremia
e) Hypocalcemia

Methodological development №3

The topic: Effects of continual current on excitable tissues. Main indicators of tissue's excitability.
The number of hours: 2 hours
The class takes place at: educational laboratory
The object of learning:
To know: patterns of occurrence of local response and action potential in excitable tissues due to the influence of direct current, stimulation laws and their physiological interpretation.
Be able to: explain the parameters of excitability in clinical practice.

Theoretical questions for self-preparation

1. Effect of direct current on excitable tissues depending on its parameters.
2. The local graded response and its difference from the action potential.
3. Curve of time and force and its physiological characteristics.
4. Refractory period of excitable cells and its mechanisms.
5. Lability of excitable structures and its measurement.

Key words and terms: local response, local depolarization, local hyperpolarization, the critical level of depolarization.

Definitions of key terms and concepts:

The critical level of depolarization – it is the value of depolarization of the membrane, where local response becomes action potential.
Local response – it is depolarization of the membrane, which is observed at the action of subthreshold stimuli.
The threshold current – is a minimal power of continual current, which cause an action potential.
Refractory period – is the inability of the cell membrane to respond to treshhold stimuli in order to produce an action potential.
Lability **-** is the maximum frequency of AP, which the excitable tissue is capable to produce, during electrical irritation.
Cathode depression - is a decreased excitability of the cell membrane under the cathode as a result of its prolonged depolarization.

Control questions and answers on the topic

1. How is it possible to determine in the experiment whether tissue is excitable or not?
By recording of action potential which arises in excitable tissue in response to irritation

and does not occur in unexcitable tissue.
2. What are the main criteria by which we can estimate the level of excitability of tissues?
The threshold potential, threshold strength of the stimulus, the threshold duration of stimulus' action.
3. What is the threshold potential?
That is the minimal value of the membrane potential in order to trigger the excitation (action potential).
4. What is the critical level of depolarization of the cell membrane (critical value of membrane potential)? How is it marked?
That is the minimal value of depolarization of the cell membrane when the local response turns into an action potential.
5. What is the irritation force in physiology? Give examples.
The degree of expression of the excitability of the stimulus on the tissue, for example, power of electric current, ambient temperature, concentration of chemicals, sound's power.
6. What is the threshold strength of stimulus'? How does it depend on excitability?
This is the smallest power of the stimulus, which can cause tissue excitation (action potential). In reverse: the lower is the excitability of tissue, the greater would be the threshold strength stimulus'.
7. What indicator (threshold potential or threshold strength) most accurately characterizes level of tissue's excitability? What is the ratio of the threshold potential and degree of tissue's excitability?
The threshold potential. The higher is excitability of tissue, the less value of threshold potential.
8. What is the threshold duration of stimuli? Point out a second name for the threshold duration.
The minimum time during which the stimulus of threshold strength must act in order to trigger tissue's excitation. Useful time.
9. What is the dependence between overthreshold stimulus' strength and time of its effect on tissue that are needed for excitation?
There is inverse dependence: when strength of the stimulus is increasing - duration of irritation is decreasing, which is necessary for appearance of excitation.
10. How does the chronaxie of a skeletal muscle change after the degeneration of its motor nerve?
Increases in 100 times approximately.
11. What are the three mandatory conditions of tissue's irritation, at which the excitation occurs?
The threshold stimulus' strength, duration of stimulus' action and increase in the stimulus' steepness.
12. What kind of effect occurs in the organism under the influence of a local

overtreshhold and ultra-high frequent electrical current? Does an excitation occur? Why?
Increase in tissue's temperature. Excitement does not occur as a result of short-term actions of individual stimuli (in this case the potential of the cell membrane does not have time to reach critical level).
13. Which phenomenon is developing in excitable tissues at slowly rising stimulus? How is it expressed?
Accommodation. It is expressed by reducing tissue's excitability and action potential amplitude up until its full disappearance at slowly rising stimulus.
14. What changes in the properties of membrane of excitable cells underlie in the phenomenon of accommodation? Describe its essence.
Shift in cell membrane permeability to sodium and potassium ions, resulting in inactivation of sodium channels and activation of potassium ones.
15. What is the origin of the absolute refractory period? Compare with the mechanism of accommodation development.
Both occurrence of absolute refractory period and accommodation is explained by inactivation of sodium channels and activation of potassium ones.
16. How does the excitability of a tissue change in the area of cathode and anode under the influence of the continual current? How these changes of unexcitability are called?
The excitability is increasing in the area of cathode and it is decreasing in the area of anode. Physiological electrotone.
17. Why does the excitability decrease in the area of the anode under the effect of the continual current?
Because membrane is in the state of hyperpolarization, membrane resting potential is increasing and gets further from the critical level of depolarization, this leads to increase in the threshold potential.
18. Why does the excitability increase in the area of cathode under the influence of a continual current?
Because the membrane is in the state of depolarization, the membrane resting potential is decreased and approach the critical level, this leads to decreasing the threshold potential.
19. What is called tissue's lability (functional mobility)?
The speed of reproduction of one cycle of excitation (action potential).
20. What is the measure of lability? What does the lability of a tissue depend on?
Maximum number of action potentials that tissue reproduces in 1 sec. in accordance with the rhythm of irritation. It depends on the speed of one cycle of excitation (AP), which is determined by the velocity of the ions into and out of the cell.
21. What is the dependence between tissue's lability and the duration of its refractory phase?
It is a reverse dependence: the longer is the refractory phase, the lower is the lability.
22. How can we experimentally determine the lability of a tissue?

By recording the action potentials and determining their maximum number which a tissue can produce accordingly to the rhythm of irritation.
23. What is the lability of nerve, skeletal muscle and neuromuscular synapse equal to?
500-1000 imp. per sec, 200-300 imp. per sec, 100-150 imp. per sec, respectively.
24. How does tissue's lability change in conditions of prolonged organ's inactivity, at the exhaustion and after denervation?
It is reduced in all cases.
25. What is called the phenomenon of assimilation of irritation's rhythm?
The ability of tissue to response with higher frequency of excitation to rhythmic irritations compared with the output frequency.

Examples of MCQs

1. How can we experimentally determine the lability of a tissue?
What changes of electrical status of the membrane will be detected in this situation:
a) Depolarization
b) Hyperpolarization
c) The action potential
d) Local response
e) Changes will not be
1. Local response differs from action potential:
a) Occurs under the action of subthreshold stimuli
b) Occurs when the action threshold and overthreshold stimuli
c) Subject to the law of "all or nothing"
d) Is spreading character
e) All answers are correct
2. Depolarization of the membrane, which is observed by the action of subthreshold stimuli. What will occur:
a) Lability
b) Local response
c) Refractory
d) Relative refractory
e) Cathode depression
3. Excitable cells treated with chemicals, which lead to opening the number of membrane sodium channels. It can lead to the development:
a) Afterpotential
b) Relative refractory
c) Membrane depolarization
d) Absolute refractory
e) Hyperpolarization of the membrane
4. An increase in sodium conductance is associated with which of the following?

a) The end-plate potential of the skeletal muscle fiber
b) The plateau phase of the ventricular muscle action potential in heart
c) The downstroke of the skeletal muscle action potential
d) The upstroke of the smooth muscle action potential
e) The refractory period of the nerve cell action potential

Methodological development № 4

The topic: Physiology of nerves. The mechanisms of excitation's conduction on nerves.
The number of hours: 2 hours
The class takes place at: educational laboratory
The object of learning:
To know: the mechanisms of excitation conduction by myelinated and unmyelinated nerve fibers, the main factors, which determine the speed of excitation's conduction on integral nerves, classification of nerve fibers.
Be able: draw schematically the mechanism of excitation conduction by myelinated and unmyelinated nerve fibers.

Theoretical questions for self-preparation

1. Structural characteristic of nerve fibers.
2. Physiological properties of nerve fibers.
3. Classification of nerve fibers.
4. Mechanism of excitation conduction by myelinated and unmyelinated nerve fibers.
5. Physiological benefits of saltatory conduction of excitation on nerves.

Key words and terms: anatomical and physiological integrity, non-decrement excitation's conduction, nerve fiber, node of Ranvier, saltatory conduction.

Definition of key terms and conceptions

Saltatory conduction of excitation – conduction of action potentials along myelinated nerve fibers by jump-like excitations of nodes of Ranvier.
Non-decrement conduction– conduction of action potential without interruption.

Control questions and answers on the topic

1. What are the functions of main structural elements of nerve fiber: myelinated membrane, membrane of axial cylinder, neurofibrils?
The myelinated membrane is an electrical isolator, which provides trophic and support

functions. The membrane of axial cylinder plays the main role in conduction of excitation. Neurofibrils transport the substances.
2. What are physiological properties and functions of nerve fiber?
Properties: excitability and conductivity. Functions: conduction of excitation and transport of substances.
3. What is the mechanism of excitation of a nerve fiber? What is the role of nodes of Ranvier in conduction of excitation along the nerve fiber?
Electrical mechanism: appearance of local ionic currents between excitable and unexcitable areas of nerve fiber. Action potential appears in nodes of Ranvier.
4. What is a saltatory conduction of excitation? Where does the salutatory conduction of excitation take place? Where does the non-decrement conduction of nerve impulse take place?
The saltatory conduction of excitation is jumping-like conduction of nerve impulse ("overjumping") from one node of Ranvier to another. The saltatory conduction of excitation takes place in myelinated nerve fibers. Non-decrement conduction of nerve impulse takes place in unmyelinated nerve fibers.
5. What are the benefits of jumping-like abrupt conduction of excitation over non-decrement conduction along the membrane?
The benefits of salutatory conduction lie in the following: higher speed of conduction of AP and less spending of energy, so it is more economical.
6. Why does the process of excitation use less energy at jumping-like conduction than at non-decrement one?
Because the ions are moving only in the area of nodes of Ranvier, where action potential appears, namely on small areas of nerve fiber. Thus, a little energy is used for work of ion`s pump.
7. What are the properties of the conduction of excitation in nerve fiber?
Bilateral, isolated, non-decrement conduction of excitation, the practical infatigability of nerve, large speed of conduction of excitation and high lability.
8. How the conduction of excitation by a nerve can be stopped without cutting it?
By means of cooling, the anesthetic pharmacological agents (for example procaine), ligation or action of the anode.
9. How can we prove bilateral conduction on nerve fiber?
a) by irritation of one of the nerve`s areas;
b) by registration of potentials on both sides from the place of irritation.
10. Why is the conduction in nerve fiber non-decrement (continuos)?
Because in each area of nerve fiber the action potential appears according to the law "all or none".
11. What is the importance of isolated conduction of excitation along a nerve fiber? How can we prove it?
To ensure localization of sensitivity and accuracy of ruling the function of any organ. When the anterior root of the spinal cord is being irritated, contraction appears only in

those groups of muscle fibers, which innervates them.

12. Which structural and functional properties of myelinated and unmyelinated nerve fibers affects the speed of conduction of excitation along them?

The value of action potential and diameter of nerve fiber. Besides, for myelinated fibers, the distance between nodes of Ranvier also influences on the speed of conduction of excitation by nerve fibers. Distance between nodes of Ranvier is the distance that proportional to the diameter of fiber (the bigger is diameter of fiber, the greater is the distance between nodes).

13. Why does large amplitude of action potential and its bigger steepness increase the speed of conduction of excitation along a nerve fiber?

Because the excitation of neighboring area of nerve fiber appears faster and it accelerates the conduction of nerve impulse.

14. Why does increasing in the diameter of nerve fiber leads to increase the speed of conduction of excitation by it?

Because there is less resistance to ion`s current in thicker nerve fiber in its axoplasma.

15. Why does the increased distance between nodes of Ranvier increase the speed of conduction of excitation along the nerve fiber?

Because it provides "overjumping" of action potential on bigger distance for the same time.

16. Describe the experiment of N.E. Vvedenskyi, which proves the practical infatigability of nerve.

The nerve of neuromuscular preparation is being irritated continually at blockade of excitation's conduction between irritating electrodes and muscle, for example, using the anode. During 9-12 hours the irritation of nerve was accompanied by contraction of muscle.

Examples of MCQs

1. The saltatory type of conduction excitation takes place in:

a) Cross-striped muscle fibers

b) Synapses

c) Unmyelinated nerve fibers

d) Myelinated nerve fibers

e) Smooth muscle fibers

2. Nerve fibers are characterized by such physiological properties as excitability and conductivity, which are made according to certain laws. The defection of what law occurs when we use the local anesthetics:

a) Physiological wholeness

b) "All or nothing"

c) Bilateral conduction

d) Polar law

e) Isolated conduction of impulses

3. In unmyelinated nerve fibers in comparison with myelinated nerve fibers the excitation conducts:
a) More economical (with less use of energy)
b) Slower
c) Faster
d) Using Ranvier nodes
e) Using the transport of potassium into the fiber
4. The speed of conduction of impulses in myelinated nerve fiber mostlydepends on:
a) Acetylcholine
b) Acetylcholinesterase
c) Potassium-sodium exchange
d) Diameter of fiber
e) Activity of sodium-potassium pump
5. The nerve fibers properties are
a) Bilateral conduction of impulses
b) Slow conduction of impulses
c) Fast fatigability
d) The speed of conduction decrease in case if the diameter of fiber increase
e) One direction of conduction of impulses

Methodological development № 5

The topic: Physiology of synapses. The mechanism of synaptic transmission in excitatory and inhibitory synapses.
Number of hours: 2 hours.
The class takes place in: research laboratory.
The object of learning:
To know: the structure of chemical synapses, their classification, understand the role of mediators in the mechanism of excitation or inhibition, features of neuromuscular synapses and ways of blocking transmission in these synapses.
Be able to: schematically depict the mechanism of synaptic transmission.

Theoretical questions for self-preparation

1. Structure and classification of synapses.
2. Structure of chemical and electrical synapses.
3. Mechanism of synaptic transmission. Formation EPSP and IPSP in **chemical synapses.**
4. Physiological characteristics of mediators.
5. Interaction of synaptic processes.
6. Features of neuromuscular synapses. Cholinomimetics and muscle relaxants.

Key words and terms: mediators or neurotransmitters, receptor proteins, cationic and anionic channels, acetylcholine, excitatory and inhibitory synapses, EPSP, IPSP, selective chemosensitive potassium channels, temporal and spatial summation, tetanic potentiation, tetanic postpotentiation, cholinomimetics, cholinesterase, muscle relaxants, potential of end- plate.

Definitions of key terms and concepts

Synapse is the specialized structure that ensures the transfer of excitation or inhibition from neuron to another neuron, muscle fiber or glandular cells.
EPSP (excitatory postsynaptic potential) is the temporary depolarization of postsynaptic membrane potential caused by the flow of positively charged ions into the postsynaptic cell as a result of opening of ligand-gated ion channels.
IPSP (inhibitory postsynaptic potentials) is the temporary hyperpolarization of postsynaptic membrane potential caused by the flow of negative ions into the cell or positive ions out of the cell.
Quantum of mediator is the portion of neurotransmitter contained in one vesicle and is excreting in synaptic cleft during excitation or inhibition.
Ionotropic pathway (or a direct effect of the mediator) is the immediate change in the permeability of the ion channel upon binding neurotransmitter to receptors of the postsynaptic membrane.
Metabotropic pathway (or indirect effect of the mediator) also changes the postsynaptic membrane permeability to certain ions but through the activation of biologically active substances (second messengers) that directly affect ion channels.

Control questions and answers on the topic

1. List the structures of the neuromuscular synapse (skeletal muscle). What is an end-plate?
Presynaptic membrane (nerve endings), synaptic cleft, postsynaptic membrane is the end-plate (contact of the muscle cell membrane with branching motor nerve fibers).
2. List the processes which lead to the release of neurotransmitter from the presynaptic membrane into synaptic cleft.
The excitation of presynaptic endings increases the permeability of the presynaptic membrane for calcium that's why calcium entries into the nerve endings and releases the neurotransmitter into the synaptic cleft.
3. What mediator provides transmission of excitation from nerve to skeletal muscle? List main stages of this process?
Acetylcholine: effects the end-plate by opening the chemosensitive channels for sodium and potassium causing the end-plate depolarization (end-plate potential) - the development of AP in the muscle fibers.

4. Why depolarization of end-plate occurs under the action of acetylcholine despite the fact that potassium ions are moving out of the cells simultaneously with the entrance of sodium into the cell? What is the mechanism of this process?
Because the flow of sodium into the cell exceeds the flow of potassium from the cells. Due to that sodium moves according to concentration and electrical gradients and potassium outward caused only by concentration against electrical gradient hence conductivity for sodium is higher than for potassium.
5. List the processes that lead to the excitation of a muscle fiber under the influence of the end-plate potential. What properties does the end-plate potential have?
An electrotonic type of the end-plate potential conduction to the postsynaptic membrane of the muscle fiber – by increasing its permeability for sodium up to the critical level of depolarization and forming an action potential by summation of local potentials.
6. What is the role of cholinesterase in the function of a neuromuscular synapse?
Cholinesterase destroys acetylcholine, thereby restors the original functional state postsynaptic membrane to grasp another portion of the mediator.
7. Which feature of a motor neuron that innervates the skeletal muscle provides the possibility of excitation of the muscle fiber under the action of one impulse?
The motor neuron in the neuromuscular junction synapses that leads to an increased number of impulses, providing secretion of greater amount of mediator, that results the forming of the final plate threshold potential for excitation of the muscle fiber approximately by 30mV.
8. What is the minimal end-plate potential and mechanism of its occurrence? The minimal end-plate potential arises in a physiological resting state in response to spontaneous discharge of quants of neurotransmitter from the presynaptic membrane.
9. List the features of conduction of excitation by a neuromuscular synapse compared with conduction of excitation in the nerve fiber.
In synapses it is unilateral with delayed signal transmission, has low lability and fatigability and the excitation is easily blocked by specific drugs.
10. Explain the causes of unilateral excitation in chemical synapse.
The postsynaptic membrane is sensitive to mediators and the presynaptic one is insensitive. Postsynaptic potential does not excite presynaptic membrane because of the large distance between pre-and postsynaptic membranes.
11. What chemical changes in the field of neuromuscular synapse may impair its function?
The accumulation of potassium in the synapse and acidification of the medium.
12. What is the synaptic delay? How we can explain it?
It is the slower rate of excitation through synapse. Explanation: it requires a certain time for secretion of the mediator, its release into the synaptic cleft, fixation to the protein receptors for forming the end-plate potential up to the treshhold.
13. What is the lability of the nerve-muscle synapse?

150 to 100 pulses per second.

14. What part of the neuro-muscular preparation (nerve, neuromuscular synapse, muscle fiber) develops fatigue first of all during prolonged nerve stimulation? How is it proved experimentally?

A prolonged nerve irritation of a neuro-muscular preparation stopes the contraction of the muscle but a direct irritation of the muscle continues to cause the muscle contraction.

15. What is the reason of deterioration of neuromuscular transmission during fatigue?

The decrease in mediator, acidification of the medium and the accumulation of potassium ions in the synapse.

16. What trophic influence does the nerve have on the muscle via neuromuscular synapse?

The substances secreted by the nerve endings stimulate protein synthesis, activate the enzymes, preserve the stable structure of the muscles.

17. What substances are mediators of neuromuscular synapses of smooth and striated muscles?

In the neuromuscular synapse of smooth muscles acetylcholine and norepinephrine. In skeletal muscle ones- only acetylcholine.

Examples of MCQs

1. A patient came to the hospital complaining about quick fatigability and apparent muscle weakness. Examination revealed an autoimmune disease that causes disorder of functional receptor condition in neuromuscular synapses. What transmitter will be blocked?

a) Acetylcholine
b) Noradrenalin
c) Dopamine
d) Serotonin
e) Glycine

2. A 32-year-old woman presents with muscular weakness and fatigue, as well as ptosis and diplopia, with worsening of symptoms as the day progresses. An MRI ofthe chest shows enlargement of the thymus gland. The neuropathy of myasthenia gravis is caused by antibodies against which of the following?

a) Acetylcholine receptors
b) Acetylcholine
c) Nicotine
d) Acetylcholinesterase
e) The thymus gland

3. A 19-year-old sexually active female presents with lower abdominal pain for 1 week. Physical exam reveals a temperature of 101°F, tenderness on pelvic exam, and a

mucopurulent vaginal discharge. Synaptic transmission between pain fibers from the pelvis and spinal cord neurons is mediated by which of the following?
a) Substance P
b) Acetylcholine
c) Endorphins
d) Somatostatin
e) Serotonin
4. A patient came to the hospital complaining about quick fatigability and apparent muscle weakness. Examination revealed an autoimmune disease that causes disorder of functional receptor condition in neuromuscular synapses. What transmitter will be blocked:
a) Noradrenalin
b) Dopamine
c) Acetylcholine
d) Serotonin
e) Glycine
5. Deterioration of which Diffuse Modulatory System may be linked to Alzheimer's disease:
a) Norepinephrine system
b) Serotonin system
c) Acetylcholine system
d) Dopamine system
e) All of the above
6. After entering the person Curare drug, relaxation of skeletal muscle occurs. Whatis the cause of this?
a) Violation of secreting of acetylcholine
b) Blockade of Ca 2+ - channels of presynaptic membrane
c) Violation of the synthesis of cholinesterase
d) Violation of the synthesis of acetylcholine
e) Blockade of H cholinergic receptors of the postsynaptic membrane

Methodological development №6

The topic: Physiology of skeletal muscles.
The number of hours: 2 hours
The class takes place in: education laboratory
The object of learning:
To know: the structure of the sarcomere in the striated muscles, sliding filaments theory by Huxley and Hanson, types of muscle contraction, mechanism of formation of the complete and incomplete tetanus.
Be able to: describe a schema of the sarcomere during its contraction and relaxation,

sketch different types of muscle contractions.

Theoretical questions for self-preparation

1. Types of muscle tissue. Functions and properties of skeletal muscles.
2. Structure of the skeletal muscle, fiber and muscle sarcomere.
3. The molecular mechanisms of the contraction (sliding filaments theory). Role of Ca^{2+} in the mechanism of contraction.
4. Motor units and their structure in different muscles.
5. Types of contraction of the holistic skeletal muscle.
6. Mechanism of formation of the complete and incomplete tetanus in skeletal muscle.

Key words and terms: actin, myosin, troponin, tropomyosin, titin, sarcomere, auxotonic contraction, isometric contraction, isotonic contraction, eccentric contraction, concentric concentric, muscle relaxation, tetanus, motor unit, slow fibers type I, fast fibers type II, theory of sliding filaments.

Definitions of key terms and concepts:

Isotonic contraction is a muscle contraction, whereby the length of the muscle is changing but its tension remains constant.

Isometric contraction is a contraction, whereby the tension of the muscle changes while it length remains constant.

Auxotonic contraction is the muscle contractions, accompanied by a change and length and tension.

Motor unit is the motor neuron of the spinal cord and all the muscle fibers that it innervates.

Tetanic contraction is the prolonged muscle contraction involving all its fibers, which occurs at high frequency stimulation.

Muscle hypertrophy results in increased size of skeletal muscles and its components.

Muscle atrophy is the decrease of the mass of the muscles. The main reason of it is the lack of physical activity.

Hypodynamia is decrease of strength and power of muscles, due to the lack of physical activity.

Spontaneous myogenic activity is excitation and contraction of smooth muscles without external stimuli.

Plasticity – it is ability of smooth muscle to maintain the length after contraction without any additional tension.

Tonus autoregulation – it is ability of smooth muscles to adapt to the external resistance.

Control questions and answers on the topic

1. What are the main structural elements of the muscle fiber to ensure its excitation and contraction?
These are sarcolemma, sarcoplasmic reticulum, myofibrils.
2. What is the functional significance of sarcolemma in the performance of the contractile function of muscle fibers?
Sarcolemma is a wrapper for the structural elements of muscle tissue, ensure the availability of resting potential, action potential and development of excitation.
3. What is the myofibril? What is its value in the mechanism of muscle contraction?
Myofibril, very contractile fibers, groups of which extend in parallel columns along the length of striated muscle fibers. The myofibrils are made up of thick and thin myofilaments, which give the muscle its striped appearance. The thick filaments are composed of myosin, and the thin filaments are predominantly actin.
4. What is the sarcoplasmic reticulum? What its value is in the mechanism of muscle contraction?
It is closed system of intracellular tubules and cisterns surrounding each myofibril. It is the place for storage, release, reuptake of calcium during contraction and relaxation.
5. What are the structural and functional unit of the isolated muscle and skeletal apparatus of the body? What is the motor unit?
The structural and functional unit of the isolated muscle is the muscle fiber. The structural and functional unit of the locomotive apparatus is the motor unit. The motor unit is the motor neurons with the group of muscle fibers which are innervated by them.
6. What groups by the speed of contraction are motor units divided in?
Fast (0,01-0,03 seconds) and slow(0,1seconds).
7. What muscle groups are mainly consisting of the fast and slow muscle fibers?
The fast muscles are some eye muscles, the muscles of the fingers. The slow muscles are respiratory muscles, extensor extremities, back, which ensure the maintenance of posture.
8. What are the functional differences between fast and slow motor units?
Fast motor units have greater power contraction, but are easily fatigable. In slow ones it is opposite.
9. List the properties of muscle tissue.
Excitability, conductivity, contractility, elasticity, extensibility.
10. List the main functions of the skeletal muscles.
Provide all kinds of physical activity, maintain posture, respiratory function, chewing, heat, promote blood and lymph flow through the vessels to the heart.
11. What is muscle contraction? What is the direct cause of muscle contraction?
The ability of muscle to change length or tension. Sliding actin filaments along myosin filaments towards each other.
12. Why AP is considered the initiator of muscle contraction? Give proper explanation.
AP increases the permeability of the sarcoplasmic reticulum, which provides a way out of calcium ions, that are required to start the process of muscle contraction

13. Briefly describe the role of calcium ions in the mechanism of muscle contraction.
Calcium ions interact with the protein troponin-tropomyosin complex, leading to the release of active sites on the actin filaments and links on their heads myosin's bridges.
14. What processes that provide muscle contraction the energy of ATP is used on?
ATP used on the interaction of actin and myosin filaments that ensure their sliding relative to each other (shortening) and the work of ion pumps.
15. Describe the chain of events that ensure the release of ATP energy during muscle contraction.
Contact myosin heads with actin filaments - activation of myosin ATPase in the presence of Ca2 + - splitting of ATP - the energy release
16. What is the direct cause of sliding of actin and myosin filaments that provide muscle contraction? Why?
"Flexion" of myosin bridges. Because they are attached by their heads to the active sites of actin filaments.
17. Is the process of muscle relaxation active or passive?
Muscle relaxation provides active and passive processes.
18. What process that provides muscle relaxation is active? What process is passive?
The active process is the process of moving of calcium ions in the sarcoplasmic reticulum and the passive process is the sliding of actin and myosin, which reduces their mutual overlap zones.
19. What is the cause of the sliding of actin and myosin filaments relatively to each other during the muscle relaxation?
It is associated with the elastic properties of the muscle and its tendons, stretched during the muscle contraction and with the mass of organs.
20. Briefly describe the sources of energy which provide resynthesis of ATP.
The splitting of creatine phosphate, which is continuously renewed by glycolysis; oxidation of carbohydrates and fatty acids (oxidative phosphorylation).
21. What types of muscle contractions do you know?
Depending from conditions of the contraction they are: isometric and isotonic.
Depending on the nature of stimulation they are: single and tetanic contractions.
22. What are the three phases of the isolated muscle contraction? What is the basic process that takes place in the first phase?
The latent period, the period of tension and relaxation. Excitation.
23. What is the tetanic muscle contraction? What phenomenon is underlying in mechanism of the tetanic contraction?
It is the prolonged contraction of skeletal muscle that occurs in response to rhythmic stimulation. The mechanism is associated with the phenomenon of summation of muscle contractions.
24. What is the summation of muscle contractions?
It is the increase in power (or amplitude) and duration of muscle contraction under repeated stimulation.

25. Why does the amplitudeof the muscle contraction increase during summation in isotonic mode? Explain the mechanism.
It increase due to additional sliding of actin and myosin because of increased attachment of myosin bridges under the influence of additional outflow of calcium from the sarcoplasmatic reticulum.
26. Why the additional sliding of actin and myosin filaments relative to each other is possible during the summation of isometric muscle contractions mode?
Because the muscles have an ability to be stretched, what makes possible an additional shortening of the sarcomere.
27. What interval between the stimuli instead of single contractions does form tetanic contraction (compare to the duration of a single cycle)? What types of the tetanic contraction do you know?
Tetanic contraction occurs at rhythmical irritation with a shorter interval than the period of a single twitch (contraction).
28.To what phase of the single contraction must be applied every next irritation in order to form incomplete or complete tetanic contraction? Which factors affect the height of the complete tetanic contraction of an isolated muscle?
The single contraction must be applied to the muscles relaxation phase and to the muscles tension phase, respectively. The degree of the pre-stretching of the muscles and the strength and frequency of his irritation affect the height of the complete tetanic contraction of an isolated muscle.
29.What is the dependence of the height of a complete tetanic contraction on the frequency of the muscles irritation (in dynamics)?
With the increased frequency of irritation, the value of the tetanic contraction increases (to a certain level) and after it decreases till its complete relaxation.
30.What frequency of irritation is optimal for muscles and what is -pessymal?
The optimal frequency is when the tetanic contraction is the highest and stable, and the pesymal - is a very high frequency at which the muscle relaxes.
31.Why is the tetanic contraction of an isolated muscle higher and stable at optimal frequency of irritation? Why is the muscle relaxing at pesymal frequency of stimulation?
Because at the optimal frequency of stimulation each subsequent stimulus coincides with the phase of excitation, while during pesymal – it coincides with absolute refractory period.
32. What kind of factors have influence on the strength of a single muscle contraction?
The level of previous muscle stretching and force of its stimulation.
33.Why does the increased strength of stimulation lead to an increased force of muscle contraction?
Due to the increased strength of stimulation, additional muscle fibers are excited and as a result the force of the muscle contraction is increased.
34.Why does a previous moderate stretching of an isolated muscle lead to an increased

force of contraction at its single irritation?
A moderate muscle stretching is characterized by passive tension of muscle elements and by active force of contraction, which leads to an increased area of interaction of actin and myosin.
35. To what level should be stretched the muscle, in order to receive the maximum strength of muscle contraction during a single irritation in isometric period?
The muscle should be stretched to it resting length. This condition provides the maximal connection between actin and myosin.
36. How and why will the strength of contraction change, if previously the muscle has been stretched to a bigger length than it was in the resting state and after it tried to increase its degree of stretching before every next stimulation?
The strength of contraction will decrease due to reduction of actin and myosin crossbridges.
37. How do the separate muscle fibers contract: synchronously or asynchronously? Due to what mechanical effects increase the muscle contraction?
The muscle fibers contract asynchronously. The muscle contraction increase due to involving an additional amount of muscle fibers in the process, and as a result the increased actin and myosin crossbridges.
38. Does a motor unit contract according to the law “all or none”? Why?
Yes, it does. Because all impulses from the axons pass to the muscle fibers simultaneously. A motor unit is functioning as an entire whole structure.
39. In which conditions the muscle units of one neuronal pool are excited synchronously and in which asynchronously?
The muscle unit contract asynchronously during moderate physical activity and during high physical activity- synchronously.
40. What is a skeletal muscle tone? Is it connected with fatigue and great energy consumption?
A muscle tone is a constant slight tension (or contraction) and is supported by rare impulses from the CNS. It helps to maintain posture and declines during REM sleep.
41. What is the dependence of skeletal muscle contraction from the load size?
The muscle work is maximal at submaximal loads.
42. What is the “rule of average load”? How does the muscle contraction change, if the frequency of contraction also increases?
The muscle work increase if the load increases. During maximal load the muscle work decreases to zero.
43. What does the muscle fatigue mean?
The muscle fatigue is a temporary decline of work capacity.
44. In which cases the muscle fatigue will develop slower: in the whole body or in the isolated muscle?
The muscle fatigue will develop slower in the whole body, because muscles are always supplied with blood and get rid of waste products.

45. Where does fatigue appear firstly in the human body (CNS, neuro-muscular synapse or muscle)?
At first it appears in the CNS.
46. List the structural properties of smooth muscles.
They are: irregular overlapping of actin and myosin (not striated), poorly developed sarcoplasmatic reticulum, gap junctions between muscle filaments.
47. What are the peculiarities of the RMP in the smooth muscles compared to striated muscles ones?
The RMP in smooth muscle is -30, -50 mV, spontaneous depolarization is present.
48. What are the functional differences between smooth and skeletal muscles?
Smooth muscles are characterized by plasticity, more slowly contraction, high sensitivity to mediators, automaticity.
49. What is a plasticity of smooth muscle? What is its functional importance for visceral organs?
Plasticity – is the ability of smooth muscles to preserve its stretched length without any additional tension. Due to plasticity of smooth muscles the pressure in hallow organs almost does not change at different degree to be filled.
50. What is the functional unit of smooth muscles.
The functional unit of smooth muscle is a band of muscle fibers, which are connected by connective tissue capsules. The excitation in the muscle unit is transmitted from one fiber to another, that is why it functions as a unit.

Examples of MCQs

1. Which of the following muscle proteins plays an important role in contraction of both smooth and striated muscle?
a) Actin
b) Calmodulin
c) Troponin
d) Tropomyosin
e) Myosin light chains
2. Amanda's doctor treats her with an agent that will cause relaxation of the smooth muscle. Which of the following mechanism of action would produce this relaxation?
a) Increased cAMP in the smooth muscle cell
b) Increased cGMP in the smooth muscle cell
c) Increased inositol triphosphate (IP3) in the cell
d) Decreased Ca ions in the cell
e) None of these
3. Smooth muscle need help of:
a) Calmodulin for contraction
b) Acetyl choline for contraction

c) K+ for contraction
d)Monoamine oxidase for contraction
e) Increased Ca ions in the cell
4. Which of the following statements is true:
a) Nervous stimulation of smooth muscle is always excitatory, whereas nervous stimulation of skeletal muscle may be excitatory or inhibitory
b) The contractile activity of smooth muscle may be affected by hormones
c)Smooth muscle may be innervated by both sympathetic and parasympathetic neurons
d) A and B
e) B and C
5. It is known that contraction of myocytes is due to the interaction of contractile proteins of sarcomere which uses energy of ATP. Which pair of proteins provides this process:
a) Troponin and myosin
b) Myosin and myoglobin
c) Actin and tropomyosin
d)Myoglobin and troponin
e**) Actin and myosin**
6. While the sarcomere is contracting:
a) Actin filaments change its length
b) Myosin filaments change its length
c)The lengths of actin and myosin filaments do not change
d)A-band decreases
e) Any answer is correct
7. Which of the following descriptions of skeletal- and smooth-muscle contraction is correct:
a) Skeletal-muscle contraction requires the influx of extracellular Ca2+, whereas smooth-muscle contraction does not
b) Skeletal-muscle contraction involves interactions between thick and thin filaments, whereas smooth-muscle contraction does not
c)Skeletal-muscle contraction results from cross-bridge cycling, whereas smooth-muscle contraction does not
D)Smooth-muscle contraction requires release of Ca2+ from sarcoplasmic reticulum, whereas skeletal-muscle contraction does not
e) **The site of calcium regulation of skeletal-muscle contraction is on the thin filament, where as in smooth-muscle contraction it is on the thick filament**
8. A-band of the sarcomere:
a) Is formed only by myosin filaments
b) Contacts with Z - disc
c)Not has a property of double refraction of light

D)Is isotropic
e) Is anisotropic

Methodological development №7

The topic: Force and workload of muscles. Features of smooth muscle
The number of hours: 2 hours
The class takes place in: education laboratory
The object of learning:
To know: dependence of the muscles on the load, morphological and functional properties of smooth muscle and its physiological properties.
Be able to: determine muscle strength by dynamometry.

Theoretical questions for self-preparation

1. Factors that can affect the muscles contraction.
2. Types of muscle work.
3. Metabolism and mechanism of muscle fatigue.
4. Morphological and physiological properties of smooth muscles.
5. Innervation of smooth muscles and synaptic transmission in effector synapses of smooth muscles.

Key words and terms: the absolute muscle strength, hypertrophy, muscle atrophy, dynamometry, oxygen debt.

Definitions of key terms and concepts:

Muscle hypertrophy (myopachynsis) is the increase in muscle fiber cross sectional area that is accompanied by an increase in muscle volume and mass. Hypertrophy occurs in response to a higher load on muscle which activates inducible agents such as IGF-1.
Muscles atrophy efers to the loss of muscle tissue due to lack of physical activity. During muscle atrophy, proteolytic systems are activated, and contractile proteins and organelles are removed, resulting in the shrinkage of muscle fibers.
Hypodynamia is defined as a limitation of physical activity, decrease in strength or power.

Control questions and answers

1. What factors affect the strength of a single muscle contraction?
The degree of previous stretching of muscles and the strength of its irritation.
2. Why the increased strength of the muscle's irritation leads to increasing of the power of its contraction?
Due to the increased number of fibers that are contracted. Excitation of additional fibers

that at low irritation are not excited because of their lower excitability or their deeper location in the muscle.

3. Why a previous moderate stretching of the isolated muscle increases the force of its contraction during a single irritation?

As a result of the fact that in a moderately stretched muscle increases as the passive tension of elastic elements, and the active force of contraction due to an increased interaction of actin and myosin filaments.

4. To what extent is it necessary to stretch an isolated muscle, with the aim to receive the maximum force of active contraction in isometric mode during a single stimulation?

To its length at resting state for maximal contact between actin and myosin, which means the maximum number of crossbridges.

5. How and why will change the active force of a muscle contraction, if previously it is stretched to a greater length than it has in a resting state, and after it before each subsequent stimulation to increase its degree of stretching?

It will be reduced to zero by reducing the areas of mutual overlapping of actin and myosin filaments (reduced number of crossbridges up to a total lack of them).

6. Does separate muscle fibers contract synchronously or asynchronously in vivo? Which mechanical effects lead to increase of the strength of skeletal muscles contraction in vivo?

Asynchronously. Due to the involvement of a larger number of motor units increases the degree of synchronization of their excitation, additional sliding of actin and each myosin filaments in every myofibril.

7. Is a motor unit subordinated to the law "all or nothing"? Why?

It is subordinated to the law "all or nothing", because impulses through the axon twigs fit simultaneously all muscle fibers of the motor unit and they contract simultaneously, i.e. a motor unit is functioning as a unit.

8. In what conditions the motor units of the same neural pool are excited simultaneously, and in which one asynchronously?

At a moderate muscular load - asynchronously, so independently of each other, at high loads - simultaneously.

9. What is a tone of the skeletal muscle, does it develop fatigue, or high consumption of energy?

It is a constant weak tension (contraction) of skeletal muscles, supported by rare impulses of the CNS. Performed by low energy consumption with no signs of fatigue.

10. What is the dependence of the work of an isolated skeletal muscle from the load?

The work of a muscle is maximal at medium loads. With increasing of the frequency of contractions initially increases, but at higher frequencies then the optimal ones the workability decreases as fatigue is developing faster.

11. State the rule of "average loads." How will change the workability of a skeletal muscle at increased frequency of its contractions?

With increased loading, the muscle initially increases its work but at excessively big

loads when the muscle cannot lift the load it is reduced to zero.
12. What is a muscle fatigue, explain it?
It is a temporary decline of muscles performance as a result of working and it disappears after resting. Accumulation of metabolic products, gradual depletion of energy reserves.
13. In what circumstances does fatigue develop more slowly: in the intact organism, or in the isolated muscle. Why?
In the intact organism, as the muscle supplied with blood receives nutrients, oxygen and is released from metabolic products.
14. Where does fatigue develop earlier in an intact organism: in the central nervous system, in the neuromuscular synapse or in the muscle?
In the CNS, the rehabilitation of the tired muscles is possible with change of the motor activity of other muscles.
15. List the structural features of smooth muscles.
Chaotic arrangement of actin and myosin filaments, that shows no cross stripes under microscopic magnification, poorly developed sarcoplasmic reticulum, presence of nexuses between muscle fibers.
16. List the features of the resting potential, the action potential of the smooth muscles in comparison with cross-stripped ones.
The value of the resting potential of smooth muscles is smaller (-30 - 50mV), spontaneous depolarization is observed. Action potentials are peak-like and plateau-like, longer - up to 1 second.
17. What are the functional properties of smooth muscles compared with skeletal ones?
The smooth muscles are characterized by: automaticity, plasticity, by prolonged contraction (from a few seconds to 1 min.), high sensitivity to neurotransmitters.
18. What is plasticity of smooth muscles, what is its importance for the functioning of the internal hollow organs?
The ability to keep a stretched length of muscles without changing their tension. Due to plasticity of smooth muscles the pressure in hollow organs does not change at different volume of their content.
18. What is the functional unit of smooth muscles, why?
A bunch of muscle fibers incorporated into a connective tissue sheath. The excitation in muscle bundles are transmitted from one fiber to another, so it functions as a coherent whole.

Examples of MCQs

1. The role of AP in the mechanism of contraction of muscle fiber is:
a) The release of Ca2 + from sarcoplasmic reticulum
b) The release of Na + ions from sarcoplasmic reticulum
c) Stimulating the synthesis of ATP

d) Increases of permeability of the sarcolemma to K + ions
e) Changing in the length of actin and myosin filaments
2. While the sarcomere is contracting:
a) Actin filaments change its length
b) Myosin filaments change its length
c) The lengths of actin and myosin filaments do not change
d) A-band decreases
e) Any answer is correct
3. The flow of calcium into the cell is an important component of the upstroke phase of action potentials in which of the following?
a) Intestinal smooth muscle
b) Cardiac ventricular muscle
c) Skeletal muscle fibers
d) Nerve cell bodies
e) Presynaptic nerve terminals
4. When comparing the contractile responses in smooth and skeletal muscle, which of the following is most different?
a) The role of calcium in initiating contraction
b) The source of activator calcium
c) The mechanism of force generation
d) The source of energy used during contraction
e) The nature of the contractile proteins
5. Power which muscle develops is insufficient to lift cargo. What type of muscle contraction is in this case?
a) Tetanic
b) Isometric
c) Isotonic
d) Eccentric
e) Concentric

Methodological development № 8

The topic: General patterns of central nervous system work. Physiological features of neuronal circuits. Excitation in nerve centers.
The number of hours: 2 hours
The place of spending: education laboratory
The object of learning:
To know: anatomical and physiological features of nervous system, functional characteristics of the nervous system cells, structure and functions of neuronal circuits in CNS

Be able: schematically portray the arrange of neurons and structure of nervous circuits in CNS

Theoretical questions for self-preparation

1. Classification of the nervous system
2. Functional categories of cells in nervous system
3. Mechanisms of interaction between neurons in neuronal circuits
4. Nerve center and its properties
5. Reflex principle of CNS work

Keywords and terms: ganglia, afferent division, efferent division, somatic nervous system, autonomic nervous system (ANS), parasympathetic division, sympathetic division

Definitions of key terms and concepts

Nerve –is a bundle of neurons.
Ganglia – aggregations of nerve cell bodies.
Central nervous system (CNS) – includes the brain and the spinal cord.
The peripheral nervous system (PNS) consists of the nerves and ganglia outside the brain and spinal cord.
Autonomic nervous system (ANS) is divided in sympathetic, parasympathetic and enteric division.
Nerve center - is a complex of neurons, which provides the regulation of specific physiological function (center of breathing, circulation etc.)
Excitation of nerve center- is an active process, which is caused by the external and internal stimuli and appears by increasing the rhythmic reflexive activity of organs and the whole body.
Afferent division of the nervous system is responsible for carrying information toward the brain.
Efferent division of the nervous system is responsible for carrying information out and away from the brain.
Physiological role of processes of excitation in nerve centers:

1. Maintain the tone of nerve centers.
2. Provide distribution of information to the nerve centers.
3. Provide analysis and synthesis of information in nerve centers.
4. Launch the reflex reaction in body.
5. Regulate the function of effector organs. Coordinate the reflex reaction of the body.
6. Regulate the behavior of the human.

A reflex - is a stereotypic, unconscious, involuntary response to a stimulus.
Reflex cycle - is the neuronal circuit from the peripheral receptor to the effector organ

with feedback.
Divergence - is the ability of one neuron to connect with a lot of others.
Convergence - is the ability of many neurons converge and synapse with the one neuron.
Oscillating circuits have neurons arranged in a circular fashion

Control questions and answers on the topic:

1. List the main function of the CNS.
a) the management of the activity of the skeletal system; b) regulation of functions of internal organs; c) providing of consciousness and all kinds of mental activity; d) organization of interaction of the organism with the environment.
2. What does autoregulation mean? What other principles of regulation of the organism it includes?
With the help of its self-regulating mechanisms, provides an intensive activity of all organs in different conditions of life. The reflexive principle, the principle of feedback, the system principle.
3. List mechanisms of regulation of the human body. Which regulation is more important?
Nervous, humoral, myogenic. The nervous regulation is the most important.
4. What is a myogenic regulation mechanism? List organs, which are under the control of this mechanism of regulation.
The ability of the muscle to change its contractile activity under the changes of the irritation degree, as well as the automatic mechanism of smooth muscles. The skeletal muscles, heart, gastrointestinal tract, biliary and urinary bladder, ureters, uterus, etc.
5. List the main properties of humoral regulation of the body.
It is a generalized and delayed action with the help of biologically active substances.
6. List the features of the nervous regulation in comparison with the humoral.
It is an ability of exact fast localized action, which ensures the accuracy of the physiological reaction under the influence of various stimuli.
7. Name the types of influence of the nervous system to organs, explain their essence.
Starting influence (the beginning of the function) and simulating (change in the intensity of the work of the organs).
8. Give an example of the trigger and modulating effect of the nervous system on the functions of organs.
Starting effect – the start of muscle contraction due to the nerve stimulation, the cessation of muscle contraction in the absence of impulse. Simulating effect – is an increase in the frequency and strength of heart contraction under the impulses of the sympathetic nerves.
9. What is a "reflex". What is a reflex arc?
It is a reaction of the organism to respond irritations of the external or internal

environment, which is realized with the participation of the central nervous system and has an adaptive value. The reflex arc is the basic functional unit of the nervous system capable of receiving stimuli and producing responses.
10. Name the first and second branch of the reflex arch and indicate their functional significance?
The first link – the receptor – receives, transforms the energy of the stimulus into a nerve impulse and transmits to the nerve conductors. The second link – receives the AP, briefly storing and transmitting to the center of the reflex arc.
11. Name the third link of the reflex arc and indicate its functional significance.
Interneurons – transmit impulses to the efferent link and provide the connection of this reflex arc with other structures of the central nervous system.
12. Name the IV and V links of the reflex arc and indicate their functional significance.
Fourth link – efferent neurons recycle information coming from the third link and other neurons of the CNS, forms a response in a form of an AP, and transmits to the effector.
Fifth link – effector – working organ to which the efferent impulse is addressed (skeletal, smooth muscle, secretory and endocrine cells).
13. What is a nerve center?
A set of neurons that are located at different levels of the central nervous system and provide regulation of a certain function of the body.
14. What organs and tissues are innervated by somatic nervous system, and what are innervated by autonomic nervous system?
Somatic – skeletal muscles, autonomic – all organs and tissues.
15. Where are located the bodies of peripheral afferent neurons of the somatic and autonomic reflex arc?
The somatic – in the cerebrospinal ganglia and ganglia of the cranial nerves. The autonomic – the same, but in addition, in extra- and intramural autonomic ganglia.
16. Name two types of interneurons, differing in function (by the sign of action). What part of the neuron performs the trophic function that ensures the generation of the AP?
Excitation and inhibition. The body of the nerve cell and the axonal hillock, respectively.
17. Where is located the efferent neuron that innervates the working organ of the somatic and autonomic nervous system?
The somatic – in the anterior horns of the spinal cord and motor cranial nerves, the autonomic – outside of the central nervous system (in extra- and intramural autonomic ganglia).
18. What is the receptive field of the reflex (reflexogenic zone)?
The set of receptors in a certain area of the organism, the irritation of which causes this reflex.
19. List the types of interneuronal synapses, differing in function and the mechanism of excitation transmission.
By function – excitatory and inhibitory, by the mechanism of transmission of excitation

– chemical and electrical.
20. What is the phenomenon of relief (post-tetanic, post-active potentiation)? What is the main reason of this phenomenon?
Temporal relief of excitation in chemical synapses after their activation. Accumulation of calcium in presynaptic endings.
21. List the main mediators of the central nervous system.
Acetylcholine, catecholamines, serotonin, gamma-aminobutyric acid, substance P, glycine.
22. List the main properties of the excitation post-synaptic potential (EPSP). How does the excitability of the cell membrane change in case of EPSS occurrence?
It does not spread, does not subordinate the law "all or nothing", it depends on the force of irritation that is capable to summation.
23. What is the response of a neuron to a single afferent stimulus and to series of impulses?
In response to a single impulse, the local potential (depolarization) occurs, that is ten times smaller than the threshold potential; a series of impulses can cause EPSP, which reaches the threshold and initiates the process of excitation.
24. What is the relation between the number of afferent and efferent impulses in CNS neurons?
Efferent impulses are tens and hundreds times smaller than afferent ones.
25. Why does the excitation of a neuron (AP) begin from the axon hillock?
The excitability of the neuron is the greatest in the area of the axon hillock.
26. What is the latent time of a reflex? What does it depend on? What components include the latent reflex time?
It is the time from the onset of irritation to the occurrence of an appropriate reaction. It depends on the number of interneurons, on the strength of the stimulus, on the functional state of the nerve centers. On the time that is necessary for the appearance of excitation in the receptor, conduction of excitation along all links of the reflex arc and the latent period of the effector.
27. The time of which reflexes (extero-, inter-, proprioceptive) in humans is shorter and why?
The proprioceptor reflexes, the reflex arc of which is the shortest, neuronal, and its nerve fibers have the highest speed of excitation conduction.
28. List the features of excitation conduction in the central nervous system?
One-way, slow, the possibility of circulation of excitation, irradiation and convergence of excitation.
29. What are the reason of irradiation, convergence and circulation of excitation in the central nervous system?
The presence of many collaterals in the central nervous system, the ascension of many afferent paths to one neuron, the presence of circular neural chains.
30. How to prove the one-way conduction of excitation along the reflex arc?

In the case of irritation of the anterior root of the spinal cord, excitation does not occur in the posterior root. During irritation of the posterior roots of the spinal cord, the excitation is recorded in the anterior root of the same segment of the spinal cord.

31. What is the irradiation of excitation in the central nervous system, how to prove it?

It is a widespread excitation in the central nervous system. For example, with increasing force of the stimulus of the posterior limb of the frog, all limbs are triggered in the reaction.

32. For what purpose is used blockade of conduction of excitation in the central nervous system in the clinical practice?

For anesthesia in surgical practice and for the treatment of various pathological processes.

33. What is the background activity of nerve centers? What does it cause?

The generation of impulses in the nerve centers occurs due to spontaneous depolarization of the membrane, which is effected by neurohumoral mechanisms and constant afferent impulsation.

34. What factors determine the magnitude of the reflex reaction?

The level of excitability of the nerve center (functional state of the central nervous system) stimulation of the reflexogenic zone.

35. What is the time limit for reanimation (return to life) after clinical death caused by cardiac arrest? Why?

The increased sensitivity of cells of hemispheres to lack of oxygen – they die within 5-6 minutes. After cessation of blood circulation.

Examples of MCQs

1. During an experiment the myotatic reflex has been studied in frogs. After extension in a skeletal muscle its reflex contraction was absent. The reason for it might be a dysfunction of the following receptors:

a) Muscle spindles
b) Nociceptors
c) Articular
d) Golgi tendon organs
e) Tactile

2. In response to the strong quick muscle contraction its reflex relaxation is observed. Which receptors are stimulated at the beginning of reflex reaction:

a) Muscle spindles
b) Articular receptors
c) Tapping receptors
d) Pain receptors
e) Golgi tendon receptors

3. Irradiation of excitation is done due to:

a) Divergence;
b) Convergence;
c) Reverberation;
d) Spatial summation of local responses;
e) The presence of feedback in neural chains.
4. During experiment we explore the excitation of different areas of nerve cell. Which area is response by action potential on minimal strength stimuli:
a) Axon
b) Neuron body
c) Dendrite
d) Postsynaptic membrane
e) Axon hillock
5. During an experiment the dorsal roots of the spinal cord of an animal have been cut. What changes will be observed in the innervation zone:
a) Loss of motor functions
b) Sensitivity loss
c) Decrease in muscle tone
d) Increase in muscle tone
e) Sensitivity loss and loss of motor functions

Methodological development №9

The topic: Inhibitory processes in the nerve centers, their features and physiological role. Basic principles of coordination of reflex activity.
The number of hours: 2 hours
The class takes place in: education laboratory
The object of learning:
To know: patterns of occurrence of inhibition processes in the central nervous system, their types and values, the main mechanisms of interaction between processes of excitation and inhibition in coordination of reflex activity.
Be able to: draw diagrams of individual types of central inhibition; to learn methods of studying of inhibition of reflexes.

Theoretical questions for self-preparation

1. Interaction of processes of excitation and inhibition in the central nervous system.
2. Inhibitory processes in the nerve centers and their physiological role.
3. Types of central inhibition and neural mechanisms of their occurrence.
4. Characteristics of presynaptic and postsynaptic inhibition.
5. Reciprocal, reverse and lateral inhibition, their significance.
6. Basic principles of coordination of reflex activity.

Key words and terms: inhibition, dominant, coordination of reflex activity, relief

reflexes, feedback principle, occlusion of the reflex, the principle of a common pathway, reciprocal interaction of reflexes, central inhibition.

Definitions of key terms and concepts

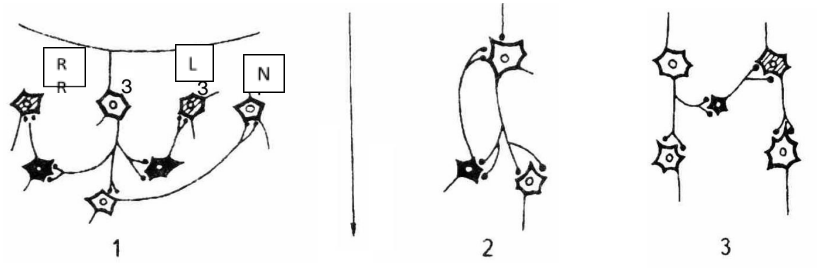
Inhibition is an active physiological process that suppresses or stops the process of excitation.
Central inhibition is an active nervous process that occurs in the nerve centers and in the central nervous system and leads to inhibition or cessation of a certain reflex reaction of the organism.
Central inhibitory processes:
1) limit the wide irradiation of CNS excitation;
2) prevent the occurrence of a reflex reaction in the absence of the necessary conditions for its implementation (for example, the movement of red light, the realization of action in case of prohibition of this activity);
3) provide coordination in the reflex activity;
4) stop the reflex reaction after its completion;
5) facilitate the timely switching of one reflex reaction to the next;
Coordination of reflex activity is the coordination of the activity of neurons, nerve centers and nerve processes in order to provide the most adequate reflex response to the action of the current stimulus.
The dominant is the temporarily dominant reflex excitation cell, which determines the coordinated nature of the activity of the nerve centers, defines and directs the targeted behavior of the organism (e.g. student behavior on examinations, hungry person in everyday life).
Properties of the dominant center: high excitability, long excitation until the end of the reflex action, excitement summation, high inertia, inhibition of other nerve centers.
The aim of inhibition: coordination, protection, inhibition of some significant reactions, coordination of the work of antagonistic centers.
Post-synaptic inhibition is easily removed by administering a strychnine that is competing with the glycine brake mediator in the post-synaptic membrane.
The tetanus toxin also suppresses postsynaptic inhibition. Therefore, the administration of strychnine or tetanus toxin is accompanied by cramping of the muscles, which occurs as a result of increased excitation in the central nervous system, in particular, motor neurons.
In clinical practice, the drug bromide sodium is used as a sedative (soothing) remedy. The mechanism of its action is associated with increased postsynaptic inhibition.

Control questions and answers on the topic

1. What process in the central nervous system is called inhibition?

Active nervous process, the result of which is the cessation of excitation or decrease in the excitability of the nerve cell.
2. Describe the experiment of I.M. Sechenov, who explains the central inhibition.
The increasing in reflex time was observed during the irritation of the area of the visual tuberculum in the thalamic frog.
3. What is the priority of I.M. Sechenov in the field of physiology of the central nervous system?
Expanded the reflectory mechanism to mental activity, discovered the phenomenon of summation of excitation in the nerve centers and central inhibition.
4. What is reciprocal inhibition? Who discovered it?
Inhibition of the nerve center during the excitation of the second center, its antagonist under the influence of afferent impulses coming to them. Prof. N.E. Vvedensky.
5. Name two types of inhibition in the neurons of the central nervous system, which differ from each other in the mechanism of origin and localization.
Post-synaptic and presynaptic.
6. What is post-synaptic neuronal inhibition? With which cells does it occur? In which parts of the central nervous system it takes place?
Inhibition, which is associated with a decrease of neurons' excitability by inhibitory interneurons. Occurs in different parts of the central nervous system.
7. Which mediator could cause IPSP in the motor neurons of the spinal cord? How can you register IPSP?
Under the influence of the inhibitory mediator glycine. With the introduction of microelectrodes inside the cell and registration of its activity during reciprocal bending and subsequent extension of the limb.
8. What is the movement of ions and in what framework ensures the emergence of IPSP?
Movement of chlorine into the cell, potassium from the cell.
9. List the properties of the IPSP. How does the excitability of the cell change in the event of a IPSP?
It does not spread, does not comply the law "all or nothing", it can be summed up. It is reduced due to hyperpolarization of the cell membrane.
10. List the types of postsynaptic inhibition.
Direct: reciprocal, reverse, lateral.
11. Will the neuron be excited when the stimulus and inhibitory cells, which can cause equal to the magnitude of the EPSP and IPSP, come on shortly before, why?
It will not be excited, because of the summation of EPSP and IPSP, the membrane potential will not change.
12. What is presynaptic inhibition? What is the reason of its appearance and in what parts of the CNS it occurs?
Inhibition occurs in the presynaptic terminal due to stable subthreshold depolarization. Occurs in different parts of the central nervous system.

13. What is the reason of depolarization of the axons' terminal of the excitatory neuron in case of presynaptic inhibition?
The influence of a mediator excreted from the axonic end of the inhibitory interneuron.
14. Why, in the case of a stable depolarization of the presynaptic terminal, the excitation of the postsynaptic neuron is not transmitted?
Because there is no AP (or very small) in the presynaptic terminal, as a result, the mediator from the presynaptic end to the synaptic cleft is not allocated, or it is allocated little.
15. Will the excitation of the postsynaptic neuron and its membrane potential be changed by the presynaptic inhibition? Explain the mechanism.
Does not change, as the depolarization of the presynaptic terminal causes a blockade of the nerve impulse on the pathway to the postsynaptic neuron.
16. What is the significance of different types of inhibition in the central nervous system?
Inhibition is an important factor in coordinating the activity of the central nervous system, in the processing of information that enters the neuron and performs a protective role.
17. How and why does strychnine effect on spread of excitation in the central nervous system? What consequences will this lead to?
Strychnine excludes postsynaptic inhibition, which leads to irradiation of excitation in the central nervous system and as a consequence - generalized convulsive contraction of skeletal muscle.



Inhibitory processes in neuronal circuits:
1 - reciprocal inhibition in the centers of the spinal cord, which control the movements of the lower extremities; R - rights; L- left leg; N- neurons that control exterminators.

2 - reverse inhibition (Renshaw) in the spinal cord; 3 - lateral inhibition.

Examples of MCQs

1. Inhibition of alpha-motoneuron of the extensor muscles was noticed after stimulation of alpha-motoneuron of the flexor muscles during the experiment on the spinal column. What type of inhibition can this process cause?
a) Reciprocal
b) Presynaptic
c) Depolarizational
d) Recurrent
e) Lateral
2. A 42-year-old woman consults a dermatologist to evaluate and treat her glabellar lines (frown lines on the forehead just above the nose). After her treatment options are explained, the patient asks the dermatologist to administer Botox (botulinum type Botox injections smooth out glabellar lines by which of the following methods?
a) Blocking the release of synaptic transmitter from a-motoneurons
b) Preventing the opening of sodium channels on muscle membranes
c) Decreasing the amount of calcium released from the sarcoplasmic reticulum
d) Increasing the flow of blood into the facial muscle
e) Enhancing the enzymatic hydrolysis of acetylcholine at the neuromuscular junction
3. An inhibitory presynaptic neuron can affect a postsynaptic neuron by
a) producing an IPSP in the postsynaptic neuron.
b) hyperpolarizing the plasma membrane of the postsynaptic neuron.
c) causing K+ to diff use out of the postsynaptic neuron.
d) causing Cl− to diff use into the postsynaptic neuron.
e) all of the above.
4. IPSP could result from___:
a) opening of K + channels
b) opening of ligand-gated cation channels
c) closure of Cl- channels
d) closure of potential-gated Ca ++ channels
e) all of these
5. Presynaptic inhibition depends upon:
a) augmented release of chemical transmitter from presynaptic terminals
b) continued depolarization of presynaptic terminals
c) GABA receptors in presynaptic terminals
d) opening of voltage-gated Ca ++ channels in presynaptic terminals
e) none of these

Methodological development №10

The topic: The role of the nervous system in the regulation of motor function of the body.
The number of hours: 2 hours
The class takes place in: education laboratory
The object of learning:
To know: the role of the spinal cord, midbrain and cerebellum in the regulation of motor functions and the main motor pathways in CNS.
Be able: to investigate and analyze motor reflexes.

Theoretical questions for self-preparation

1. Neuronal organization of motor functions of the nervous system.
2. Role of the spinal cord in the regulation of motor functions of the organism. Spinal shock.
3. The role of the midbrain. the regulation of motor functions.
4. Functions of the motor nuclei of the middle brain.
5. Role of different parts of the central nervous system in the formation of orientation reflexes.
6. The cerebellum and its role in the regulation of motor functions of the body

Keywords and terms: spinal shock, static reflexes, tonic reflexes, phase reflexes.

Practical skills

Proprioceptive reflexes.

A) **Knee reflex (knee jerk)**. The person is offered to sit on a chair and put a foot on the leg. You should strike on the tendon of the quadriceps (below the kneecap) by the neurological hammer. As a result, you should observe the extension in the knee joint. Compare reflexes on the right and left legs. The reflex center is located in 3-4 lumbar segments of the spinal cord.

If the knee reflex is weak, it can be strengthened. To do this, the person must grasp the fingers of both hands and force them to stretch them. The knee reflex will increase significantly.

B) **Achilles reflex**. Person stand knee-high on the chair. The feet are free to hang down. A neurological hammer has a slight hit on the tendon of the calf muscle. Observe the foot flexion in the ankle joint.

The reflex center is localized in 1-2 sacral segments of the spinal cord.

C) Biceps reflex

This is most easily done with the patient seated.

Identify the location of the biceps tendon. To do this, ask the patient flex at the elbow while you observe and palpate the antecubital fossa. The tendon will look and feel

like a thick cord. The patient's arm can be positioned in one of two ways: allow the arm to rest in the patient's lap, forming an angle of slightly more than 90 degrees at the elbow.
Make sure that the biceps muscle is completely relaxed. It may be difficult to direct your hammer strike such that the force is transmitted directly on to the biceps tendon, and not dissipated amongst the rest of the soft tissue in the area. If you are supporting the patient's arm, place your thumb on the tendon and strike this digit. If the arm is unsupported, place your index or middle fingers firmly against the tendon and strike them with the hammer. Make sure that the patient's sleeve is rolled up so that you can directly observe the muscle as well as watch the lower arm for movement. A normal response will cause the biceps to contract, drawing the lower arm upwards.

Definitions of key terms and concepts

Muscle tone (long-lasting muscle tension or tonus) is the continuous and passive partial contraction of the muscles, or the muscle's resistance to passive stretch during resting state. It helps to maintain posture. The motoneurons are important in maintaining of muscle tone - working posture of the organism in space (standing, sitting). They cause this tone due to a small frequency of action potentials (from 3 to 40 imp/s). The muscle tone is maintained reflexively, mainly from proprioceptors of the musculoskeletal system, vestibular receptors, and due to the regulatory effects of the cerebellum, reticular formation, red nuclei of the middle brain and other CNS parts.
Static reflexes occur during changes in the position of the head in space. There are reflexes of posture and straightening. The posture reflexes cause a redistribution of the tone of the muscles of the trunk and extremities during changes in the position of the head in space. Reflexes of straightening are observed when the position of the body is disturbed in space (in case of falling and after it, in case of rising from a lying position) and lead to the restoration of the natural posture (position) of the body in space.
Stato-kinetic reflexes are response reflexes of the body at accelerated movements in space. The receptive field for linear acceleration are located in the utricle and the saccule. Semicircular channels detect rational movements.
Static-kinetic reflexes consist of rapid redistribution of the tone of the limb muscles (flexors and extensors) at the beginning and at the end of the accelerated motion. These reflexes are important in maintaining body's balance during movement of the body in space (jumping or riding in the vehicle).

Control questions and answers on the topic

1. What are the main functions of the spinal cord? The Bell-Magendie Law.
To provide reflexes and conduct the nerve impulses. The anterior roots of the spinal cord are motor, and the posterior are sensitive. The Bell-Magendie Law is the law of

distribution of sensitive and motor fibers in the spinal cord centers.
2. What is the significance of the afferent impulses that enter the central nervous system from the posterior roots of the spinal cord?
Provide reflex regulation of the functions of the internal organs and motor apparatus, support the tone of the central nervous system, inform the central nervous system about the environment.
3. What are the segmental and suprasegmental nerve centers? In which parts of the central nervous system they are located?
Segmental nerve centers consist of neurons that are directly related to the effector of certain body metameres. The above segmental nerve centers do not have direct communication with the effector. Segmental - in the spinal cord, as well as in the medulla oblongata and the middle brain (the nuclei of the cranial nerves). Extra-segmental - in the brain, as well as in the cervical upper chest segments of the spinal cord.
4. How many segments of the spinal cord innervate each body metamere? What is the biological significance of this fact?
Three segments. It is a case of reliability, when there is damage of the roots of one segment of the spinal cord, their function is partially compensating by the roots of two adjacent segments.
5. List the types of motor neurons of the spinal cord. What is the functional significance of α-motor neurons of Type I and II?
α-motor neurons of type I and II, ɣ -motor neurons. α-motor neurons of type I control the contraction function of fast (white) muscle fibers. α -motor neurons of type II innervate slow (red) muscle fibers.
6. What innervates ɣ-motor neurons and what is the functional significance of this innervation?
ɣ-moto neurons innervate the intrafusal muscle, which regulates the tone of the skeletal (extrafusal) muscles.
7. List the main descending tracts of the spinal cord.
Pyramidal - corticospinal (direct and cross) and extrapyramidal: cortico-rubro-spinal, cortico-vestibular spinal, cortico-reticulo-spinal.
8. On what neurons of the spinal cord are ended the pyramidal and cortico-reticulo-spinal descending paths? What is the role of these paths?
On α and ɣ-motor neurons, on excitatory and inhibitory interneurons. Pyramid paths provide voluntary movements, reticulo-spinal regulate muscle tone.
9. On what neurons of the spinal cord the rubro-spinal and vestibular-spinal descending are ended? What is the role of these paths?
On excitatory and inhibitory interneurons. Regulation of muscles tone and position of the body in space.
10. Identify the segments of the spinal cord from which the muscles of the lower extremities are innervated.

2-5 lumbar and 1-5 sacral segments.

11. Why are spinal reflexes investigated on spinal animals? Why the cut is done below the 5th cervical segment during investigation of spinal reflexes?

To eliminate the influence of the above-located CNS parts on the activity of the spinal cord with aim to maintain diaphragmatic breathing.

12. What is a spinal shock? What is the main cause of spinal shock? What is the duration of a spinal shock in a frog, a dog and a person?

It is a sharp suppression of the excitation and reflex activity of the spinal cord below its injury or cutting. It arises as a result of the exclusion of activatory effect of the above-located parts of CNS on the activity of the spinal cord. In case of a frog it lasts minutes, dog – days, human – months.

13. What motor reflexes (reaction-response types) can be caused in a spinal animal?

Bending, extension, rhythmic, posterior-tonic.

14. Describe the state of the spinal animals' muscle tone, its mechanism?

The tone is minimal, has reflex origin, due to excitation of proprioceptors as a result of their stretching, spontaneous activity of proprioceptors and the action of ɣ-motoneurons, which also possess spontaneous activity.

15. What nucleus of the medulla oblongata is involved in the regulation of muscle tone?

Nucleus vestibularis deiters.

16. What will happen with the muscle tone after the cutting of the brainstem between the pons and the middle brain? Name this state?

A sharp increase in the tone of the extensor muscles. Decerebral rigidity.

17. What is the explanation of the state of decerebral rigidity?

That the α-motor neurons of the spinal cord receive more excitatory impulses than inhibitory ones, due to exclusion of inhibitory effects of the red nucleus on the extensor muscles.

18. List the main motor and sensitive nuclei of the midbrain.

Motor: red nuclei, black substance, nucleus of the oculomotor and trochlear nerves;
Sensitive: primary auditory and visual centers (nuclei of a corpora quadrigemina).

19. What is the role of red nuclei in the regulation of motor activity of an organism?

It controls the tone of skeletal muscles and provide the preservation and restoration of the affected posture.

20. Do the red and Deiters nuclei excite or inhibit the α- and ɣ-motoneurons of muscle flexors and extensors?

The red nuclei inhibit the neurons of extensors, but Deiters nuclei – excite them. They make opposite influence on flexors.

21. List the types of static reflexes and their reflexogenic zones.

They are: reflexes of posture and straightening. They have receptors in the skin, neck muscles and vestibular apparatus.

22. What reflexes are "reflexes of straightening"? List them.

They are reflexes, providing restoration of a normal posture. Straightening the head and straightening the trunk.

23. List the stato-kinetic reflexes.

They are: nystagmus of eyes and head, lift reflexes, redistribution of tone of muscles at jumps and run.

24. How is performed the orientation reflex, can it occur in case of a mesencephalic animal? What nuclei and centers of the brainstem provide the orientation reflex?

It is performed by turns of the body, head and eyes to the direction of sound or light stimuli and by increased tone of muscle flexors. May occur. The red nuclei, the primary visual and primary auditory nerve centers, which are respectively the upper and lower tubercles of corpora quadrigemina, the nucleus of III and IV pairs of cranial nerves.

25. List the functions of the black substance (substantia nigra).

They are: coordination of chewing and swallowing, participation in regulation of muscle tone, small movements of fingers, emotional behavior.

26. What does the reticular formation represent in the structural plan?

A cluster of neurons of various types and sizes that are associated with a large number of fibers that directed to different directions and form a reticle across the entire brainstem.

27. From what structures does the reticular formation receive impulses that support and regulate its activity?

From all receptors of the body and from all parts of the central nervous system.

28. Are the neurons of the reticular formation poly- or monomodal? To which parts of the central nervous system do they send impulses?

They are polymodal, send impulses to all parts of the central nervous system.

29. List the properties of the reticular formation. What effect does the reticular formation make on all parts of the central nervous system? By means of excitatory or inhibitory neurons is this done?

It has spontaneous activity, high excitability, high lability (up to 1000 Hz), is sensitive to barbiturates. Regulates the excitability and tone of the whole central nervous system by activating inhibitory and excitatory neurons with a predominance of the latter.

30. What state of the animal appears after destruction of the reticular formation and why, as well as after cutting of afferent pathways that are connected to it?

A deep inhibition of the higher parts of the central nervous system appears as a result of a sharp decrease in ascending activating impulses.

31. What three parts of the cerebellum are identified in the structural-functional meaning? From which receptors do impulses come into the cortex of the cerebellum?

The middle part ("worm"), the intermediate part adjoins to "worm", and the hemisphere cerebellum is located on both sides of "worm". From receptors of skin and proprioceptors of the body.

32. Which parts of the central nervous system are connected with the cerebellum by

lower, middle and upper peduncles?
The lower peduncle of the cerebellum provides a connection to the medulla oblongata, the middle with the pons, and through the pons with the cerebral cortex, the upper peduncle – with the middle brain.
33. By means of which nuclei and structures of the brainstem the cerebellum implements its regulatory influences on the tone of the skeletal muscles and the motor activity of the organism? Are they excitatory or inhibitory?
By the Deiters nuclei, the red nuclei, the reticular formation of the medulla oblongata and the pons. They are both excitatory and inhibitory, with predominance of inhibition.
34. What functions does the middle part of the cerebellum ("worm") have and by what structures of the brainstem are they realized?
It regulates the muscle tone and maintains the posture (balance) by the Deiters nuclei and reticular formation of the brainstem.
35. What motor function do the hemispheres of the cerebellum and how is it carried out?
They correct planned movements by refining the cortical movement program without comparison with the result of action.
36. What effect does the cerebellum have on homeostasis, how does homeostasis change at damage of the cerebellum?
It has stabilizing effect. At damages of the cerebellum, homeostasis is disturbed.

Examples of MCQs

1. Inhibition of alpha-motoneuron of the extensor muscles was noticed after stimulation of alpha-motoneuron of the flexor muscles during the experiment on the spinal column. What type of inhibition can this process cause?
a) Reciprocal
b) Presynaptic
c) Depolarizational
d) Recurrent
e) Lateral.
2. As a result of destruction of certain brainstem structures an animal has lost its orientative reflexes in response to strong photic stimuli. What structures were destroyed?
a) Anterior tubercles of quadrigeminal plate
b) Posterior tubercles of quadrigeminal plate
c) Red nuclei
d) Vestibular nuclei
e) Black substance
3. As a result of damage to certain structures of brainstem an animal lost orientation reflexes. What structures were damaged?
a) Quadritubercular bodies

b) Medial nuclei of reticular formation
c) Red nuclei
d) Vestibular nuclei
e) Black substance.

4. A 72-year-old man visits his physician because he finds it difficult to hold his hand steady when painting. Examination reveals a resting tremor and rigidity. The symptoms are relieved by single dose of levodopa, suggestive of Parkinson's disease. This patient's neurological signs are most likely related to a lesion within which of the following?

a) The substantia nigra
b) The cerebellum
c) The premotor area
d) The caudate nucleus and putamen
e) The hippocampus

5. The precentral gyrus and corticospinal tract are essential for which of the following?

a) Voluntary movement
b) Vision
c) Olfaction
d) Auditory identification
e) Kinesthesia

6. A 72-year-old male is evaluated by a physiatrist after a stroke. The patient is observed to suffer from dysmetria, ataxia, and an intention tremor. These neurological signs are most likely related to a lesion within which of the following regions of the brain?

a) Cerebellum
b) Medulla
c) Cortical motor strip
d) Basal ganglia
e) -

7. A 59-year-old woman is admitted to the hospital because of agitation and aggression. Three years prior to admission her irregular, flinging movements had become so severe that she could not walk or assist in her own care. She is diagnosed with Huntington's chorea, which is a hereditary disease affecting neurons within which of the following?

a) Striatum
b) Anterior cerebellum
c) Subthalamus
d) Substantial nigra
E) Limbic system cranial nerve

8. A 3-month-old baby is brought to her pediatrician for a checkup. Stroking the plantar surface of the foot produces a reflex extension of the large toe rather than the expected flexion. The Babinski sign elicited by the physician indicates damage to which of the following?

a) Pyramidal tracts
b) Spinal cord
c) Brainstem
d) Cerebellum
e) Basal ganglia

Methodological development №11

The topic: The role of the basal nuclei and the cerebral cortex in the regulation of motor functions of the body.
The number of hours: 2 hours
The class takes place in: education laboratory
The object of learning:
To know: functions of the higher divisions of the central nervous system.
To be able: to record and to analyze the electrical activity of the cerebral cortex - electroencephalogram (EEG).

Theoretical questions for self-preparation

1. Cerebrum. Its functions and structure.
2. The functions of cerebral cortex and its areas.
3. The role of the basal ganglia.
4. The asymmetry of the human brain. Diffuse modulatory systems.
5. The method of electroencephalography (EEG) and its usage in physiological and clinical practice.

Keywords and terms: electroencephalography, basal ganglia, cerebral cortex

The definition of key terms and concepts

Cerebral cortex is the outer covering of gray matter over the hemispheres.
Basal Ganglia is a group of nuclei (masses of gray matter), which is located deeply between the forebrain and the upper part of diencephalon.
The main components of the basal ganglia:
- the dorsal striatum (caudate nucleus and putamen)
- ventral striatum (nucleus accumbens and olfactory tubercle)
- globus pallidus, ventral pallidum, substantia nigra, and subthalamic nucleus.

The function of basal ganglia includes: the control of motor function, regulation of muscle tone and coordination of rhythmic movements (e.g. arm swinging while walking).
The extrapyramidal system includes a part of the cerebral cortex (premotor area, gyrus cingularis), basal ganglia, substancia nigra and the red nuclei of the middle brain, reticular formation of the brainstem, cerebellum and vestibular nuclei of medulla

oblongata. This system has a special role in regulation of those movements of the body, which do not require an active attention of the person.

Pyramidal tract - starts from the pyramidal neurons of the motor zone of the cortex and is directed straight to the medulla oblongata and spinal cord, where acts the motor neurons through interneurons. The pyramidal tracts affect the work of skeletal muscles, regulate complex voluntary movements that require the attention of the person.

An orientative reflex – is an involuntary reaction-response of the body to environmental changes. These reflexes are manifested by the turning of the head towards sudden light stimuli (upper tuberculum – dorsal) or sound stimuli (lower tuberculum – ventral).

Plasticity is the ability of nerve cells and centers to rearrange their functional properties under the influence of prolonged external actions. In usual conditions plasticity provides adaptive function, and in pathological conditions (after injuries, brain hemorrhages) – compensatory (restorative) function.

Plasticity is conditioned by changes of efficiency or direction of links between nerve cells. Due to the plastic reorganization of interneuronal connections, new micro- or macrostructural interconnections of the system, the implementation of adaptive and compensatory functions arises.

Plasticity in the nervous system can manifest itself both at the cellular level and at the level of integrative nervous activity (dominant, learning, motivation).

The plasticity of the function is the ability of cells, tissues, organs and systems to change their activities in appropriate limits when environmental conditions change, as well as as a result of the development of compensatory and restorative processes (after injuries, operations, prosthetics).

An ***electroencephalogram (EEG)*** – is an electrophysiological monitoring method to record electrical activity on the scalp.

Control questions and answers on the topic

1. What are the main parts of the brain?

The brain consists of the brainstem, cerebellum, diencephalon, and cerebrum.

2. What are the motor areas of the cerebral cortex and what are their location?

The main motor areas:

The **primary motor** cortex is located in the precentral gyrus and in the anterior paracentral lobule of the brain.

The **supplementary motor area** is located on the midline surface of the hemisphere, just in front of the primary motor cortex.

The **premotor cortex** is located ahead primary motor cortex in the depth of Sylvian sulcus.

The **additional motor area** is located in posterior parietal cortex.

3. What is the cerebral cortex and what are its functions?

Cerebral cortex is a thin layer of gray matter that covers the outer part of cerebrum. It contains 40% of all neurons of the nervous system. It is divided in four lobes, which have specific functions.
a. Frontal Lobe - the frontal lobe is a primary motor area, also known as the somatomotor area. It is responsible for voluntary movements and partly for speech.
b. Parietal Lobe - the parietal lobe is a general sensory area. Therefore, it is completely sensory.
c. Occipital Lobe - the occipital lobe is primarily responsible for vision. Sometimes it is called the visual cortex.
d. Temporal Lobe - the temporal lobe is the auditory area. It has primary importance for hearing and partly for speech. Sometimes it is called the auditory cortex.
4. To which 3 areas can be divided the cerebral cortex according to its functional specialization?
- sensory areas are specialized on interpreting the sensory inputs;
- motor areas control the skeletal muscles (voluntary movements)
- associative areas are responsible for concentrating, planning, complex problem solving, the speech understanding, complex interpretation of sensory experience, memory storage of visual scenes, music, and complex patterns.
5. Where can be EEG used?
EEG is used in clinic to diagnose the epilepsy and brain death.
6. Which EEG patterns do you know?
- alpha, - beta, - theta, - delta
7. What is the frequency of each wave?
- alpha, 8-13 cycles/sec. ,50-100 mkv
- beta, 13-30 cycles/sec., <50 mkv
- theta, 4-7 cycles/sec., >100 mkv
- delta, 1-5 cycles/sec., > 100 mkv
7. What is the pyramidal system (tract)? What is its function?
It is a system of pyramidal cells that are linked to alpha motoneurons directly or by interneurons. It provides voluntary movements and control afferent impulses.
8. List the main structural components of the extrapyramidal system?
Premotor area of the cerebral cortex, corpus striatum, black substance, red nuclei, reticular formation, vestibular nuclei, cerebellum.
9. What is the function of the extrapyramidal system?
It provides unvoluntary movements, regulates the muscle tone, maintains the posture.
10. What functions do corpus striatum and globus pallidum provide?
They provide: rotation of the head and trunk, movements of limbs on the opposite side.
11. List the basic functions of the corpus striatum?
- complex motor actions, unconditioned reflexes, instincts, regulation of muscle tone.
- conditional reflexes and emotions.
- regulation of vegetative functions.

12. What are the functional interrelations between the corpus striatum and globus pallidum? What motor disturbances arise when corpus striatum is damaged?
Corpus striatum has inhibitory effect on globus pallidum. Hyperkinesia (excess of unvoluntary movements), decreased muscle tone (hypotonia).
13. What motor disturbances arise when globus pallidum is damaged?
Hypokinesia (lack of mobility), increased tone of the muscles (rigidity).

Examples of MCQs

1. The gray matter of cerebral cortex consists of
a) Cell bodies, dendrites and axons
b) Cell bodies, axons and glial cells
c) Cell bodies, dendrites and glial cells
d) Axons, dendrites and glial cells
e) Cell bodies and glibly cells
2. Language comprehension is a function of
a) Auditory cortex
b) Broca's area
c) Visual cortex
d) Wernicke's area
e) Premotor cortex
3. Speech production and articulation is a function of
a) Auditory cortex
b) Broca's area
c) Visual cortex
d) Wernicke's area
e) Premotor cortex
4. The patient with apraxia cannot:
a) Name his fingers
b) Carry out an imagined act
c) Draw simple diagrams
d) Speak fluently
e) Write the text
5. The putamen, caudate and globus pallidus are involved in:
a) Movement
b) Vision
c) Behavior
d) Audition
e) Sensation
6. Which lobe is primarily responsible for vision:
a) frontal lobe

b) temporal lobe
c) occipital lobe
d) parietal lobe
e) central lobe
7. Which EEG pattern is common in newborn:
a) alpha
b) alpha and beta
c) beta
d) delta
e) theta
8. Deterioration of which Diffuse Modulatory System may be linked to Alzheimer's disease:
a) Norepinephrine system
b) Serotonin system
c) Acetylcholine system
d) Dopamine system
9. This system is important in the expression of fear, rage, and instinctual sexual behavior. How does it call?
a) limbic system
b) reticular formation
c) norepinephrine system
d) insula
e) thalamus
10. Regarding the functions of the cerebral hemispheres
a) the parietal lobes are involved in pain perception
b) damage to the parietal lobes is associated with paralysis of the muscles on the contralateral side of the body
c) damage to the temporal lobes can lead to a failure of object recognition.
d) the parietal lobe on the right side of the brain plays a significant role in the comprehension of speech
11. Which structure separates cerebrum from cerebellum:
a) longitudinal fissure
b) transverse fissure
c) lateral fissure
d) central sulcus of Rolando
e) corpus callosum
12. The organization of most functions of the brain is contralateral, meaning:
a) Each hemisphere controls the opposite side of the body
b) Both hemispheres are dominant
c) The right–hemisphere controls most functions
d) The left–hemisphere controls most functions

e) there is no correct answer

Methodological development №12

The topic: Sensory physiology. Somatosensory system.
The number of hours: 2 hours
The class takes place in: education laboratory
The object of learning:
To know: analyze the main sensory functions of the nervous system, mechanisms and processing of sensory information.
Be able to: explore and analyze perception and processing of different types of sensations in different areas of the skin

Theoretical questions for self-preparation

1. Basic concepts of sensory physiology.
2. Receptors and their features.
3. The main sensory tracts.
4. The sensory functions of the thalamus.
5. Sensory function of the cortex.

Key words and terms: sense, general senses, special senses, receptor, exteroceptor, proprioceptor, interoceptors, chemoreceptor, nociceptor, thermoreceptor, photoreceptors, osmoreceptor, free nerve ending, separate receptor cell, coding of sensory information, adaption, somatosensory system, somatosensory cortex, homunculus.

Definitions of key terms and concepts

Sense is the ability to perceive stimuli. The brain receives information about the environment and the body from senses.
Receptors are sensory nerve endings or specialized cells capable of responding to stimuli by developing action potentials.
Adaptation is a decrease in the size of the receptor potential with a constant stimulus.
Somatosensory system provides the conscious perception of information from exteroceptors and proprioceptors of the body. These receptors detect information about pressure, temperature, pain and body position.

Control questions and answers on the topic

1. What are the main types of senses?
   They are:

- **General senses (**formed by receptors over a large part of the body):

- somatic – it provides sensory information from the skin (touch, pressure, itch, vibration), proprioceptors: from skeletal muscles, tendons, joints and ligaments.

- visceral – provides information from internal organs and vessels including pain and pressure.

- **Special senses:** smell, taste, vision, hearing, balance.

2. What are the main types of receptors?

- **chemoreceptors** respond to changes in the concentration of chemicals. Receptors associated with the senses of smell and taste are of this type. Chemoreceptors in internal organs detect changes in the blood concentrations of oxygen, hydrogen ions, glucose, and other chemicals.

- **pain receptors**, also called nociceptors respond to tissue damage. Triggering stimuli include exposure to excess mechanical, electrical, thermal, or chemical energy.

- **thermoreceptors** are sensitive to temperature change. Localization: skin, blood vessels of skin and subcutaneous, cornea of the eye, mucous membranes, central nervous system (midbrain, spinal cord).

- **mechanoreceptors** are of several types and sense mechanical forces by detecting changes that deform the receptors. 4 primary mechanoreceptors are found in the human skin: Merkel's disks, which are unencapsulated, respond to light touch. Meissner's corpuscles, Ruffini endings, Pacinian corpuscles, and Krause end bulbs are all encapsulated. Meissner's corpuscles respond to touch and low-frequency vibration. Ruffini's endings detect stretch, deformation within joints, and warmth. Pacinian corpuscles detect transient pressure and high-frequency vibration. Krause end bulbs detect cold.

- **proprioceptors** sense changes in the tension of muscles and tendons.

- **pressoreceptors** are also called baroreceptors, located in certain blood vessels detect changes in blood pressure, and stretch receptors in the lungs sense degree of inflation.

- **photoreceptors** in the eyes respond the light energy of sufficient intensity.

3. What is the role of the receptor?

The perception of stimuli and primary analysis of stimuli.

4. What process helps the receptor to perceive the stimuli?

The receptors transform the energy of stimuli into nerve impulses.

5.What types of information do sensory receptors transmit?

- modality (quality) – refers to the type of stimulus or sensation (vision, hearing, taste).

- location – is determined by which of sensory (afferent) nerve fibers is identified in the brain the site or location of the stimuli.

- intensity – is determined by the number and kind of nerve fibers which are firing and the time between action potential.

- duration – is determined by changes of firing of nerve fibers.

5. What a free nerve ending?

A free nerve ending is a dendritic terminal of an afferent neuron.

6. What is a separate receptor cell (secondary sensitive receptor)?

A separate receptor cell (secondary sensitive receptor) is a specialized epithelial cell, which contacts with afferent neurons by synapses.

7. What is the process of information coding?

The process of coding is the process of transformation of the energy of stimuli into a sequence of action potentials.

8. What are the characteristics of the stimuli coded by receptors?

Receptors distinguish the stimulus modality, location and intensity of stimulus.

9. What receptors provide information to the somatosensory system?

The somatosensory system provides conscious perception of information from exteroceptors and proprioceptors of the body.

10. Why do we feel cold firstly during diving in hot water?

Because the cold receptors are located more superficially and their number is in several times higher than the number of hot receptors, that`s why they can be excited by hot water firstly (above 45˚C).

11. Irritation of which receptors and under what stimuli causes the pain sensation?

Irritation of free nerve endings or any other receptors under the influence of a strong stimuli can cause a pain sensation.

12. What pathway transmits information from mechanoreceptors and proprioceptors?

Dorsal Column-Medial Lemniscus Pathway.

13. What pathway transmits information from thermoreceptors and nociceptors?

Spinothalamic Tract.

Examples of MCQs

1.Regarding sensory receptor properties

a) All receptors respond to a specific quality of a stimulus

b) A touch receptor will generate a constant rate of discharge of its axon for as long as the receptor is stimulated.

c) The first step in sensory transduction is the generation of an action potential

d) The frequency of a train of action potentials in an afferent fiber reflects the intensity of the stimulus given to its receptor.

2.Regarding receptors in the skin

a) All skin receptors are encapsulated

b) The receptive fields of touch receptors are uniform in area

c) The nociceptors of the skin are bare nerve endings.

d) All sensory information from the skin reaches the brain via the dorsal column pathway.

3. All of these receptors are skin receptor EXCEPT:
a) Pacinian corpuscle.
b) Golgi tendon.
c) Merkel's discs.
d) Ruffini ending.
e) Naked free nerve.
4. The cutaneous senses would include all of the following except
a) pressure
b) heat
c) odor
d) touch
e) cold

Methodological development №13

The topic: Pain and temperature sensation
The number of hours: 2 hours
The class takes place in: education laboratory
The object of learning:
To know: neurophysiologic mechanisms of pain, pathways of pain and temperature sensation.
Be able to: interpret violation of pain and temperature sensitivity.

Theoretical questions for self-preparation

1. Mechanism of pain perception.
2. Modulation of pain signals.
3. Physiology of anesthesia.

Key words and terms: pain, substance P, referred pain, Zacharyin-Head's zones, gate control theory, endogenous analgesia, enkephalin.

Definitions of key terms and concepts

Pain is important, because it helps us to avoid damaging stimuli and helps us to prevent further damage.
Referred pain is formed by stimulation of nociceptors in the visceral organs. It is a referred pain because it is referred to a certain body surface.
Types of pain:
Somatic pain can be classified as either:
- cutaneous (peripheral or superficial pain) – arises from skin;
- deep pain – arises from connective tissue, joint receptors, tendons, muscles and fascia.
Visceral pain

Thalamic pain- the condition is associated with a severe intracranial pain in the contralateral side of the thalamic lesion and associated with sensory loss. Lesions in the spinothalamic tract can induce alteration of sensory, motor and endocrine components because of the functional diversity of the thalamus. Subjects with this syndrome experience spontaneous aching and burning pain in body regions where sensory stimuli normally do not lead to pain. For example, patient experiences unrelenting pain, when breeze touches his skin.

Neuropathic pain – is a sharp, shooting and devastating pain. It is a persistent pain that arises from functional changes occurring in the CNS, secondary to peripheral nerve injury. Once the nerve is damaged, the damaged nerve elicits sustained activation of nociceptors and (or) nociceptive afferents. For example, hyperalgesia. This means that you get severe pain from a stimulus or touch that would normally cause only slight discomfort. For example, a mild prod of the painful area may cause intense pain.

Psycosomatic pain – psychic reaction to pain includes all the well-known responses to pain such as anguish, anxiety, crying, depression, nausea and excess muscular excitability through the body. These reactions vary tremendously from one person to another following a comparable degree of pain stimuli. The sensation of pain can be influenced by emotions, past experiences and suggestions. The same stimulus can elicit different responses in different subjects under the same conditions.

Reffered pain – visceral pain may be feeled as if it is coming from some part of the body that differ from the stimulated area. For example, pain originating in the heart may be referred to the left shoulder or the medial surface of the left upper limb. Pain from the lower esophagus, stomach, or small intestine may seem to be coming from the upper central (epigastric) region of the abdomen. Pain from the urogenital tract may be referred to the lower central (hypogastric) region of the abdomen or to the sides between the ribs and the hip.

Phantom pain – the phenomenon of phantom limb pain is a common experience after a limb has been amputated or its sensory roots have been destroyed. The patient feel the pain in that part of the body that no longer exists. Pain from an amputated arm is referred to the viscera as a result of disruption to the "balance" between different peripheral inputs to the dorsal horn. A complete break of the spinal cord also often leads to a phantom body pain below the level of the break.

Acute pain arises from activation of nociceptors for a limited time and can be associated with significant tissue damage (e.g., a pin prick).

Chronic pain is a prolonged pain lasting for months or longer that arises from tissue injury, inflammation, nerve damage, tumor growth, lesion or occlusion of blood vessels.

Control questions and answers on the topic

1. What is a natural analgesic system of the body?

Endorphins, enkephalins, and dynorphin— are important in the body's natural analgesic system. These endogenous opiates serve as analgesic neurotransmitters; they are released from the descending analgesic pathway and bind with opiate receptors on the afferent pain-fiber terminal. This binding suppresses the release of substance P, blocking further transmission of the pain signal. Morphine binds to these same opiate receptors, which is widely used for its analgesic properties.

2. What are the neuronal circuits that modulate pain?

The «Gate Control» theory and the ascending/descending pain transmission system are the two suggestions of such circuits. In the gate control theory, the experience of pain depends on a complex interaction of the CNS and the PNS as each of them process pain signals in their own way. Upon injury, pain messages originate in nerves associated with the damaged tissue and is conducted along the peripheral nerves to the spinal cord and up to the brain. So far, this is roughly equivalent to the specificity theory of pain described above. However, according to the gate control theory, these pain messages encounter "nerve gates" in the spinal cord before they reach the brain that are able to open or close depending on number of factors (possibly including instructions coming down from the brain). When the gates are opened, pain messages "get through" more or less easily and pain can be intense. When the gates are closed, pain messages are prevented from reaching the brain and may not even be experienced.

3. What are the effective ways of pain treatment?

Effective treatments for pain may include: acupuncture, electropuncture and other methods of reflexology. The basis of the analgesic effect in reflexology is to increase the threshold of excitability of pain receptors with inhibition of conduction of excitation by nociceptive paths. At the same time, the activity of the central antinociceptive system can increase, which is ensured by the normalization of the balance of mediators and pain modulators.

4. What are the surgical methods of pain management?

The surgical methods of pain management include:

• the separation of the corresponding sensory nerve above the place of occurrence of pain (peripheral neurotome);
• crossing of the pain pathways in the spinal cord (lordotomy);
• surgery on the brain (thalamotomy, prefrontal lobotomy).

Examples of MCQs

1. When there is damage to cells, the cells will release lots of____which will then stimulate the nociceptors.

a) Na
b) **K**
c) Cl
d) H
e) Ca

2. Pain, temperature and touch information synapses in the_____horn of the spinal cord in either the_____or _____
a) Ventral horn; substantia gelatinosa; nucleus proprius
b) Dorsal horn; substantia gelatinosa; nucleus proprius
c) Ventral horn; gracile fasciculus; cuneate fasciculus
d) Dorsal horn; substantia gelatinosa; nucleus proprius
3. Central connections (body) for pain and temp is sent through the _____tract to the_____of the thalamus.
a) Spinothalamic; ventral posteromedial nucleus
b) Trigeminothalamic; ventral posteromedial nucleus
c) Spinothalamic; ventral posterolateral nucleus
d) Trigeminothalamic; ventral posterolateral nucleus
4. Which of these factors does NOT affect the perception of pain?
a) The expected pain intensity.
b) The attention given to the pain.
c) The actual intensity of the painful stimulus.
d) The existence of the neurons producing the pain stimulus.
5. Which fibers are responsible for the transmission of the first pain response?
a) A beta
b) A delta
c) B
d) C
6. Which of the following transmits pain signals?
a) Free nerve endings
b) Meissner's corpuscle
c) Merkel's disc
d) Pacinian corpuscle
e) Ruffini's ending

Methodological development №14

The topic: The optical system of the eye and its characteristics. Photoreceptors and their functions.
The number of hours: 2 hours
The class takes place in: education laboratory
The object of learning:
To know: structural and functional organization of the optical system of eye, methods of basic visual functions of the central and peripheral vision, clinical defects in vision, functions of photoreceptors, phototrunsduction, neural pathways for vision.

Be able to: draw the scheme of functional structure of eye, accommodation mechanism of eye, determine visual acuity and give her assessment as quantitative indicator of central vision, define the field of view and give its assessment as peripheral vision, investigate color vision by polychromatic Rabkin's tables.

Theoretical questions for self-preparation

1. The optical system of the eye and its characteristics.
2. Correction of the refraction defects.
3. Photoreceptors and their functions.
4. Phototransduction.
5. Color perceptions.
6. Neural pathways for vision.

Key words and terms: accommodation, refractive errors, binocular vision, diopter, pupillary reflex sight, peripheral vision, refraction, central vision, anomalies of color vision, visual pigments, cones, rods, the retina, the theory of color vision.

Definitions of key terms and concepts

Accommodation – is a process by which the eye increases optical power to maintain a clear image (focus) of the object.
A dioptre, or diopter, is a unit of measurement of the optical power of lens or curved mirror, which is equal to the reciprocal of the focal length measured in meters (that is, 1/meters).
Emmetropia is a normal refraction of the optical system. This condition of the normal eye is achieved when the refractive power of the cornea and the axial length of the eye are balanced, which focuses rays exactly on the retina, resulting a perfect vision. An eye in a state of emmetropia requires no correction.
Myopia – near objects are seen clearly but not distant objects because the refractive power of the lens or cornea is too strong for the length of the eyeball. It is corrected by concave lens that cause light waves to diverge. Eye accommodates for near vision.
Hyperopia – the lens or cornea is too weak for the length of the eyeball. Distant objects can be focused only with accommodation and lens cannot accommodate enough for near objects. It is corrected by convex lens.
Astigmatism – is connected with irregularities on the cornea or lens surface that cause uneven refraction and results in distortion.
Anisocoria is a condition characterized by an unequal size of the eyes' pupils.
Mydriasis is a dilation of the pupil, usually defined with oculomotor nerve palsy.
Binocular vision is important for compensation of imperfection of vision of one of the eyes.
Rhodopsin- is a light-sensitive receptor protein. It is a biological pigment of retina photoreceptor cells (rodes). **Hlorolab, erytrolab, iodopsin** – are visual pigments of

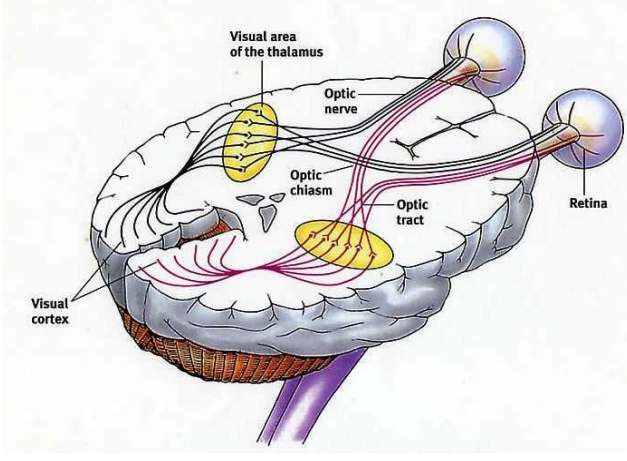
cones.
Color blindness / daltonism / – violation of color perception; protanopia – lack of sensitivity to red color; deuteranopia – lack of sensitivity to green; tritanopia – lack of sensitivity to blue; achromatism – complete color blindness.

Control questions and answers on the topic

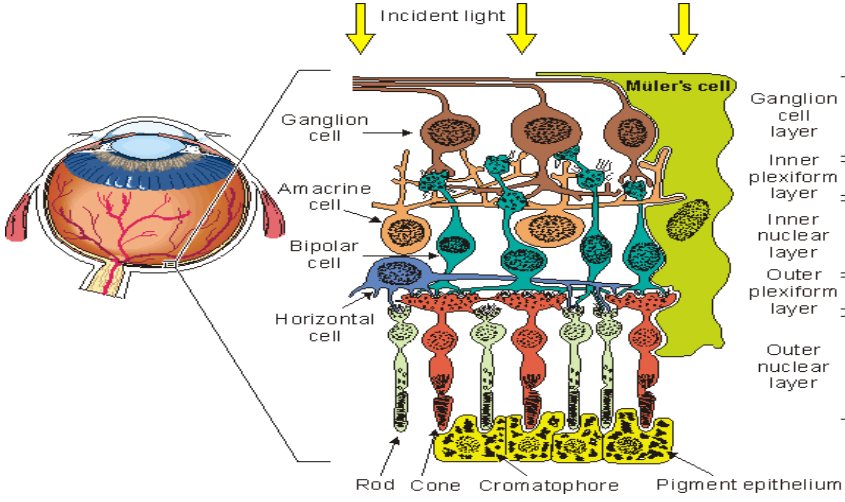
1. What are the main refractive components of the eye and their refractive power at examining near and far located objects. The cornea, lens and vitreous body; 55 and 70.5 diopters respectively. The lens - from 15 to 29 D.
2. List refraction anomalies of the eye.
Myopia, hyperopia, astigmatism.
3. What is myopia?
Myopia is a condition when light rays parallel to the main optical axes converge before the retina. This causes distant objects to be blurry while near objects appear to be normal. Usage of glasses or contact lenses for correction is the most common approach; other approaches include vision therapy, orthokeratology and surgery. Myopia is corrected by diverging lenses (minus).
4. What is hyperopia?
The light rays parallel to the main optical axis converge behind the retina. It can be corrected by usage of converge lens (plus).
5. What is astigmatism?
Astigmatism is connected by refraction of light in different eye planes differently. In this case, the image can't be precisely focused on the retina. This can lead to eye discomfort and headaches.
6. How often do children have myopia, at what age usually happens? What is its direct reason?
Myopia occurs in 30-40% of preschool and school age. The reason of it is the increased longitudinal axis of the eye.
7. What factors contribute to the development of myopia in children?
Longlasting reading in a sitting position with great inclination of the head or reading the book too close to the eyes (less than 30 cm), lack of light, small items, genetic predisposition (lack of rigidity of the sclera).
8. Why do all this factors lead to myopia?
The above listed factors lead to an increased blood supply of the eye, and thus to increased intraocular pressure.
9. Due to what vision can we see large objects as a whole and its parts?
Due to central and peripheral vision, providing a greater range of angle view.
10. Why the visual acuity is greater in fovea centralis than in the periphery of the retina?
There are only cones, their diameter is the smallest, and they are connected with a smaller number of bipolar neurons (sometimes one).

11. List all photopigments that you know.
They are: rodes contain rhodopsin, cones – iodopsyn, hlorolab, erytrolab, they provide color vision.
12. What is a blind spot of the retina? What experience prove its existence?
The area of the retina that does not contain photoreceptors, where the optic nerve is formed. Mariotte's Experiment proves its existence.
13. Describe this Mariotte's Experiment.
The person takes a picture with a white circle and a cross on its black background. One eye closed, the other looks at the cross (thus seeing the circle), and then slowly alienated the picture – at a distance of 15-25 cm from the eye – the circle disappears.
14. Why does the circle disappear at the distance of 15-25 cm?
Because at this distance at a fixed view on the cross the white circle is located on the blind spot of the retina.
15. What is the macula lutea and the central fovea?
The macula lutea – is a place of best vision, where are mainly cones, and the central fovea where only cones are found there.
16. List types of daltonism.
They are: protanopia – blindness to red, deuteranopia – blindness to green, tritanopia – blindness to blue.

17. The visual pathway.



18. The structure and function of the retina.



The retina contains the photoreceptor cells, the bipolar cells, ganglion cells, amacrine cells and the horizontal cells. Photoreceptor cells are of two types: rods and cones. The rods are sensitive to dim light while cone are sensitive to color or details. The light is directed to the photoreceptor cells by the amacrine cells and the horizontal cells. In the retina the photoreceptor cells are connected to the bipolar cells which are in turn connected to the ganglion cells. The ganglion cells are connected to the nerve cells which carry the nerve impulse generated to the occipital lobe of the brain where it is interpreted.

Mechanism for vision:

1.Phototransduction (initiation of vision)

2.Processing and transmission of visual sensation

3. Visual perception (visual cortex)

Light shining onto outer segment leads to the hyperpolarization of the photoreceptor and reduction of neurotransmitter released.

Visual Pigments

Rods and cones contain light-sensitive pigments that decompose when they absorb light energy. The light-sensitive pigment in rods is rhodopsin or visual purple, and it is embedded in membranous discs stacked in these receptor cells. In the presence of light, rhodopsin molecules break down into molecules of a colorless protein called opsin and a yellowish organic molecule called retinal (retinene) synthesized from vitamin A.

In darkness, sodium channels in portions of the receptor cell membranes are kept open by a nucleotide called cyclic guanosine monophosphate (cGMP). When rhodopsin molecules absorb light, they change shape and release opsin, in trillionths of a second. The released opsin then becomes an active enzyme, which activates a second enzyme (transducin), which, in turn, activates another enzyme (phosphodiesterase). The third enzyme of this series breaks down cGMP, and as the concentration of cGMP decreases, sodium channels close, and the receptor cell membrane hyperpolarizes. The degree of hyperpolarization is directly proportional to the intensity of the light stimulating the receptor cells. The hyperpolarization reaches the synaptic end of the cell, inhibiting release of neurotransmitter. Through a complex mechanism, decreased release of neurotransmitter by photoreceptor cells either stimulates or inhibits nerve impulses (action potentials) in nearby retinal neurons. Consequently, complex patterns of nerve impulses travel away from the retina, through the optic nerve, and into the brain, where they are interpreted as vision.

An **optical illusion** (also called a **visual illusion**) is an illusion caused by the visual system and characterized by visually images that differ from objective reality. The information gathered by the eye is processed in the brain to give a percept that does not tally with a physical measurement of the stimulus source. There are three main types: literal optical illusions that create images that are different from the objects that make them, physiological illusions that are the effects of excessive stimulation of a specific type (brightness, color, size, position, tilt, movement), and cognitive illusions, the result of unconscious inferences. Pathological visual illusions arise from a pathological exaggeration in physiological visual perception mechanisms causing the aforementioned types of illusions.

Optical illusions are often classified into categories including the physical and the cognitive or perceptual, and contrasted with optical hallucinations.
Physiological illusions, such as the afterimages following bright lights, or adapting stimuli of excessively longer alternating patterns (contingent perceptual aftereffect), are presumed to be the effects on the eyes or brain of excessive stimulation or interaction with contextual or competing stimuli of a specific type—brightness, color, position, tile, size, movement, etc. The theory is that a stimulus follows its individual dedicated neural path in the early stages of visual processing, and that intense or repetitive activity in that or interaction with active adjoining channels cause a physiological imbalance that alters perception.

Examples of MCQs

1. In the experiment on the animal the part of the cerebral cortex hemispheres was removed. It caused elimination of previously formed conditioned reflex to the light

irritation. What part of the cortex was removed?
a) Occipital cortex
b) Precentral convolution
c) Postcentral convolution
d) Limbic cortex
e) Temporal lobe
2. Regarding the physiology of the eye
a) The pressure within the eye (the intraocular pressure) is about 1.5 mm Hg (0.2 kPa).
b) When light is shone in one eye, both pupils constrict.
c) The pupils dilate when the eye is focused on a near object
d) The aqueous humour is an ultrafiltrate of plasma.
e) None of the answers is correct
3.Regarding vision
a) Protanopes cannot distinguish between red and green because they lack the pigment for detecting green light.
b) Full color vision is possible in dim light.
c) Full dark adaptation takes nearly 30 minutes.
d) In a dark-adapted eye, the visual acuity is best at the center of the visual field.
e) All mentioned above
4. How many different types of cone code for color are in the fovea of the retina?
a) two
b) three
c) four
d) six
e) zero

Methodological development №15

The topic: Physiology of the ear and vestibular apparatus. Physiological mechanisms of equilibrium.
The number of hours: 2 hours
The place of spending: education laboratory
The object of learning:
To know: physiological features of the ear and vestibular apparatus, coding sound intensity and pitch, physiological mechanisms of equilibrium.
Be able: schematically portray the neural pathway for hearing and for equilibrium.

Theoretical questions for self-preparation

1. Physiology of the external, middle and inner ear (labyrinth). Functions of the hair cells.
1. Physiological steps in sounds perception.

2. Coding sound intensity and pitch.
3. Neural pathway for hearing. Hearing impairment.
4. Physiological mechanisms of equilibrium. Static and dynamic equilibrium.
5. Neural pathways of equilibrium.
6. Nystagmus and its clinical significance.

Keywords and terms: cochlea, spiral organ, hair cells, sound perception, volume and pitch of sound, conduction deafness, sensorineural hearing loss, semicircular canals, static equilibrium, dynamic equilibrium, nystagmus, motion sickness.

Definition of main terms and conceptions

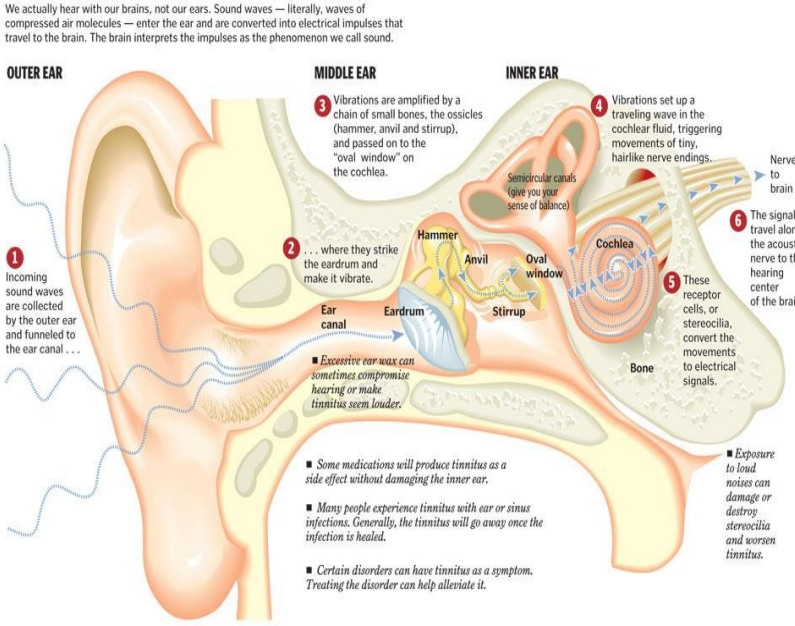
Volume (loudness) is based on degree of the basilar membrane displacement, which causes the hairs to bend in direct proportion to volume.
Pitch (frequency) is based on the region of the cochlea, which are stimulated by vibrations.
Conduction deafness involves a mechanical deficiency in the transmission of sound waves from the external ear to the spiral organ.
Static Equilibrium is the maintenance of body position (mainly the head) relative to the force of gravity.
Dynamic Equilibrium is the maintenance of body position (mainly the head) in response to sudden movements such as rotation, acceleration, and deceleration (balance while moving).
Nystagmus is involuntary oscillations of the eyes when spin is stopped.
Sensorineural hearing loss involves the damage of spiral organ or neuronal pathways.

Control questions and answers on the topic

1. What are the main components of the sound?
Volume (loudness) and frequency (pitch).
2. What is the connection between loudness of the sound and number of stereocilia bending?
The greater the intensity (loudness) of sound the greater the bending of the stereocilia.
3. What is the connection between frequency of the sound and deflection of the basilar membrane?
High frequency sounds cause greater deflection of the basilar membrane where it is narrow and stiff and lower frequency sounds produce greater deflection where the basilar membrane is loose and flexible.
4. Name the parts of the ear and their functions
The organs of hearing and balance are divided into three parts: the external, middle, and inner ear. **The external ear** is the part extending from the outside of the head to

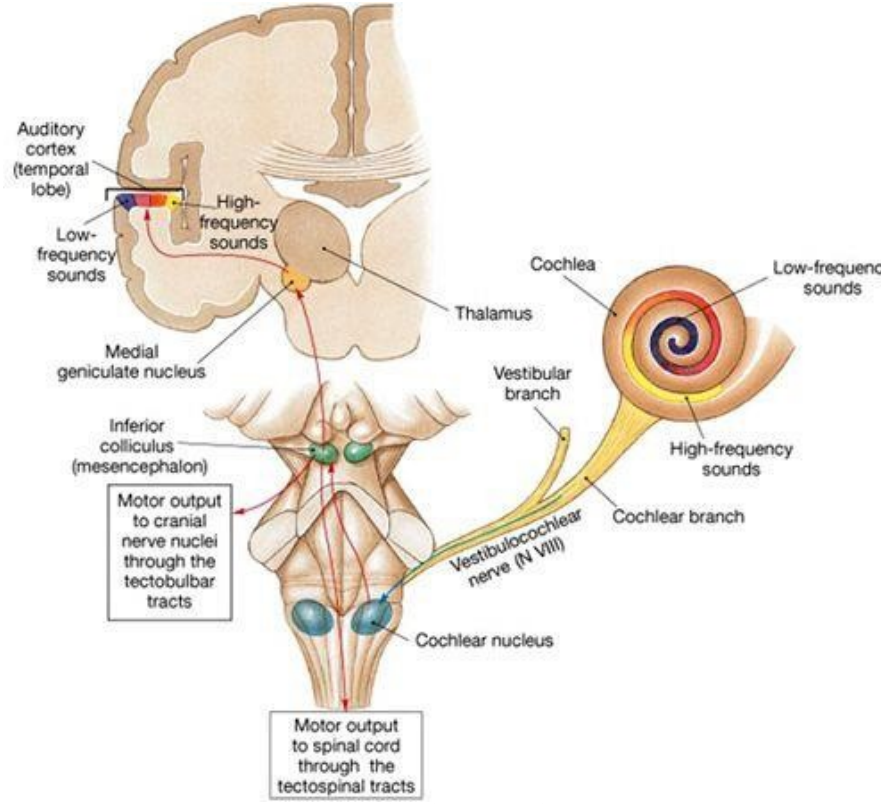
the tympanic membrane or eardrum. **The middle ear** is an air-filled chamber medial to the tympanic membrane. **The inner ear** is a set of fluid-filled chambers medial to the middle ear. The external and middle ears are involved in hearing only, whereas the inner ear functions in both hearing and balance.

Physiological steps in sound perception.



5. What is the schema of neural pathway for hearing?

Ganglion of CN VIII – cochlear nucleus in medulla oblongata – inferior colliculus of midbrain – thalamus – auditory cortex.



6. What are the main features of neural pathways for hearing?

Neurons in different regions of basilar membrane stimulate neurons in the corresponding areas of the auditory cortex (each area of cortex represents a different part of the basilar membrane and a different pitch).

7. How equilibrium of the body reaches?

Through the interpretation of vestibular receptors` responses, visual input, stretch receptor input from muscles and tendons.

8. What is the schema of neural pathway of equilibrium?

Hair cells in vestibular apparatus – vestibular ganglion of CN VIII – cerebellum and vestibular nuclei of medulla – oculomotor center (control eye movement) – neurons in spinal cord – movement of head, neck and limbs.

9. What are the physiological mechanisms of nystagmus when the person spins?

When person spins the bending of cupula occurs in the opposite direction. As the spin continues the cupula straightens. Endolymph and cupula are moving in the same direction and speed affects muscular control of the eyes and body.
10. What are the physiological mechanisms of nystagmus if movement suddenly stops?
If movement suddenly stops the inertia of endolymph causes it to continue moving in the direction of spin.
11. How does occur pathological nystagmus?
Pathological nystagmus occurs without spinning and informs about CNS disorders.
12. What is the reason of motion sickness appearance?
Its due to sensory mismatch of visual input sensing a fixed position (your cabin on a ship) and your vestibule apparatus sensing movement (the rough seas).
13. What are the warming signs of motion sickness?
Increased salivation, pallor, rapid deep breathing, sweating.
14. What violations occur after the unilateral destruction of vestibular apparatus?
Head's deviation, forced rotary movements, falling in the same side where the vestibular apparatus was destructed.
15. What violations occur after the bilateral destruction of vestibular apparatus?
Dizziness, nausea and impossibility to save upright posture.

Examples of MCQs

1. In experiment the cochlea`s middle part of internal ear was destroyed in animal. It will cause abnormalities in the sound perception of the following frequencies:
a) middle;
b) low;
c) high;
d) high and low;
e) no abnormalities.
2. A man who went for a ride on a roundabout had amplification of the heart rate, sweating and nausea. What receptors stimulation is it primarily connected with?
a) vestibular;
b) proprioceptors;
c) tactile;
d) auditory;
e) visual.
3. Which is the last structure to vibrate in this sequence?
a) malleus;
b) oval window;
c) stapes;
d) incus;
e) eardrum.

4. The actual receptors for hearing and balance are_____.
a) chemoreceptors;
b) otoliths;
c) cochlear cells;
d) hair cells;
e) photoreceptors.

Methodological development №16

The topic: Physiology of taste and smell.
The number of hours: 2 hours
The class takes place in: education laboratory
The object of learning:
To know: structure and functional organization of taste and olfactory sensations, mechanisms of taste and olfactory sensations.
Be able to: sketch functional structure of the olfactory epithelium, the distribution of taste buds, their innervation and maximum sensitivity to different tastes in human tongue; draw a diagram of transduction taste and olfactory information to the cerebral cortex of the brain.

Theoretical questions for self-preparation

1. Types, structure and functions of taste bunds.
2. Primary tastes.
3. Signal transduction in taste sensation.
4. Neuronal pathway of taste.
5. Olfactory receptors.
6. Olfactory transduction.
7. Neuronal pathway of olfaction.

Key words and terms: taste bud, filiform papillae, fungiform papillae, circumvallate papillae, microvilli, support cell, primary tastes, ageusia, hypogeusia, taste blindness, dysgeusia, odorants, olfactory hairs, olfactory bulb, olfactory glomeruli, anosmia, hyposmia, hyperosmia.

Definitions of key terms and concepts

Ageusia is loss of taste sensation.
Hypogeusia is the reduced ability in taste sensation. It is due to increase in threshold for different taste sensations.
Taste blindness is a rare genetic disorder in which the ability to recognize substances

by taste is lost.

Dysgeusia is disturbance in the taste sensation. It is found in temporal lobe syndrome, particularly when the anterior region of temporal lobe is affected.

Anosmia is total loss of smell sensation, i.e. inability to recognize or detect any odor. It maybe:

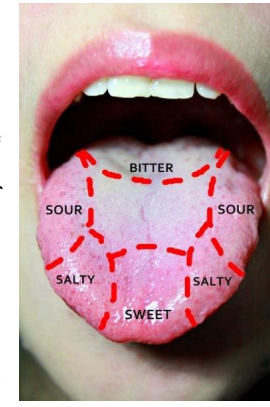
- *Temporary* anosmia is due to nose obstruction, which occurs during common cold, nasal sinus and allergic conditions.
- *Permanen*t anosmia occurs in case of olfactory tract lesion, meningitis and degenerative conditions such as Parkinson`s disease and Alzheimer`s disease.

Hyposmia is the reduced ability to recognize and to detect any odor. The odors can be detected only at higher concentrations. It is the most common disorder of smell sensation. Hyposmia also may be temporary or permanent.

Hyperosmia is the increased or exaggerated olfactory sensation. It is also called olfactory hyperesthesia. It occurs in brain injury, epilepsy and neurotic conditions.

Control questions and answers on the topic

1. What is the name of sensory structure that detects taste stimuli?
It is taste bud.
2. What types of papillae (located on tongue) do you know?
Filiform, fungiform, circumvallate and foliate papillae.
3. How many receptor cells does the taste bud contain?
It contains 50-150 receptor cells.
4. What is a normal lifespan of the taste buds` cells?
It is about 10 days.
5. What types of taste do we have in different part of the tongue?
Primary tastes are unequally distributed over the surface of the tongue:
on the apex – sweet;
on lateral surface - sour and salty;
at the root of the tongue – bitter;
at the center of the tongue – umami.



6. Where are the 1st order neurons of the taste neuronal pathway located?
They are located in nuclei of cranial nerves in medulla oblongata.
7. What part of the nasal cavity is lined with olfactory epithelium?
It is a small superior part of the nasal cavity.
8. What are the characteristics of olfactory neurons?
Olfactory neurons are bipolar neurons with dendrites extending to the epithelial surface of the nasal cavity.
9. What is the name of long specialized cilia of bulbous enlargements from the ends of

the olfactory cell dendrites?
It is called olfactory hairs.
10. What is a normal lifespan of the olfactory neurons?
It is about 2 months.
11. Where are the 2nd order neurons of olfactory tract located?
They are located in olfactory glomeruli (mitral cells).
12. What tract does not go through thalamus?
Olfactory tract.

Examples of MCQs

1. Loss of the taste sensation is referred to as_____.
a) dysosmia;
b) ageusia;
c) hypogeusia;
d) asnosmia;
e) hypoanosmia.
2. Which of these statements about the sense of smell IS NOT TRUE?
a) olfactory receptor cells are bipolar neurons that are not replaced when damaged;
b) chemicals are received by specific plasma membrane receptors in the olfactory receptor cells;
c) olfactory receptors do not adapt quickly;
d) the main areas of the brain that interpret the sense of smell lie in the temporal and frontal lobes;
e) there is no correct answer.
3. The portion(s) of the tongue that actually perceives taste is/are the_____.
a) taste hairs;
b) papillae;
c) epithelium of the tongue;
d) taste buds;
e) basal cells.
4. Taste information from the tongue is conveyed to the brain along____cranial nerves.
a) one;
b) two;
c) three;
d) four;
e) five.

Methodological development №17

The topic: Physiology of the autonomic nervous system.
The number of hours: 2 hours.
The class takes place in: education laboratory.
The object of learning:
To know: structural and functional features of autonomic nervous system (ANS), autonomic ganglia and their role, sympathetic and parasympathetic divisions of the autonomic nervous systems and their importance in the regulation of vital body functions.
Be able to: analyze autonomic reflexes of the body and their features, draw schema of autonomic reflex arc.

Theoretical questions for self-preparation

1. Anatomical and functional features of the peripheral section of autonomic nervous system.
2. Characteristics of the sympathetic division of ANS.
3. Characteristics of the parasympathetic division of ANS.
4. The functional antagonism of sympathetic and parasympathetic divisions of ANS.
5. Autonomic ganglia and their physiological role.
6. The synaptic transmission in peripheral section of autonomic nervous system.

Key words and terms: autonomic nervous system, parasympathetic division of ANS, sympathetic division of ANS, autonomic ganglia.

Definitions of key terms and concepts

Autonomic Nervous System (ANS) is the part of nervous system that regulates the internal organs, skin, smooth muscles, endocrine glands and heart; blood supply and trophic of all tissues, organs.
Autonomic functions are aimed on the internal organs work regulation and in maintenance of the constant internal environment of the organism (homeostasis).
Autonomic ganglia – a significant aggregation of nerve cells that innervate life important organs. Ganglia have all the basic properties of the nerve centers – low lability, the excitation unilateral ability to summation and transformation rate of excitation.

Control questions and answers on the topic

1. What organs are innervated by the sympathetic and parasympathetic nervous system?
The sympathetic nervous system – universal, innervates the smooth muscles of all internal organs and vessels, heart, glands, subcutaneous fat, sensory organs, CNS.
The parasympathetic nervous system – all internal organs (except the uterus), vessels of the oral cavity and small pelvis, external genital organs, cerebral membranes, tear glands.
2. Where are the centers of sympathetic nervous system located?
The centers of SNS are located from the VII-th cervical to the III-rd lumbar segment of the spinal cord inclusive.
3. Where are the centers of parasympathetic nervous system located (name these parts of the CNS)?
The centers of PNS are in the midbrain and medulla oblongata, in the sacral region of the spinal cord.
4. Which nerves consist of parasympathetic fibers?
Oculomotor (III), facial (VII), glossopharyngeal (IX), vagus (X) and pelvic nerves.
5. What are the differences between reflex arc of the autonomic and somatic nervous system?
In the autonomic nervous system efferent neurons are transmitted from the central nervous system to the periphery, the afferent neurons are located in the extra- and intramural ganglia (except for the spinal ganglia).
6. What are the main characteristics of the excitation`s conduction in the peripheral part of the autonomic nervous system?
The main characteristics of the excitation`s conduction in the peripheral part of the autonomic nervous system are low speed and generalized excitation distribution.
7. What is the generalized nature of the distribution in the peripheral part of the autonomic nervous system?
The phenomenon of animation in autonomic ganglia, branching of unmyelinated nerve fibers on the periphery, the release of mediator in many sites along the terminal branching of the sympathetic fibers.
8. What is called the phenomenon of multiplication in autonomic ganglia? How this phenomenon is carried out?
Increase the number of impulses at the output of the ganglion. It is possible because of branching axons that go into the ganglion and formed synapses with many neurons.
9. What neurotransmitter and chemical receptors are responsible for excitation`s conduction in autonomic ganglia of both sympathetic and parasympathetic nervous system?
In ganglia of the sympathetic and parasympathetic nervous system excitation is transmitted using acetylcholine that acts on N-cholinergic receptors.
10. What neurotransmitter and chemical receptors are responsible for the efferent effects of both sympathetic and parasympathetic nervous system?
In the sympathetic nervous system norepinephrine is used. Adrenergic receptors: alpha

and beta.
In parasympathetic nervous system acetylcholine is used to act on M-cholinergic receptors.

Examples of MCQs

1. Autonomic nervous system in contrast to somatic nervous system:
a) is controlled by voluntary regulation;
b) **has synaptic rupture outside the central nervous system**;
c) has clear segmental structure;
d) there is no nerve centers` autonomy;
e) all answers are correct.
2. The sympathetic nervous system is characterized by:
a) preganglionic fibers are long and postganglionic fibers are short;
b) **synaptic transmission in the ganglia is realized by the action of acetylcholine on N-cholinoreceptors**;
c) its ganglia are located intramural;
d) the bodies of preganglionic neurons are located in the midbrain, medulla oblongata and the sacral region of the spinal cord;
e) no answer is correct.
3. Which organs have only sympathetic innervation:
a) salivary glands;
b) tear glands;
c) **sweat glands**;
d) arterial circulation;
e) liver.
4. The excitation of beta-adrenergic receptors causes:
a) smooth muscles contraction;
b) relaxation of the gastrointestinal tract sphincters;
c) **glycogenolysis enhancement**;
d) contraction of the skeletal muscles;
e) pupils narrowing.
5. Ganglion blockers include:
a) phentolamine;
b) arphonad;
c) anaprilin;
d) carbcholin;
e) atropine.
6. In experiment on the dog the peripheral part of nervus vagus of the neck was irritated. What changes of the heart function would be observed?
a) decrease in contraction rate;
b) increase in contraction force;

c) increase in atrioventricular conduction;
d) increase in contraction force and rate;
e) increase in myocardial excitability.
7. Students who are taking examinations often have dry mouth. The mechanism that causes this state is the realization of the following reflexes:
a) conditioned sympathetic;
b) unconditioned parasympathetic;
c) conditioned parasympathetic;
d) unconditioned sympathetic;
e) unconditioned peripheral.
8. A peripheral segment of vagus nerve on a dog's neck was being stimulated in course of an experiment. The following changes of cardiac activity could be meanwhile observed:
a) heart rate falls;
b) heart rate increases;
c) enhancement of atrioventricular conduction;
d) heart rate and heart force amplification;
e) increase in excitability of myocardium.
9. In course of an experiment a peripheral section of vagus is being stimulated in animal. What changes will be observed?
a) heart rate falls;
b) heart rate increases;
c) pupil dilation;
d) increase in respiration rate;
e) bronchi dilation.
10. Person has hypersalivation, bradycardia (heart rate – 45 beats per minute), narrowed pupils. What is the most likely reason for this?
a) increase in sympathetic effects;
b) decrease in sympathetic effects;
c) increase in parasympathetic effects;
d) decrease in parasympathetic effects;
e) decrease in autonomic effects.
11. In patient the contraction force and heart rate should be decreased. What drug can be prescribed in this case:
a) α-adrenoblockers;
b) β-adrenoblockers;
c) α- and β-adrenoblockers;
d) M-cholinoblockers;
e) N-cholinoblockers.
12 The toxicological department received a patient with symptoms of poisoning: difficulty breathing, pupils narrowed, hypersalivation, pulse reduction to 40 beats / min,

blood pressure 80/50 mm Hg. Which substances can lead to such state?
a) muscarine;
b) large doses of nicotine;
c) adrenaline;
d) atropine;
e) noradrenalin.

Methodological development №18

The topic: The influence of the autonomic nervous system on the effector organs.
The number of hours: 2 hours.
The class takes place in: education laboratory.
The object of learning:
To know: the role of different parts of the nervous system, the integrative functions of the hypothalamus, the limbic system and the cerebral cortex in the regulation of the autonomic functions of the body, and the main autonomic reflexes of clinical significance.
Be able to: to prove the effect of higher autonomic parts of the nervous system on the function of internal organs under experimental conditions.

Theoretical questions for self-preparation

1. The role of different parts of the nervous system in the regulation of autonomic functions.
2. Integrative functions of the hypothalamus.
3. Functions of the limbic system.
4. The importance of the cerebral cortex in the regulation of body`s autonomic functions.
5. Main autonomic reflexes and their characteristics, importance in clinical practice.

Keywords and terms: autonomic reflexes, autonomic functions, higher autonomic centers.

Definitions of key terms and concepts

Integration is an association in a single functional unit of separate parts. This is a phenomenon of the functional unification of interconnected structural elements and physiological mechanisms, their reciprocity and coordination of activities to ensure the normal course of the organism`s life functions.

Control questions and answers on the topic

1. What reactions do hypothalamus involved in additionally to the regulation of internal

organs?
In the regulation of sleep and wakefulness, excitability of the cortex and the spinal cord, in the formation of behavioral reactions (food, sexual, attack, protection), emotional reactions (fear, aggression, rage).
2. What part of the brain is called the higher autonomic center?
Hypothalamus is the higher autonomic center of the brain.
3. What groups of chemicals (neurosecrets) release from the hypothalamus to the anterior pituitary and their significance? What hormones are released to the posterior pituitary?
The liberines and statins are released to anterior pituitary. These substances provide regulation of the tropic hormones` production by the pituitary gland. The oxytocin and antidiuretic hormone are released to the posterior pituitary.
4. What receptors that perceive deviations from the normal parameters of the internal environment are found in the hypothalamus?
Osmoreceptors, thermoreceptors and glucoreceptors.
5. What regulatory centers of biological needs are detected in the hypothalamus?
Saturation, hunger, thirst, sleep, regulation of sexual behavior.
6. What is the adaptive-tropic influence of the sympathetic nervous system?
In the adaptation of the organs` functional state and the organism as a whole to the needs at the moment by activating the metabolism.
7. What changes occur in the heart, gastrointestinal tract and vascular tone of the skeletal muscles during physical activity?
The work of the heart increases, the function of the digestive tract is inhibited, the tone vascular tone of the skeletal muscles is reduced, the vessels expand.
8. What types of autonomic nervous system reflexes according to closing level do you know?
Peripheral (intraorganic and extraorganic) and central.
9. What is called peripheral reflex?
Reflex with arc that closes at the level of autonomic ganglia (due to the synaptic connection of afferent and efferent neurons).

Examples of MCQs

1. Where do the centers of autonomic nervous system receive information:
a) proprioceptors
b) interoceptors
c) exteroceptors
d) intero-, extero- and proprioceptors;
e) there is no correct answer.
2. What knowledge are lied in the application of physiotherapeutic massage methods:
a) viscero-visceral reflexes;

b) viscero-dermal reflexes;
c) **dermato-visceral reflexes**;
d) motor-visceral reflexes;
e) viscero-spinal reflexes.
3. What is the highest autonomic subcortical center:
a) basal ganglia;
b) associative zones of cortex;
c) midbrain;
d) hypothalamus;
e) caudate nuclei.
4. What centers are found in the hypothalamus, EXCEPT:
a) satiety;
b) hunger;
c) thirst;
d) respiratory;
e) all answers are correct.
5. The referred pain in the left epigastric region is a manifestation of:
a) viscero-visceral reflexes;
b) dermato-visceral;
c) viscero-motor;
d) motor-visceral;
e) viscero-dermal.
6. The minute blood volume in a patient with transplanted heart has increased as a result of physical activity. What regulative mechanism is responsible for these changes?
a) catecholamines;
b) sympathetic unconditioned reflexes;
c) parasympathetic unconditioned reflexes;
d) sympathetic conditioned reflexes;
e) parasympathetic conditioned reflexes.
7. A man was intoxicated with mushrooms. They contain muscarine that stimulates muscarinic-cholinoreceptors. What symptoms signalize intoxication with inedible mushrooms?
a) miotic pupils;
b) mydriatic pupils;
c) bronchi dilatation;
d) increase in heart rate;
e) rise of arterial pressure.
8. A man presents with increased heart rate, mydriatic pupils, dry mouth. This condition results from the activation of the following system:
a) sympathetic;
b) parasympathetic;

c) metasympathetic;
d) vago-insular;
e) hypothalamo-pituitary-adrenal.
9. A 62-year-old male with COPD (chronic obstructive pulmonary disease) presents to the emergency room in respiratory distress. The attending physician uses succinylcholine to produce skeletal muscle relaxation prior to tracheal intubation. Soon after infusion of the succinylcholine the patient develops a severe bradycardia. Which of the following drugs would counteract the bradycardia without affecting muscle relaxation?
a) atropine;
b) curare;
c) epinephrine;
d) acetylcholine;
e) dopamine.
10. An 18-year-old male, who became ill after eating mushrooms, is brought to the Emergency Department where he is treated for muscarinic poisoning. Which of the following signs is consistent with muscarinic poisoning?
a) bradycardia;
b) skeletal muscle contractures;
c) dilation of the pupils;
d) hypertension;
e) diuresis.
11. In an experiment on animal one of the brain parts was destroyed. As a result, the animal refused to eat and died after some time from exhaustion. What area of the brain was destroyed?
a) lateral hypothalamus;
b) ventro-medial hypothalamus;
c) nonspecific nuclei of thalamus;
d) specific nuclei of the thalamus;
e) reticular formation of the brainstem.
12. Patient with a craniocerebral trauma was brought to the hospital admission department. He had a respiratory, cardiac activity and arterial pressure disturbances. Which part of the central nervous system is likely to be damaged?
a) medulla oblongata;
b) midbrain;
c) diencephalon;
d) forebrain;
e) the cerebellum.
13. What knowledge are lied in the usage of therapeutic physical training in internal organs` diseases:
a) viscero-dermal reflex;

b) dermato-visceral reflex;
c) viscero-motor reflex;
d) motor-visceral reflex;
e) there is no correct answer.

Methodological development №19

The topic: Types of humoral regulation of the organism functions and general regularities of the hormones` action.
The number of hours: 2 hours
The class takes place at: educational laboratory
The object of learning:
To know: structural and functional organization of the endocrine system, classification and basic physiological properties of hormones, types of physiological action.
Be able to: draw a diagram illustrating the mechanism of hormones` action.

Theoretical questions for self-preparation

1. The difference between nervous and humoral regulation. The main functions of the endocrine system.
2. Structural and functional organization of the endocrine system.
3. Classification and basic physiological properties of hormones.
4. Mechanism of hormones` action on target cells.
5. Regulation of the endocrine glands` functions.
6. Factors influencing the effective concentration of the hormone in plasma.
7. General pathophysiological mechanisms of endocrine pathology.

Key words and terms: true hormones, tissue hormones, regulatory metabolites, local self-regulation, hormonal regulation, diffuse neuroendocrine system, APUD system, hormone, target cells, messenger.

Definitions of key terms and concepts

Humoral regulation is a kind of biological regulation where information carriers are biologically active chemicals that provide regulatory influence.
The humoral (from the lat. humor – "liquid") – is bounded to the body fluids.
The reactogenic action of the hormone is the ability to change the sensitivity of the tissue to the action of other hormones or biologically active substances.
The diffuse neuroendocrine system – a set of neuroendocrine cells that are located in different parts of the central nervous system and in the walls of the internal organs and

produce hormone-like biologically active substances (neuropeptides).
Secondary messengers are mediators that stimulate the activity of intracellular enzymes.
Adenylate cyclase is a membrane enzyme that catalyzes the transformation of ATP (adenosine triphosphate) into cAMP (cyclic adenosine monophosphate) and together with cAMP forms a messenger system.
The APUD system (system of amine precursors` capture and their decarboxylation) is located in the wall of the intestine and other internal organs producing biologically active substances having the property of hormones.
The paracrine action (near + krino – from the greek "to release") – the effect of hormonal substances released by the endocrine cells on adjacent cells through an intercellular fluid without the participation of blood vessels. The paracrine action has histamine and several regulatory peptides.
Reactogenic pairs:
- Thyroid hormones – catecholamines;
- Glucocorticoids – catecholamines;
- Somatotropic hormone – glucocorticoids;
- Somatotropic hormone – catecholamines;
- Insulin – somatotropic hormone;
- Folliculin – progesterone;
- Prolactin – antidiuretic hormone;
- Prolactin – aldosterone;
- Glucocorticoids – insulin.

Control questions and answers on the topic

1. What groups of substances involved in the humoral regulation of the body`s functions?
Hormones, mediators, metabolites (including tissue hormones – peptides).
2. What glands are called endocrine glands? List them.
Glands that release secretion products directly into the bloodstream. Thyroid, parathyroid, pancreas, gonads, thymus, pituitary gland, epiphysis.
3. List the basic physiological properties of hormones.
High physiological activity, specificity (action on a certain "target cell"), long duration of action, distant action.
4. What is the high hormones` specificity?
With the presence in the cell membranes and other elements of their specific structures – hormonal receptors.
5. What are the main effects of hormones on target cells?
Change in the membrane permeability for several substances, the rate of enzymes synthesis and the activity of enzymes.
6. What are the hormones that act directly on target organs; pituitary hormones acting

on other glands; hormones of the hypothalamus affecting the pituitary gland?
Effector hormones, tropic pituitary hormones, liberins and statins, respectively.
7. List the basic studying methods of the internal secretion glands` functions.
The endocrine gland extirpation, injection of endocrine glands` extracts and hormonal drugs, glandular transplantation, fluorescent antibodies` method, radiological methods, quantitative determination of hormones (in the gland, blood, urine), clinical observations.
8. List the functions of the hormones (meaning for the organism as a whole).
Regulate growth, sexual and mental development, various functions and constants of the organism, adaptive reactions.
9. What groups of hormones according to their chemical structure do you know? What is the state of hormones (active or not active) in the blood?
There are three groups of hormones according to their chemical structure: amino acids and their derivatives; polypeptides and proteins; steroids.
In active (free) and inactive (bounded to blood proteins).
10. What mechanisms of regulation of the internal secretion glands` functions do you know? What is understood by the principle of feedback in regulation of the hormones` production? Give an appropriate explanation.
Nervous and humoral regulation. The relationship between the amount of hormone in the blood and its production. Deviation of the hormones` amount from the norm and the constants` parameters that it regulates leads to appropriate changes in the production of the hormone.
11. What are the main groups of humoral substances that regulate the internal secretion glands` functions?
Releasing hormones (liberine) and inhibiting hormones (statins) of the hypothalamus and tropic pituitary hormones.
12. What are the main substances that mediate the effects of hormones on the cellular enzyme systems?
Cyclic nucleotides (cAMP, cGMP), calcium ions, derivatives of inositol triphosphate.
13. What is the special importance of hormones for children and adolescents?
Hormones provide physical, sexual and mental development in children and adolescents.
14. List the hormones that play a major role in the physical, mental and sexual development of children and adolescents?
Growth hormone, thyroid hormones, sex hormones, insulin.
15. What is the peculiarity of the consequences of the internal secretion glands lesion in children compared with adults?
Children have more severe often irreversible violations of physical, mental and sexual development.

Examples of MCQs

1. What is the effector hormone:
a) adrenocorticotropic hormone;
b) **prolactin**;
c) thyroid hormone;
d) follicle-stimulating hormone;
e) luteinizing hormone.
2. What is called the corrective action of hormones:
a) the ability of the hormone to change the sensitivity of tissues to the action of other hormones or biologically active substances;
b) the ability of hormones to activate effector activity;
c) changes in the activity of organs or processes that occur in the absence of hormone;
d) influence of hormones on processes of formation, differentiation and growth of organism`s structural elements;
e) changes in the tissue metabolism.
3. What hormones are included to the amino acids and their derivatives chemical group:
a) aldosterone;
b) corticosterone;
c) **epinephrine**;
d) renin;
e) all hormones are derivatives of amino acids.
4. Which hormone doesn't use secondary messenger to realize its mechanism of action:
a) adrenaline;
b) insulin;
c) **aldosterone**;
d) glucagon;
e) all these hormones realize their effect through to the secondary messengers.
5. What hormones are true, EXCEPT:
a) tropic hormones of the pituitary gland;
b) insulin;
c) **serotonin**;
d) glucocorticoids;
e) thyroxine.
6. There is only one hormone among the neurohormones which refers to the derivatives of amino acids according to classification. Point it out:
a) melatonin;
b) thyroliberin;
c) vasopressin;
d) oxytocin;
e) somatotropin.

7. A patient due to insufficient insulin production by beta-cells of the pancreas is prescribed subcutaneously 20 units. of insulin. What chemical group this hormone is related to:
a) amino acids;
b) amino acids derivatives;
c) steroid hormones;
d) proteins and polypeptides;
e) there is no correct answer.
8. The patient make repeated appointment to the endocrinologist with hyperfunction of the thyroid gland and next complaints: increased sweating, intolerance to high temperature, tremor of hands, restless sleep. The above-mentioned disorders may be explained by the following action of thyroid hormones:
a) autocrine;
b) morphogenetic;
c) kinetic;
d) corrective;
e) reactogenic;
9. 30 years old woman with complaints of pain in joints, fever came to the doctor. The doctor prescribed her cortisone (this hormone has an anti-inflammatory effect). What chemical group this hormone is related to:
a) steroids;
b) roteins;
c) amino acids derivatives;
d) polypeptides;
e) phospholipids.

Methodological development №20

The topic: Endocrine function of the thyroid gland, parathyroid glands and kidneys.
The number of hours: 2 hours.
The class takes place in: education laboratory.
The object of learning:
To know: physiological effects of thyroid hormones and thyrocalcitonin, mechanisms of their blood level regulation, the role of the kidneys in the regulation of the calcium ions` metabolism, the role of the renin-angiotensin-aldosterone system (RAAS) in the regulation of the organism functions.
Be able to: draw a scheme of the calcium ions exchange regulation and the juxtaglomerular apparatus.

Theoretical questions for self-preparation

1. Hormones of the thyroid gland, mechanisms of their secretion and effects on target cells.
2. Physiological effects of iodinated hormones, calcitonin and regulation of their secretion.
3. The endocrine pathology associated with thyroid function disturbances.
4. Parathyroid hormone, its physiological effects, regulation of secretion. The endocrine pathology associated with disturbance of the parathyroid glands` function.
5. The endocrine function of the kidneys. The concept of RAAS (renin-angiotensin-aldosterone system).

Key words and terms: hypothyroidism, hyperthyroidism, goiter, cretinism, myxedema, renin-angiotensin-aldosterone system, tetany.

Definitions of key terms and concepts

The normal concentration of calcium in the blood is 2.0 - 2.5 mmol/l
Negative feedback means that the output signal of the system reduces the input. The activation of any function suppresses regulatory mechanisms that enhance this function. Negative feedback helps maintain homeostasis.
Goiter – increase in size of the thyroid gland.
Cretinism – is a syndrome of a pronounced retardation of the physical and mental development in thyroid gland hypofunction in childhood.
Myxedema is a hypothyroidism syndrome, which is the result of the hydrated mucopolysaccharides accumulation in the interstitial space.

Control questions and answers on the topic

1. Name two iodinated thyroid hormones. What effects do they have on the body?
Thyroxine (T4) and triiodothyronine (T3). The regulation of the basal metabolic rate (calorie effect) intensity, adaptation to cold, CNS excitability.
2. What hormone of the thyroid gland doesn't contain iodine? What are the main physiological effects of this hormone?
Calcitonin. It reduces the level of calcium in the blood.
3. Do the absence of any substance in food and water reduces the function of the thyroid gland? How is called condition associated with this?
The absence of iodine. Hypothyroidism.
4. How is called the hormone of parathyroid glands? What is its physiological role?
Parathyroid hormone. It increases calcium concentration and decreases phosphorus concentration in the blood plasma.
5. How and why does the insufficient parathyroid hormone concentration in the blood affect the skeletal muscle? What function of the body and why is disturbed in this

condition?
Increase in neuromuscular excitability that leads to convulsive contractions of the skeletal muscles, including respiratory, which can lead to severe breathing disorders.
6. What violations are observed in children with hyperfunction of the thyroid gland?
The increased growth and acceleration of body development is observed.
7. What violations are observed in children with hypofunction of the thyroid gland?
The congenital hypofunction leads to cretinism.
8. What violations are observed in children with hypofunction of the parathyroid glands?
Increase in excitability of the central nervous system and muscles that leads to tetany (convulsive attacks), intestine disorders (frequent liquid defecation), bone development and growth of hair and nails.
9. What violations are observed in children with hyperfunction of the parathyroid glands?
Excessive ossification in the background of the increase in the level of calcium in the blood.
10. What thyroid hormones secretion are regulated by thyroid stimulating hormone?
Iodized hormones – thyroxine (T4) and triiodothyronine (T3).

Examples of MCQs

1. What factors cause secretion of renin, EXCEPT:
a) concentration of sodium in the urine of distal convoluted tubules;
b) **blood pressure in the efferent arterioles**;
c) blood pressure in the afferent arterioles;
d) decrease in blood flow through the renal glomeruli;
e) sympathetic stimulation.
2. What are the effects of angiotensin-2:
a) decrease in blood pressure;
b) dilates arterial vessels;
c) **decrease in myocardial contractility**;
d) increases in myocardial contractility;
e) has no relation to the formation of thirst and drinkable behavior.
3. What statement is TRUE about parathyroid hormone:
a) decrease in blood calcium concentration;
b) activates osteoblasts;
c) decrease in calcium absorption in the gastrointestinal tract;
d) stimulates reabsorption of phosphates in the kidneys;
e) **enhances reabsorption of calcium in the renal tubules**.
4. What are the physiological effects of thyroid hormones:
a) **decrease in the proteins` synthesis**;

b) increase in lipolysis and oxidation of fatty acids;
c) activation of glycogen synthesis in the liver;
d) decrease in the blood calcium level;
e) all answers are correct.
5. What are the symptoms of hypothyroidism in adults (myxedema):
a) increase in excitability of the nervous system;
b) increase in T3 and T4 secretion;
c) **face puffiness**;
d) increase in the level of basal metabolic rate;
e) increase in thyrocalcitonin secretion.
6. 2-year-old child experienced convulsions because of lowering calcium ions concentration in the blood plasma. Function of what structure is decreased?
a) Parathyroid glands;
b) Hypophysis;
c) Adrenal cortex;
d) Pineal gland;
e) Thymus.
7. A 2 y.o. child has convulsions because of lowered concentration of calcium ions in blood plasma. It is caused by reduced function of:
a) parathyroid glands;
b) hypophysis;
c) adrenal cortex;
d) pineal gland;
e) thymus.
8. Examination of a 43 y.o. anephric (absence of one kidney) patient revealed anemia symptoms. What is the cause of these symptoms?
a) reduced synthesis of erythropoietin;
b) enhanced destruction of erythrocytes;
c) iron deficit;
d) vitamin B_{12} deficit;
e) folic acid deficit.
9. Inhabitants of territories with cold climate have high content of an adaptive thermoregulatory hormone. What hormone is meant?
a) thyroxin;
b) insulin;
c) glucagon;
d) somatotropin;
e) cortisol.
10. A spasm of the glottis with asphyxia threat suddenly developed in the child. The predisposition to vomiting after feeding, convulsions are present in anamnesis. What gland is injured?

a) parathyroid;
b) thymus;
c) pancreas;
d) thyroid gland;
e) gonads.
11. Patient with complaints of weight loss – 10 kg in 2 months, heartbeat, tediousness (exophthalmos) was examined by endocrinologist. What endocrine gland hyperfunction can be manifested by these complaints?
a) pancreas;
b) parathyroid glands;
c) adrenal glands;
d) ovaries;
e) t**hyroid glands**.
12. In the 4-month-old child pronounced manifestations of rickets are observed. There are no signs of digestive disorders. The child spends a lot of time under the sun. The child received vitamin D3 within 2 months, but the manifestations of rickets did not decrease. What substance synthesis disturbance can lead to the development of rickets in this child?
a) **calcitriol**;
b) calcitonin;
c) thyroxine;
d) insulin;
e) parathyroid hormone.

Methodological development №21

The topic: Endocrine function of the hypothalamic-pituitary system. The adrenal medulla hormones and regulation of their secretion.
The number of hours: 2 hours
The class takes place at: educational laboratory
The object of learning:
To know: structural and functional interrelations between the hypothalamus and pituitary gland, physiological effects of tropic and effector hormones of adenohypophysis, functions of neurohypophysis, hormones of adrenal medulla and regulation of their secretion.
Be able to: explain the physiological effects of catecholamines, depending on the presence of alpha- and beta-adrenergic receptors in the effector organ.

Theoretical questions for self-preparation

1. General understanding of the hypothalamic-pituitary system functions. The

hypothalamic releasing-hormones and their physiological role.
2. The physiological effects of neurohypophysis hormones and regulation of their secretion.
3. The physiological effects of adenohypophysis hormones and regulation of their secretion.
4. The adrenal medulla hormones and regulation of their secretion.
5. Basic physiological effects of epinephrine and norepinephrine. Adrenergic receptors and their functions.

Key words and terms: pituitary nanism, gigantism, acromegaly, alpha- and beta-adrenergic receptors, releasing-hormones (liberins, statins), catecholamines (epinephrine, norepinephrine).

Definitions of key terms and concepts

Adrenoreceptors – a specialized protein nature area of the postsynaptic membrane of adrenergic synapses.
Alpha-adrenergic receptors – binding of catecholamines cause contractions of smooth muscle fibers.
Beta-adrenoreceptors – binding of catecholamines cause relaxation of smooth muscle fibers.
Catecholamines – hormones of the adrenal medulla, mediators of the sympathetic nervous system and the central nervous system.
Adaptation is the process of organism adaptation to the changeable environmental conditions.
The hypophysiotropic hypothalamic zone is a part of the hypothalamus, which is located in its median elevation and affects the secretion of the adenohypophysis hormones.

Control questions and answers on the topic

1. What is called neurosecretion? What part of the diencephalon is able to neurosecretion? What are the neurosecretions of the hypothalamus?
The neurosecretion is formation of hormones by neurons. Hypothalamus is able to neurosecretion. Antidiuretic hormone (ADH, vasopressin) and oxytocin, adenohypophysiotropic hormones (releasing-hormones – liberin and inhibitory hormones – statins).
2. What events lead to change in the secretion of effector hormones in case of hypothalamic-pituitary system activation?
The hypothalamic hormone (liberin or statin) release – its effect on the anterior

pituitary – the change in the tropic hormone amount in the blood – its effect on the endocrine gland – the effector hormone release.
3. How is the secretion of tropic hormone changed with an increase in the blood concentration corresponding effector hormone? What is the principle of regulatory interactions? What is its physiological essence?
The decrease in tropic hormone secretion. The principle of negative feedback. The maintenance of relative stable amount of hormone in the blood.
4. What are the main lobes of the pituitary gland and how they are called? What lobes produce tropic hormones?
Anterior (adenohypophysis), middle and posterior (neurohypophysis). The tropic hormones are produced by the anterior lobe of the pituitary gland.
5. What are the tropic hormones of the pituitary gland? Give them a full and abbreviated name.
Adrenocorticotropic hormone (ACTH), thyroid-stimulating hormone (TSH), follicle-stimulating hormone (FSH), luteinizing hormone (LH).
6. What glands of the internal secretion are under the influence of adenohypophysis?
Thyroid and adrenal glands (adrenal cortex), gonads.
7. How does the follicle-stimulating hormone (FSH) affect the sexual glands?
Accelerates the development and growth of follicles in the ovaries, spermatogenesis.
8. What effect does the luteinizing hormone have on the body?
Stimulates oogenesis, ovulation, growth of the yellow body (corpus luteum), production of male and female sex hormones.
9. List the effector hormones of the anterior lobe of the pituitary gland.
Prolactin (PRL) and growth hormone (GH) or somatotropic hormone (STH).
10. What effect does the growth hormone have on adult?
It regulates protein, carbohydrate and lipid metabolism.
11. What are the effects of prolactin on the body?
The main (specific) effect – stimulates the growth of the mammary glands and secretion of milk, responsible for maternal instinct.
12. What hormone produces the middle lobe of the pituitary gland? What is its role?
Melanocyte-stimulating hormone (MSH). It regulates the skin pigmentation (enhances the synthesis of melanin).
13. What two hormones are deposited in the neurohypophysis? Where are they produced?
Antidiuretic hormone (ADH) and oxytocin. They are produced by the hypothalamus.
14. What body constants are regulated by the antidiuretic hormone and how is it implemented?
The volume of fluid in the body, blood pressure, osmolality by changing the volume of water reabsorption in the nephrons` tubules.
15. What is the mechanism of antidiuretic hormone action on water reabsorption in kidneys?

Increases the permeability of the distal convoluted tubules and collecting ducts to the water by triggering the enzymatic processes that provide the activation of protein kinase and hyaluronidase.
16. What are the main factors that increase the secretion of ADH?
Increase in osmotic pressure and decrease in circulating blood volume.
17. What is the effect of oxytocin on the body?
It stimulates uterine contractions and milk ejection by the mammary glands.
18. What hormones are produced by adrenal medulla? Specify their percent interrelation in person.
Epinephrine (80%) and norepinephrine (20%).
19. What effect does the epinephrine and norepinephrine have on blood vessels?
The norepinephrine – narrows. The epinephrine narrows and dilates (depending on the ratio of alpha- and beta-adrenergic receptors in the vessels).
20. What hormone of adrenal medulla helps to increase blood sugar concentration? Describe the mechanism.
Epinephrine. It breaks down glycogen in the liver and muscles, mobilizes fats from the depot for gluconeogenesis.
21. How does hypo-and hyperfunction of adenohypophysis manifest in children under the age of 4-7?
With hypofunction: reduction of the main metabolism and body temperature, slowing or stopping growth (dwarfism). With hyperfunction – gigantism.

Examples of MCQs

1. What glands of the internal secretion are hypophyseal dependent, **EXCEPT**:
a) follicular tissue of the thyroid gland;
b) **parathyroid glands**;
c) fascicular layer of adrenal cortex;
d) reticular layer of adrenal cortex;
e) gonads.
2. Regarding catecholamines the following statements are **TRUE**:
a) norepinephrine has a greater affinity for beta-adrenergic receptors;
b) epinephrine has a greater affinity for alpha-adrenergic receptors;
c) epinephrine and norepinephrine increase the power of cardiac contractions;
d) only epinephrine stimulates energy metabolism;
e) both epinephrine and norepinephrine narrow the bronchi.
3. What are the hormones of the adenohypophysis:
a) somatostatin;
b) **thyroid-stimulating hormone**;
c) relaxin;
d) antidiuretic;

e) oxytocin.
4. Select the basic physiological effect of oxytocin:
a) stimulation of the testicles and ovaries secretion;
b) stimulation of erythropoiesis;
c) inhibition of lactation in women after delivery;
d) **provision of labor activity**;
e) stimulation of glyconeogenesis.
5. All characteristics are incorrect for the somatotropic hormone, **EXCEPT**:
a) **physiological effects are realized only by a direct influence on target cells**;
b) absence of daily oscillations;
c) suppression of fats synthesis;
d) impact on bone growth;
e) reactogenic action to thyroid hormones.
6. Prolactin secretion is tonically suppressed in non-pregnant women by which of the following hormones?
a) Ddopamine;
b) estrogen;
c) progesterone;
d) follicle-stimulating hormone;
e) luteinizing hormone.
7. A woman presents to her obstetrician with concerns that she has had trouble breast feeding. She reports that her mother-in-law told her that alcohol would relax her and allow her milk to flow more readily, but it has not helped, even with drinking up to a bottle of wine a day. Which of the following hormones is involved in the ejection of milk from a lactating mammary gland?
a) oxytocin;
b) growth hormone;
c) FSH;
d) LH;
e) prolactin.
7. Hyponatremia (decrease in sodium concentration) will result from an excess secretion of which of the following?
a) vasopressin (ADH);
b) atrial natriuretic hormone;
c) norepinephrine;
d) insulin;
e) aldosterone.
8. Usage of oral contraceptives with sex hormones inhibits secretion of the hypophyseal hormones. Secretion of which of the indicated hormones is inhibited while using oral contraceptives with sex hormones?
a) follicle-stimulating;

b) vasopressin;
c) thyrotropin;
d) somatotropic;
e) oxytocin.
9. Osmotic pressure of a man's blood plasma is 350 mosmol/l (standard pressure is 300 mosmol/l). First, it will result in high secretion of the following hormone:
a) vasopressin;
b) aldosterone;
c) cortisol;
d) adrenocorticotropin;
e) natriuretic.
10. Examination of a patient revealed overgrowth of facial bones and soft tissues, tongue enlargement, wide interdental spaces in the enlarged dental arch. What changes of the hormonal secretion are the most likely?
a) **hypersecretion of the somatotropic hormone**;
b) hyposecretion of the somatotropic hormone;
c) hypersecretion of insulin;
d) hyposecretion of thyroxin;
e) hyposecretion of insulin.
11. A 32-year-old patient consulted a doctor about the absence of lactation after parturition. Such disorder might be explained by the deficit of the following hormone:
a) prolactin;
b) somatotropin;
c) vasopressin;
d) thyrocalcitonin;
e) glucagon.
12. Which of the following hormones is primarily responsible for development of ovarian follicles prior to ovulation?
a) follicle-stimulating hormone;
b) chorionic gonadotropin;
c) estradiol;
d) luteinizing hormone;
e) progesterone.
13. A couple presents at the Fertility Center concerned that they have not been able to conceive a child. The reproductive endocrinologist evaluates the wife to be certain that she is ovulating. Which of the following is an indication that ovulation has taken place?
a) an increase in serum progesterone levels;
b) an increase in serum FSH levels;
c) a drop-in body temperature;

d) an increase in serum LH levels;
e) an increase in serum estrogen levels.

Methodological development №22

The topic: The endocrine function of the adrenal cortex.
The number of hours: 2 hours
The class takes place at: educational laboratory
The object of learning:
To know: functional structure of adrenal cortex, basic physiological effects of mineralocorticoids, glucocorticoids, regulation of their secretion, endocrine diseases associated with the disturbances in these hormones` secretion.
Be able to: explain the mechanisms of physiological effects and regulation of the glomerular and fascicular layers` hormones of adrenal cortex.

Theoretical questions for self-preparation

1. The functional anatomy of adrenal cortex.
2. The Physiological effects of mineralocorticoids and regulation of their secretion.
3. The endocrine function of the heart.
4. The physiological effects of glucocorticoids and regulation of their secretion.
5. The endocrine diseases associated with a violation of the adrenal cortex hormones` secretion.

Key words and terms: adaptive hormones, hyper- and hyponatremia, hyper- and hypokalemia, hyper- and hypochloremia, contrinsular hormones, gluconeogenesis, stress.

Definitions of key terms and concepts

Gluconeogenesis is a synthesis of glucose from amino acids.
Contrinsular hormones – hormones that have the opposite metabolic effect comparing with insulin.
Adaptive hormones – increase the body's resistance to the effects of stress factors.
Stress – a concept that reflects the diversity of the overall systemic response of the organism to the action of internal or external factors.
Renin-angiotensin-aldosterone system (RAAS) – hormonal system that regulates blood pressure and water-electrolyte metabolism.
Hypernatremia is an increase in plasma sodium concentration more than 157 mmol/L.
Hyperkalemia is an increase in plasma potassium concentration more than 5.2 mmol/L.
Water-electrolyte metabolism – a set of processes that ensure the distribution of water

and electrolytes in the body`s spaces.
Hyperchloremia – an increase in plasma chloride concentration more than 107 mmol/L.
Hypochloremia – a decrease in plasma chloride concentration less than 97 mmol/L.
Hyponatremia – a decrease in plasma sodium concentration less than 130 mmol/L.
Hypokalemia – a decrease in the plasma potassium concentration less than 3.8 mmol/L.
Electrolytes are substances that dissociate in solutions to ions and carry electrical charges.

Control questions and answers on the topic

1. What are the three types of hormones produced by the adrenal cortex?
Mineralocorticoids, glucocorticoids, sex hormones.
2. What hormones are produced in the glomerular, reticular and fascicular layers of adrenal cortex?
In the glomerular – mineralocorticoids (aldosterone), in the fascicular – glucocorticoids (cortisol, cortisone), in the reticular – sex hormones (androgens).
3. What group of adrenal cortex hormones is aldosterone related to? What type of metabolism is regulated by aldosterone?
To mineralocorticoids. It participates in the regulation of water-electrolytes metabolism.
4. What organism`s constants are regulated by aldosterone?
In the regulation of osmotic pressure, fluid volume in the body, blood pressure, the content of Na^+, K^+, Cl^- in the body.
5. What changes in the body lead to increase in aldosterone secretion?
Decrease in sodium concentration, increase in potassium concentration, decrease in blood plasma volume, decrease in blood pressure.
6. What changes in the body lead to decrease in aldosterone secretion?
High concentration of sodium in blood, high osmotic pressure, decrease in blood potassium concentration, increase in blood plasma volume and blood pressure.
7. What substances` metabolism are regulated by glucocorticoids? Name the two main glucocorticoids.
Carbohydrates and proteins, to a lesser extent – fats. Cortisol, cortisone.
8. What is called adaptive action of hormones? How does the body's resistance to the effects of adverse factors (stressors) change with insufficient secretion of glucocorticoids?
Increase in resistance of the organism to the adverse effects of external and internal environment. The resistance of the body decreases with insufficient secretion of glucocorticoids.
9. What endocrine gland has a leading role in adaptation of the body to the effects of adverse factors (stressors)? Name these four hormones.
The adrenal glands. Cortisol, cortisone, epinephrine and norepinephrine.
10. What causes the animal death after adrenal glands` removal?

Due to the loss of a large sodium amount with urine, as well as reducing the body's resistance to the adverse effects of external and internal environment.
11. What adrenal cortex hormones increase the blood glucose level? Explain the mechanism.
Glucocorticoids (cortisol, cortisone). It stimulates the synthesis of carbohydrates from non-carbohydrate precursors (gluconeogenesis).
12. What period of child development adrenal glands begin to function more effectively? What is the manifestation of the adrenal glands` hypofunction in children?
During puberty period. The protein, carbohydrate metabolism disturbances and decrease in immunity are manifestations of adrenal glands` hypofunction.
13. What is the manifestation of the adrenal glands` hyperfunction in children?
Obesity in girls, false hermaphroditism and in boys – false premature sexual maturation.

Examples of MCQs

1. What adrenal cortex hormones increase blood glucose levels?
a) **cortisol**;
b) progesterone;
c) aldosterone;
d) epinephrine;
e) norepinephrine.
2. All systemic effects of glucocorticoids are manifested by such signs, **EXCEPT**:
a) increase in resistance of the organism to stress;
b) increase in blood pressure;
c) **increase in inflammatory reactions**;
d) anti-inflammatory action;
e) inhibition of immune reactions of the organism.
3. The introduction of glucocorticoids is not appropriate in the treatment of:
a) autoimmune states;
b) allergic conditions;
c) **hypertensive states**;
d) hypotensive states;
e) inflammatory processes.
4. Glucocorticoids suppress immune responses due to:
a) increase in antibodies` production to foreign proteins;
b) **reduction in antibodies` production to foreign proteins**;
c) increase in the number of lymphocytes and eosinophils in the blood;
d) glycogenolysis;
e) gluconeogenesis.
5. The main metabolic effects of glucocorticoids are manifested in:
a) **increase in the blood glucose concentration**;

b) reduction in both proteins and fats catabolism;
c) reduction in gluconeogenesis;
d) stimulation of blood glucose reduction;
e) increase in glucose utilization by cells and synthesis of proteins;
6. The person has decreased diuresis, hypernatremia, hypokalemia. What hormone hypersecretion can cause such changes?
a) aldosterone;
b) vasopressin;
c) atrium natriuretic peptide;
d) adrenalin;
e) parathormone.
7. Examination of a patient revealed hyperkalemia and hyponatremia. What hormone hyposecretion may cause such changes?
a) aldosterone;
b) vasopressin;
c) cortisol;
d) parathormone;
e) natriuretic peptide.
8. Which of the following causes metabolic acidosis?
a) hypoaldosteronism;
b) hypoventilation;
c) hypovolemia;
d) hypokalemia;
e) hypocalcemia.
9. The patient continued to take glucocorticoids (several weeks). After abrupt withdrawal of the drug complains of myalgia, increased fatigue, emotional instability, headache, insomnia, loss of appetite, nausea was observed. The glucocorticoids withdrawal syndrome developed. What drugs can be prescribed for correction of this condition?
a) glucocorticoids;
b) corticosteroids;
c) mineralocorticoids;
d) **adrenocorticotropic hormone**;
e) epinephrine.
10. 44 years old woman complains of general weakness, pain in the area of the heart, a significant increase in body weight. Objectively: the face is moon-shaped, hirsutism, blood pressure – 165/100 mm Hg, height – 164 cm, weight – 103 kg, mainly accumulation of fat on the neck, upper shoulder girdle, abdomen. What is the main pathogenetic mechanism of obesity in a woman?
a) reduced production of thyroid hormones;
b) reduction of glucagon production;

c) **increase in production of glucocorticoids**;
d) increase in insulin production;
e) increase in mineralocorticoid production.
11. 20 years old woman came to the doctor with complaints of joint pain, fever. The doctor prescribed hormone that has anti-inflammatory effects. What is this hormone?
a) insulin;
b) melanoliberin;
c) thyrocalcitonin;
d) cortisone;
e) epinephrine.

Methodological development №23

The topic: General adaptive syndrome (stress).
The number of hours: 2 hours
The class takes place at: educational laboratory
The object of learning:
To know: hormonal supply of stress reactions, the sequence of various organs and systems inclusion in the implementation of the general adaptive syndrome.
Be able to: analyze adaptive reactions of the organism from the positions of the general adaptive syndrome.

Theoretical questions for self-preparation

1. The concept of general adaptive syndrome (stress).
2. Types of stress and stressors.
3. The mechanisms of stress at different stages of stress-reaction.
4. The main stress-limiting (anti-stress) systems of the organism.
5. Diagnostics, treatment and prevention of stress conditions. Stress and disease.

Keywords and terms: stress, stressor, reaction "fight-or-fly", stress-limiting systems of the organism.

Definitions of key terms and concepts

Stress - the psychophysiological reaction of organism to an important stimulus, a way to achieve organism resistance under the action of harmful factor or a factor that threatens the body.
Eustress – a type of stress when the body's reaction runs without loss from the body,

"painlessly."
Distress – excessive stress when protection from the damaging factor is harmful to the body, with a decrease in its capabilities.
The fight-or-fly reaction is the reaction of body mobilization to carry out muscular activity in response to the stressor's action.
The stress-limiting system includes: GABA, endogenous opiates, prostaglandins, antioxidants, parasympathetic system.
Antioxidants: superoxide dismutase, vitamin E, sulfur-containing amino acids (cysteine, methionine).

Control questions and answers on the topic

1. Who is the founder of the stress doctrine?
Hans Selye (1907-1982) in 1926 first published a work in which he described similar symptoms (loss of appetite, muscle weakness, increased blood pressure, loss of motivation to achievement) in patients with various somatic diseases. This work has begun extensive study of the general adaptive syndrome mechanisms.
2. What is the general adaptive syndrome (stress-reaction)?
Nonspecific reaction of the organism aimed at fighting any adverse factor, the action of which threatens the physiological and (or) psychological integrity of the organism.
3. List the types of stress.
By force – eustress and distress. By duration – acute and chronic. By origin – physical and mental (psycho-emotional).
4. Name the physical stressors.
High and low temperature, gas pollution, high radiation level, trauma, hypoxia, etc.
5. Indicate the main causes of mental (psycho-emotional) stress.
1) work in a time deficit; 2) work at risk for life; 3) a conscious threat to life (and / or the psychics); 4) isolation; 5) group pressure; 6) lack of control over events; 7) lack of purpose; 8) lack of stimuli (deprivation).
6. What structures of the central nervous system work out the information about the stimulus and determine its stressfulness?
Information from the receptors enters the neocortex and in parallel to the reticular formation, the limbic system, the hypothalamus where its value for the organism is evaluated in accordance with the previous experience. If the stimulus is perceived as a threat, a challenge, or something too unpleasant (means the received information from the environment does not coincide with the expected), there is an emotional reaction, the stimulus causes the development of a stress reaction.
7. Describe the mechanism of the sympathetic-adrenal reaction development.
Neocortex – limbic system – ergotropic nuclei of the hypothalamus, brainstem (locus coeruleus) – thoracic segment of the spinal cord – adrenal medulla – epinephrine and norepinephrine release.
8. What is the adrenocortical mechanism of the stress reaction?

Neocortex – septal-hippocampal-hypothalamic complex – release of corticoliberin – release of ACTH – release of glucocorticoids.
9. How do somatotropic and thyroid mechanisms of stress develop?
Neocortex – septal-hippocampal-hypothalamic excitation – somatoliberin (1), thyroliberin (2) – STH (1) and TSH (2) of the anterior pituitary gland – thyroid hormones of the thyroid gland (2).
10. Name the stages (phases) of the general adaptation syndrome and their indicative duration.
1.Anxiety (6-48 hours). 2. Resistance (days-weeks). 3. Exhaustion (days-weeks)
11. Identify the stress-limiting (anti-stress) system of the body.
GABA-ergic, endogenous opiates, prostaglandins, antioxidants, parasympathetic autonomic system.
12. What diseases development provoke psycho-emotional stress?
Bronchial asthma, ischemic heart disease, arterial hypertension, rheumatoid arthritis, stomach and duodenum ulcer, migraine, nonspecific ulcerative colitis, eczema, depression and others due to the immune and endocrine homeostasis violation.

Examples of MCQs

1. What are the main characteristic of chronic stress, **EXCEPT**:
a) increase in blood pressure;
b) formation of ulcers in the gastrointestinal tract;
c) **accelerated healing of wounds**;
d) sleep disturbance;
e) hypertrophy of adrenal cortex.
2. What happens during stress reaction:
a) decrease in the blood glucose concentration;
b) blood pressure does not change or decreases;
c) **increase in the blood level of epinephrine and norepinephrine**;
d) increase in the blood concentration of potassium;
e) decrease in heart rate.
3. What biologically active substances provides an increase in blood pressure during the stress reaction?
a) enkephalins;
b) glucocorticoids;
c) GABA;
d) prostaglandins of group E;
e) atrium natriuretic peptide.
4. What structures of the central nervous system are involved in the implementation of the sympathetic-adrenal reaction?

a) cerebellum;
b) substance nigra;
c) red nuclei;
d) limbic system;
e) quadrigemina plate.
5. What hormones are involved in the formation of a stress reaction?
a) cortisone, androgens, parathormone;
b) corticosterone, progesterone, epinephrine;
c) **corticotropin, glucocorticoids, norepinephrine**;
d) corticoliberin, thyroxin, insulin;
e) somatotropin, adrenaline, progesterone.
6. An aged man have raise in arterial pressure under a stress. It was caused by activation of:
a) sympathoadrenal system;
b) parasympathetic nucleus of vagus;
c) functions of thyroid gland;
d) functions of adrenal cortex;
e) hypophysis function.
7. A middle-aged man went to a foreign country because he had been offered a job there. However, he had been unemployed for quite a long time. What endocrine glands were exhausted most of all in this man?
a) adrenal glands;
b) parathyroid glands;
c) seminal glands;
d) substernal gland;
e) thyroid gland.
8. A careless student suddenly met with the dean. What hormones concentration will rapidly increase in the student`s blood?
a) adrenaline;
b) thyroliberin;
c) corticotropin;
d) cortisol;
e) somatotropin.
9. In state of emotional excitement the adrenaline production in the human body increases. Where is it produced in the endocrine system?
a) adrenal medulla;
b) adrenal cortex;
c) adenohypophysis;
d) neurohypophysis;
e) supraoptic nuclei of the hypothalamus.
10. A middle-aged man traveled to another country on the promised job, but he failed

in finding a job for a long time. Which of the endocrine glands is most exhausted?
a) parathyroid;
b) testis;
c) thymus;
d) thyroid glands;
e) adrenal glands.

Methodological development №24

The topic: Endocrine function of the pancreas.
The number of hours: 2 hours
The class takes place at: educational laboratory
The object of learning:
To know: the functional structure of the pancreas, the types gland`s cells and the hormones they secrete.
Be able to: explain the physiological effects of insulin and glucagon, the regulatory mechanisms of these hormones secretion.

Theoretical questions for self-preparation

1. General characteristics of the endocrine function of the pancreas.
2. Physiological effects of insulin and regulation of its secretion.
3. Physiological effects of glucagon and regulation of its secretion.
4. Violation of the endocrine function of the pancreas.
5. The concept of type 1 diabetes and type 2 diabetes.

Key words and terms: type 1 diabetes, type 2 diabetes, metabolic syndrome (X-syndrome), ketoacidic coma, hyperglycemia, hypoglycemia, glycogenesis, glycogenolysis, glycolysis, glycosuria, polydipsia, polyuria, polyphagia, ketone bodies.

Definitions of key terms and concepts

Insulin is a protein hormone consisting of two polypeptide chains that are bound by disulfide bridges.
Glucagon – a protein hormone that consists of one chain.
Somatostatin is a biologically active oligopeptide that acts on the secretion of insulin and glucagon.
The ***norm of the blood glucose concentration*** is 3.3-5.5 mmol/L.
Ketone bodies – acetoacetic and beta-hydroxy-butyric acid, acetone.
Hyperglycemia is an increase in blood glucose concentration.
Hypoglycemia is a decrease in blood glucose concentration below 3.3 mmol/L.

Glycosuria – the appearance of glucose in urine.
Glycogenesis - (greek – genesis) –glycogen synthesis from glucose.
Polyuria – a significant increase in excreted urine (up to 10 liters per day).
Polydipsia – increased thirst.
Polyphagia – increased appetite.
Glycogenolysis - (greek: glyhys – "sweet", lysis – "decomposition", "dissolution") – splitting of polysaccharide chains in the glycogen molecule to form free glucose.
Glycolysis – an enzymatic process of glucose splitting into lactic acid proceeding without the use of oxygen (anaerobic).

Control questions and answers on the topic

1. Name the glands of the internal secretion that take part in maintaining of the normal blood glucose level.
The pancreas, adrenal glands, pituitary gland, thyroid gland (indirectly – due to the increased activity of other hormones, such as insulin, adrenaline, glucocorticoids).
2. Where is insulin formed? What effect does it have on carbohydrate metabolism?
In the beta-cells of the Langerhans islets of the pancreas. It promotes the utilization of glucose, stimulates the synthesis of glycogen.
3. How does insulin affect protein metabolism? Explain the mechanism.
It promotes protein synthesis by increasing the cellular membrane`s permeability for amino acids and stimulating the synthesis of matrix RNA, inhibits the conversion of amino acids to glucose during gluconeogenesis.
4. Where is glucagon formed and how does it affect the level of glucose in the blood?
In the alpha-cells of the Langerhans islets of the pancreas; it increases the blood glucose concentration by the cleavage of the glycogen in the liver.
5. What is manifested in children with a violation of the internal secretion of the pancreas?
In a sharp violation of the carbohydrates` metabolism – the development of diabetes, exhaustion, growth and mental development disturbances.

Examples of MCQs

1. Diabetes mellitus is characterized by:
a) it arises because of insulin hyperproduction;
b) **in patients the blood glucose level increases**;
c) increased utilization of glucose and oxidation of ketone bodies;
d) in the body the blood calcium level increases;
e) there is no correct answer.
2. The hypoglycemic effect of insulin is provided by:
a) **increase in permeability of muscle and fat cell membranes for glucose**;
b) inhibition of the glucose utilization by these cells;
c) enhancement of gluconeogenesis;

d) increase in glycogenolysis in the liver;
e) there is no correct answer.
3. What can stimulate insulin secretion:
a) decrease in blood glucose concentration;
b) **increase in the blood glucose concentration**;
c) somatostatin;
d) potassium ions;
e) adrenocorticotropic hormone.
4. What are the physiological effects of glucagon, **EXCEPT**:
a) increase in cardiac contraction force;
b) **inhibition of gluconeogenesis**;
c) stimulation of proteins` catabolism;
d) activation of glycogen decomposition;
e) increase in blood glucose levels.
5. What hormone secretion increases because of increased concentration of glucose:
a) glucagon;
b) **insulin**;
c) somatotropic hormone;
d) somatostatin;
e) atrium natriuretic peptide.
6. A 30-year-old woman was diagnosed with insufficiency of exocrine function of pancreas. What nutrients` hydrolysis will be disturbed?
a) proteins, fats, carbohydrates;
b) proteins, fats;
c) proteins, carbohydrates;
d) fats, carbohydrates;
e) proteins.
7. A 58 years old woman. Her state is difficult, the consciousness is shadowed, the skin is dry, the eyes are burning, cyanosis, the smell of rotten apples from the mouth. Objectively: blood glucose 15.1 mmol/L, glucose urine 3.5%. What is the most likely reason for this?
a) hypoglycemic coma;
b) hyperglycemic coma;
c) hypovolemic coma;
d) uremic coma;
e) anaphylactic shock.
8. Patient with diabetes mellitus after the injection of insulin the convulsion began. What is the concentration of glucose in biochemical blood test?
a) 2,5 mmol/L;
b) 10.0 mmol/L;
c) 5.5 mmol/L;

d) 3.3 mmol/L;
e) 8.0 mmol/L.
9. In the experiment, an increase in the glucose movement into cells (excluding brain cells), activation of the glucose conversion to glycogen in the liver and muscles, decrease in gluconeogenesis were observed. What hormone can cause these effects?
a) glucagon;
b) insulin;
c) somatostatin;
d) triiodothyronine;
e) aldosterone.

Methodological development №25

The topic: Endocrine function of the gonads, reticular layer of the adrenal cortex, placenta, epiphysis, and thymus gland.
The number of hours: 2 hours
The class takes place at: educational laboratory
The object of learning:
To know: structural and functional architecture of gonads, hormones that are released from gonads.
Be able to: explain the physiological effects of sex hormones, adrenal cortex reticular layer hormones, placenta, epiphysis; the role of the thymus gland hormones in providing immune responses.

Theoretical questions for self-preparation

1. Hormones of the male and female gonads.
2. The sex hormones functions and regulation of their secretion.
3. Physiological effects of adrenal cortex sex hormones and regulation of their secretion.
4. The endocrine function of the placenta.
5. Hormones of epiphysis and thymus gland, their physiological role.
6. Mechanism of local humoral regulation.

Keywords and terms: androgens, gonads, inhibin, intersexuality, infantilism, tissue hormones, adrenogenital syndrome, hirsutism.

Definitions of key terms and concepts

Virilization is the manifestation of secondary male sexual characteristics in women.
Inhibin – inhibits the secretion of the follicle-stimulating hormone produced by the

pituitary gland.
Androgens – (from greek andros – "male") male sex hormones.
Gonads – sex glands.
Eunuchoid is a syndrome due to the sexual glands` hypofunction in men.
Infantilism (from lat. infant – "child") – delayed physical, mental and sexual development of a person.
Intersexuality is a violation of sexual development that manifested by a double genital type.
Gastrointestinal hormones – polypeptides synthesized by endocrine cells of the gastric mucous membrane, intestines and pancreas. These polypeptides affect the production and secretion of digestive juices, motor and absorptive function of the gastrointestinal tract.
Tissue hormones – are involved in regulation of digestive juices` secretion, changes in the smooth muscle tone of vessels and bronchi, in the processes of platelet aggregation and adhesion (kallikrein, bradykinin, prostaglandins).
Nonspecific regulatory metabolites – are formed in all cells of the body and regulate processes depending on the type of negative feedback.

Control questions and answers on the topic

1. Name the epiphysis` hormone. How does it affect the body?
Melatonin. It inhibits the secretion of gonadotropin and, to a lesser extent, other hormones. Also regulates skin pigmentation (causes skin lighting).
2. What organs produce male and female sex hormones?
Women – in the ovaries, placenta, adipose tissue from the adrenal androgens; male – in the testicles and adrenal glands.
3. List the main male and female sex hormones.
Female sex hormones (estrogens): estrone, estradiol, estriol, progesterone. Male sex hormones (androgens): testosterone of the testicles, adrenal androgens.
4. Which substances are derivatives of prostaglandins? What organs and tissues produce them?
The cyclic unsaturated fatty acids derivatives. In all organs and tissues.
5. What is the effect of prostaglandins on the smooth muscles, inhibitory or stimulatory? Give examples.
Both stimulatory and inhibitory effects. Yes, the smooth muscles of the uterus and the digestive tract are stimulated, while the smooth muscles of the vessels and bronchi relaxing (vessels and bronchi expand).
6. What effect do prostaglandins have on gastric secretion and gastrointestinal motility?
The prostaglandins inhibit secretion of hydrochloric acid and stimulate the motility of the gastrointestinal tract.
7. How does blood pressure change under the action of prostaglandins and why?
The blood pressure reduces due to vasodilation (relaxation of the vascular smooth

muscles), diuretic and natriuretic (stimulation of sodium excretion) actions.
8. What is the effect on the child`s body of the epiphysis hormone? What changes occur in children with hypofunction or hyperfunction of the epiphysis?
Participate in the regulation of puberty. The hypofunction leads to early puberty, hyperfunction – to obesity and the phenomenon of hypogonadism.
9. What are the features of the sexual glands functioning in boys and girls from the birth till 7 years?
In boys, after birth, the production of androgens decreases and rises again from 5-7 years. In girls under 7 years of age estrogen production is very small or absent with an increase in 7 years.
10. What determines the predominant production of androgens or estrogens in a child by gonads? What conditions lead to the predominant synthesis of certain hormones?
Temperature regime: in the gonads cooling conditions the male sex hormones – androgens are produced; in conditions of normal temperature (37°C) – female (estrogen).

Examples of MCQs

1. What statements are **TRUE** about the adrenal cortex androgens:
a) their secretion is stimulated by thyroid stimulating hormone;
b) their secretion is stimulated by follicle-stimulating hormone;
c) produced only in male body;
d) play a major role in childhood and old age;
e) all answers are correct.
2. What are the placenta hormones:
a) thymosin;
b) prolactin;
c) **relaxin**;
d) oxytocin;
e) luteinizing hormone.
3. What are the basic physiological effects of testosterone, **EXCEPT**:
a) sexual differentiation in embryogenesis;
b) formation of secondary sexual characteristics during puberty;
c) generalized anabolic action that provides the growth of the skeleton, muscles;
d) **stimulation of uterine contraction**;
e) stimulation of erythropoiesis.
4. Where testosterone is mostly formed in the male body:
a) **Leydig cells**;
b) Sertoli cells;
c) seminal convoluted tubules;
d) testicle appendage;

e) the ejaculatory duct.
5. What is the chemical structure of the thymus hormones:
a) steroids;
b) derivatives of tyrosine;
c) proteins;
d) amino acids;
e) cholesterol derivatives.
6. Which of the following statements about progesterone is **TRUE**?
a) **progesterone is secreted by the corpus luteum**;
b) progesterone secretion by the placenta increases at week 6 of gestation;
c) plasma levels of progesterone increase during menses;
d) plasma levels of progesterone remain constant after implantation;
e) plasma levels of progesterone decrease after ovulation.
7. Parents of a 10 y.o. boy consulted a doctor about extension of hair-covering, growth of beard and moustache, low voice. Which hormone intensified secretion must be assumed?
a) **of testosterone**;
b) of somatotropin;
c) of estrogen;
d) of progesterone;
e) of cortisol.
8. An 18-year-old emaciated female who has been on a strict diet regimen and training for a marathon presents with amenorrhea. Exogenous pulsatile administration of gonadotropin-releasing hormone (GnRH) restores ovulation and menses. Which of the following hormones` sudden increase in secretion caused ovulation?
a) luteinizing hormone;
b) follicle-stimulating hormone;
c) gonadotropic releasing hormone;
d) estrogen;
e) progesterone.
9. The 35 years old man with peptic ulcer has been made resection of the antral part of the stomach. What gastrointestinal hormone secretion as a result of surgery will be affected most?
a) gastrin;
b) secretin;
c) neurotensin;
d) histamine;
e) cholecystokinin.
10. The international class` journalists, whose professional activity is related to the flights` crossing of several time zones in a short time, due to the shift of biorhythms, both sleep disorders and wakefulness states develop – the so-called dischronous (time-

zone disease). In order to overcome the disorder, drugs that is a hormone remedy is proposed:
a) thyroid gland;
b) pituitary;
c) adrenal cortex;
d) epiphysis;
e) sexual glands.
11. During examination of 16 years old girls next symptoms were found: absence of hair follicles on pubis and under armpits, underdevelopment of the mammary glands, absence of menstruation. What hormone disturbance can lead to these symptoms?
a) hyperfunction of the thyroid gland;
b) incomplete hormonal function of the ovaries;
c) hypofunction of the thyroid gland;
d) the insufficiency of the islet apparatus of the pancreas;
e) hyperfunction of adrenal medulla.

Methodological development №26

The topic: Higher nervous activity (HNA). Physiological bases of behavior.
The number of hours: 2 hours.
The class takes place at: educational laboratory.
The object of learning:
To know: essence and physiological significance of the higher and lower nervous activity theory, types of instincts and reflexes, types of inhibition of conditioned reflexes.
Be able to: explain the theory of higher and lower nervous activity, know the principles of diagnosing the type of nervous activity, give examples of conditioned reflexes inhibition types.

Theoretical questions for self-preparation

1. 1.Forms of behavior. Higher and lower nervous activity.
2. Instincts as a component of behavior. Classification of instincts.
3. Types and properties of conditioned reflexes. Classification and mechanisms of conditioned reflexes formation.
4. Types of conditionally reflexive inhibition.

Keywords and terms: instinct, conditioned reflex, conditional and unconditional inhibition.

Practical skills

1. **Study of the time of simple and complex visual-motor reaction to various types of stimuli.**

The work is carried out using the computer complex "Prognoz". The student, after the appropriate instruction, must click the buttons with the right and left hand depending on the instructions given on the monitor screen. When determining the time of a simple visual-motor reaction you must press the button with the right hand as soon as possible after the appearance of the geometric figure or word on the screen (depending on the conditions of the task). When determining the time of a complex visual-motor reaction the student should press the appropriate button right or left hand as soon as possible after the appearance of the geometric figure or word on the screen, taking into account the type of the figure or the content of the word. The reaction time to a stimulus to some degree reflects the properties of the nervous system for processing visual information.

2. **Determination of the strength and functional mobility of the nerve processes (by M.V. Makarenko's method)**

The work is carried out using the computer complex "Prognoz". The determination of the strength and functional mobility of the nerve processes is carried out in a feedback mode when the duration of exposure to the visual stimulus depends on the reaction time on the previous stimulus. In the case of the correct response to the stimulus by examined, the exposure of the next stimulus decreases by 20 ms. In determining the functional mobility of the nerve processes take into account the time when person correctly distinguish 120 stimuli (figures or words). In determining the strength of the nervous processes the number of stimuli (figures or words) is taken into account, which are correctly differentiated by the person within 5 minutes.

Definition of key terms and concepts

Behavior **-** 1) a genetically determined program, characteristic of the biological species, and 2) sufficiently labile system of specific adaptations to changing environmental conditions.

Instincts - firmly fixed in the hereditary code of behavior.

Vital instincts - instincts that ensure the preservation of the individual`s life.

Higher nervous activity - a set of acquired in the process of individual learning behavioral reactions.

Control questions and answers on the topic

1. What are the main characteristics of instincts as a form of behavior?

a) the motivation and the ability to act is a hereditary property of the species;

b) the action does not require prior training;

c) the action is performed uniformly, stereotyped in all normal representatives of this species;

d) the action corresponds to anatomical-physiological features and ecological conditions of existence of this species.
2. What are characterized for 2 phases of instinct realization?
The first phase - the preliminary, search engine. More plastic, variable, needs to take into account the specific conditions of the situation and some individual experience. The second one is the final one, the most stable and rigidly fixed in the genotype.
3. What is characteristic of vital instincts?
a) dissatisfaction with the corresponding need leads to the death of the person;
b) no other person is need to meet one or another requirement
4. Specify the main zoo-social instincts.
Sexual, fatherhood, reflex of emotional resonance (empathy), territorial, hierarchical.
5. What is the interval between the stimulus and the reinforcement in the retired and delayed conditional reflexes?
In retired, the interval between stimulus and reinforcement - 5-30 seconds, in the delayed - more than 30 seconds.
6. At what levels of the brain you can observe areas of excitation in the formation of conditioned reflexes?
Areas of excitation exist at all levels of the central nervous system, including in the cortex.
7. What conditions are necessary for the formation of a stable temporary connection between the areas of excitation in the central nervous system?
In most cases, a multiple combination of conditional and unconditioned stimuli is required, but in some situations a steady connection may arise after a one-time coincidence of stimuli.
8. What are the main characteristics of the unconditional inhibition?
- congenital,
- does not need to be developed,
- is manifested in all representatives of this species,
- is inherited by the offspring.
9. What are the main characteristics of conditional braking?
requires special conditions for making (acquired),
not permanent,
not inherited by offspring.
10. List the types of conditional inhibition.
- exhausting inhibition; - differential inhibition; - conditional brake; - delayed inhibition.

Examples of MCQs

1. Students who are taking examinations often have dry mouth. The mechanism that causes this state is the realization of the following reflexes:
a) conditioned sympathetic;

b) unconditioned parasympathetic;
c) conditioned parasympathetic;
d) unconditioned sympathetic;
e) unconditioned peripheral.
2. The student carefully listens to the lecture. The attention was considerably worse when the neighbors had begun talking. What kind of conditioned reflexes` inhibition is the reason for this?
a) external;
b) subliminal;
c) exhausting;
d) differential;
e) delayed.
3. What are the vital instincts?
a) food reflex;
b) sexual;
c) fatherhood;
d) territorial;
e) hierarchical.
4. What are the zoo-social instincts?
a) fatherhood;
b) reflex of emotional resonance (empathy);
c) territorial;
d) hierarchical;
e) all listed.
5. Which of the above is an unconditional reflex?
a) external inhibition;
b) exhausting inhibition;
c) differential inhibition;
d) conditional brake;
e) delayed inhibition.

Methodological development №27

The topic: Features of higher human nervous activity.
The number of hours: 2 hours.
The class takes place at: educational laboratory.
The object of learning:
To know: mechanisms of formation, theories and types of memory, sleep.
Be able to: draw a pattern of sleep, define the type of HNA using questionnaire and instrumental techniques.

Theoretical questions for self-preparation

1. Memory, its types and mechanisms.
2. Sleep. Types and phases of sleep. Biological significance. Mechanisms of sleep.
3. Features of human nervous activity. Types of HNA.
4. Functional asymmetry of the cerebral hemispheres.

Keywords and terms: motivation, memory, sleep.

Definition of key terms and concepts

Memory - the property of living systems, in particular the central nervous system, to perceive, fix, store and reproduce traces of previously acting stimuli.
Sleep is a special state of the organism characterized by inhibition or even "disconnection" of consciousness, decrease in all types of sensitivity and total motor activity.
Broca's Center (lower part of the frontal lobe) - damage in this area breaks the reproduction of oral speech, motor aphasia appears (language is understood, but cannot speak).
Wernicke's Center (temporal area near the auditory zone of the cortex) - damage of this area disturbs understanding of language, inability to perceive the language and speech, sensory aphasia occurs.

Practice: Personality Temperament Test

INSTRUCTIONS: There are 4 Sections below. In each section you will find a series of descriptive words. Your task is to read each word and put a number next to it according to how well it describes the REAL you. It`s important to be honest and objective. Don`t mark a box according to how you want to be seen, rather mark it according to how you really are.

SCORING CRITERIA: Score how each word best describes you:
1 = "That is definitely NOT me!"
2 = "That is usually NOT me."
3 = "That is usually me."
4 = "That is mostly me."
5 = "That IS definitely me!"

Section 1	Section 2	Section 3	Section 4
___emotional	___	___deep feeling	___very quiet
___egotistical	optimistic	___critical	___selfish
___interrupts	___	___insecure	___
others	determined	___sensitive	unenthusiastic

__ compassionate ___impulsive ___disorganized ___impractical ___funny ___forgetful ___easily discouraged ___very positive ___easily angered __ undisciplined ___extrovert ___refreshing __ lively/spirited ___weak-willed ___spontaneous ___talkative __ delightful/cheerful ___enjoyable ___popular __ friendly/sociable ___"bouncy" ___restless ___difficulty concentrating ___likes to play ___difficulty keeping resolutions ___lives in present ___difficulty with	___bossy ___goal-oriented ___decisive ___frank ___self-confident ___sarcastic ___ workaholic ___self-sufficient ___practical ___ headstrong ___activist ___outgoing ___ domineering ___ adventurous ___ aggressive ___ competitive ___ leadership ability ___daring ___ persevering ___bold ___strong-willed ___ persuasive ___hot-tempered ___ resourceful __	___indecisive ___hard to please ___self-centered ___pessimistic ___depressed easily ___easily offended ___idealistic ___loner ___self-sacrificing ___introvert ___faithful friend ___analytical ___considerate ___likes behind the scenes ___suspicious ___respectful ___introspective ___planner ___perfectionist ___scheduled ___ unforgiving/resents ___orderly ___creative ___detailed ___moody ___gifted (musically or athletically)	___negative ___regular daily habits ___hesitant ___shy ___stingy ___aimless ___not aggressive ___stubborn ___worrier ___spectator of life ___works well under pressure ___indecisive ___adaptable ___slow and lazy ___submissive to others ___easy going ___reserved ___calm and cool __ content/satisfied ___efficient ___patient __ dependable ___listener ___witty/dry humor ___pleasant ___teases others ___consistent

appointments	insensitive __ outspoken __ unsympathetic __ productive		
Total:	Total:	Total:	Total:

After you have completed all 4 Sections go back and cancel out each description that you scored either 1 or 2 by drawing a line through that number. Since that score is so low it doesn`t really apply to your overall scoring in each Section. Now add up all of the 3's, 4's, and 5's in each Section and write your total at the bottom of each appropriate section. The section with the highest score is your Primary Temperament and the section with the second highest score is your Secondary Temperament. No one is one pure temperament, but instead we are a blend of all the temperaments.

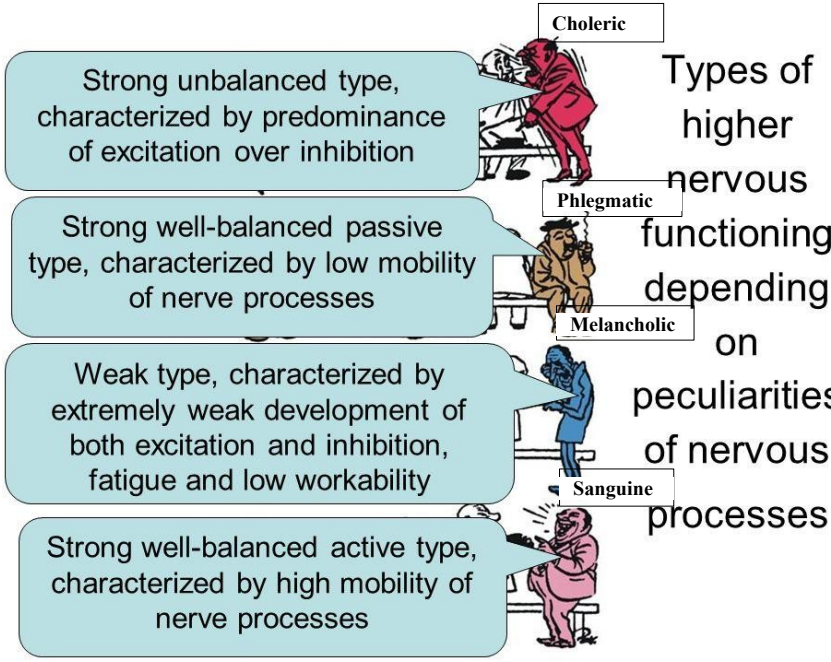
Result:

Each section represents one of four Temperaments:

SECTION 1: Sanguine Temperament (fun-loving extrovert; outgoing; very social; "the life of the party") - EXTROVERT

SECTION 2: Choleric Temperament (focused; extrovert; goal oriented; "the achiever") EXTROVERT

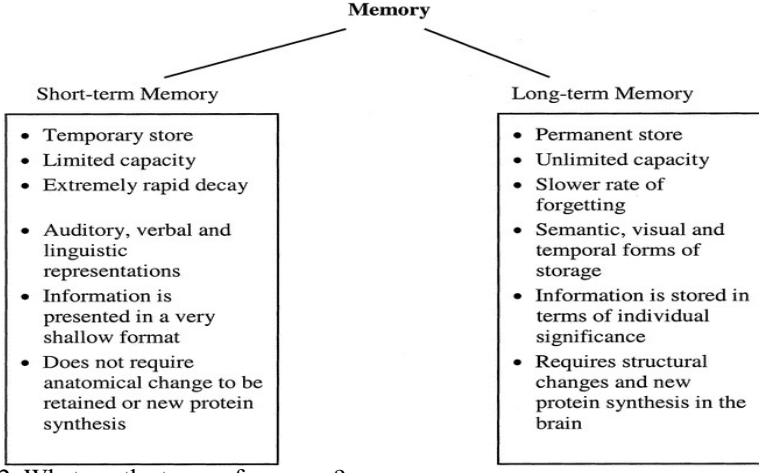
SECTION 3: Melancholy Temperament (detailed; introspective; artistic; "the naturally gifted") – INTROVERT
SECTION 4: Phlegmatic Temperament (easy going; stable; consistent; "the loyal friend") – INTROVERT



Control questions and answers on the topic

1. What is the selectivity of a person`s memory?

The ability to select, sort and store only the most important, general information.



2. What are the types of memory?

a) emotional, motor, verbal-logical memory; b) sensory, short-term, long-term.

3. Specify the most characteristic features of "slow sleep".

During a slow-wave sleep a person's pulse slows down, BP decreases, breathing becomes less frequent, redness of the skin appears, the muscles are in a lowered tone compared to the state of vivacity. The delta-rhythm is recorded on the EEG.

4. What phase of sleep does dreams mostly occur?

In the phase of a rapid sleep.

5. Specify the basic physiological properties of the delta-sleep peptide.

The introduction of delta-sleep peptide (DSP) to animals is mainly lead to delta-sleep. The DSP showed in the experiments a pronounced anti-stress effect, increased resistance to tumors, normalized the functions of the immune system. In humans, the introduction of DSP significantly improves sleep if it is violated.

6. What are the main functions of sleep?

1) compensatory restoration;
2) informational;
3) psychodynamic and anti-stress.

7. What are the main characteristics of the HNA type according to G. Jung?

- extroversion-introversion;
- emotional stability - neuroticism (emotional instability);
- mobility of nervous processes - inertia.

8. What types of constitutions determine by Sheldon?

- viscerotonic;
- somatotonic;

- cerebrotonic.

Examples of MCQs

1. Examination of a patient revealed a strong, balanced, inert type of higher nervous activity according to Pavlov. What temperament type does the patient have (according to Hippocrates classification)?
a) phlegmatic;
b) sanguine;
c) choleric;
d) melancholic;
e) –.
2. A 41-year-old man is seen by his physician complaining of "always feeling tired" and having "vivid dreams when he is sleeping." He is referred to the hospital's sleep center for evaluation. He is diagnosed with narcolepsy based on his clinical history and the presence of rapid eye movements (REM) as soon as he falls asleep. Which of the following signs will be observed when the patient is exhibiting REM sleep?
a) periods of loss of skeletal muscle tone;
b) hyperventilation;
c) slow but steady heart rate;
d) high amplitude EEG wave;
e) decreased brain metabolism.
3. A 16-year-old girl with epilepsy has an electroencephalogram (EEG) recording done during a routine visit to her neurologist. The alpha-rhythm appearing on an EEG has which of the following characteristics?
a) it disappears when a patient's eyes open;
b) it produces 20 to 30 waves per second;
c) it is replaced by slower, larger waves during REM sleep;
d) it represents activity that is most pronounced in the frontal region of the brain;
e) it is associated with deep sleep.
4. In the patient after the injury short-term memory impairment was detected. What process determines the mechanisms of memory is being disturbed?
a) reverberation of excitation in chains of neurons;
b) structural-functional changes of CNS synapses;
c) the movement of ions in membrane receptors;
d) conduction in afferent neurons;
e) structural changes in the CNS neurons.
5. In a 60 years old man hemorrhage in the brain caused a long sleep. Which structure damage most likely led to this state?
a) reticular formation;
b) hippocampus;

c) cortex of the cerebral hemispheres;
d) substancia nigra;
e) caudate nucleus.

Methodological development №28

The topic: The role of motivations and emotions in behavior formation.
The number of hours: 2 hours
The class takes place in: education laboratory
To know: mechanisms of formation, theories and types of emotions.
Be able to: explain theories of emotions.

Theoretical questions for self-preparation

1. Motivation theories of origin.
2. Basic concepts of emotions.
3. Classification of emotions.
4. The mechanism of emotions development.
5. Structural basis of emotions.

Keywords and terms: emotion, motivation, Maslow`s hierarchy.

Definitions of key terms and concepts

Emotions are the subjective reactions of person to the action of external or internal stimuli, manifested in the form of pleasure or dissatisfaction, fear, anger, joy, sorrow, etc.
Motivation is the ability to direct behavior toward specific goals.
Theories of emotions: James-Lange theory, Cannon-Bard theory, Schachter-Singer theory.

Control questions and answers on the topic

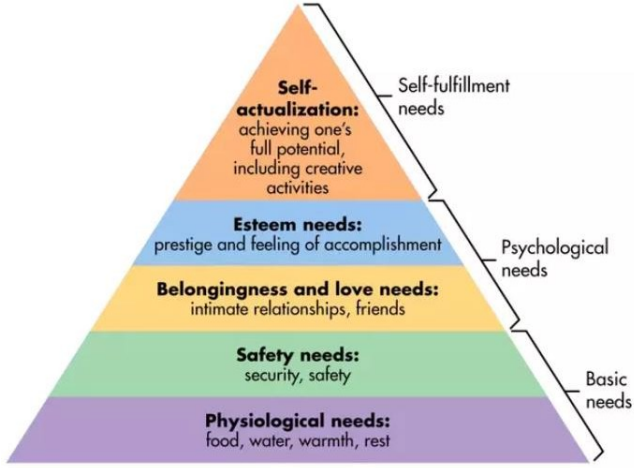
1. List the known motivational theories.
Peripheral, humoral, hypothalamic, pacemaker.
2. What is the essence of the peripheral theory of motivation?
The basis of motivation lies in the person`s desire to avoid unpleasant physiological and emotional sensations and to achieve, maintain a pleasant feeling.
3. What is the essence of the humoral theory of motivation?
The basis of motivation is insufficiency (or excess) concentration of a certain substance in the blood (level of hormones, glucose, amino acids, etc.).
4. Specify the basic biological functions of emotion.

Estimated, regulating, reinforcing, compensating.
5. What is the vegetative (autonomic) component of emotions?
The autonomic component of emotions is a change in the activity of the cardiovascular, respiratory systems, sweating, salivation and other vegetative functions under certain emotions. In the case of prolonged negative emotions this component can lead to psychosomatic illnesses.
6. Name the 4 strategically important structures in the organization of emotions according to P. Simonov.
hypothalamus, hippocampus, tonsils, new cortex.
7. What are two significant interrelated parts that could be distinguished in emotions structure?

- Subjective part manifested by psychological phenomena (experiences) - anxiety, passion, fury, pleasure of joy, elevation, etc.
- Objective part, for which the tension of the physiological systems of the organism is character.

8. What is classification of emotions by biological significance?
1. General biological (basic) ones are inherent in both animals and humans. They are related to the disturbance of homeostasis and are aimed to satisfy vital needs: the need for food, drinking, self-defense (preservation of the individual`s life), reproduction (preservation of the species). Among them there are food, oriental-research, aggressive-protective, sexual emotions.
2. Human (higher order) ones are related to the satisfaction of personal and social needs - intellectual, moral, esthetic, interaction with other members of the group, etc. These higher emotions are formed on the basis of consciousness, so they have inhibited and controlling influence on the basic emotions.
9. What are the types of emotions according to the emotional reaction direction?
- negative (dissatisfied searching)
- positive (satisfied searching).
10. What is the pyramid of A. Maslow?
Maslow`s hierarchy of needs is a motivational theory in psychology comprising a five-tier model of human needs, often depicted as hierarchical levels within a pyramid.
Needs lower down in the hierarchy must be satisfied before individuals can attend to needs higher up. From the bottom of the hierarchy upwards the needs are: physiological, safety, love and belonging, esteem, and self-actualization.

Maslow's Hierarchy of Needs



11. What structures are involved in emotion formation?

The amygdala, the mammillary bodies, cingulate gyrus, the thalamic nuclei, the hippocampus.

12. What is the role of epinephrine and norepinephrine in emotions? Give examples of other drugs.

Both norepinephrine and dopamine are chemically classified as catecholamines and known transmitters in the regions that elicit the highest rates of self-stimulation in animals equipped with do-it-yourself devices. A number of psychoactive drugs affect moods in humans, and some of these drugs have also been shown to influence self-stimulation in experimental animals. For example, increased self-stimulation is observed after the administration of drugs that increase catecholamine synaptic activity, such as amphetamine, an "upper" drug. Amphetamine stimulates the release of dopamine from dopamine-secreting neurons.

Although most psychoactive drugs are used therapeutically to treat various mental disorders, others, unfortunately, are abused. Many abused drugs act by enhancing the effectiveness of dopamine in the "pleasure" pathways, thus initially giving rise to an intense sensation of pleasure. An example is cocaine which blocks the reuptake of dopamine at synapses.

13. What is depression?

Depression is among the psychiatric disorders associated with defects in limbic system neurotransmitters. A functional deficiency of serotonin or norepinephrine or both is implicated in depression, a disorder characterized by a pervasive negative mood accompanied by a generalized loss of interests, an inability to experience pleasure, and

suicidal tendencies.
14. What drugs are used for depression treatment?
All effective antidepressant drugs increase the available concentration of serotonin or norepinephrine or both in the CNS. Prozac is the most widely prescribed drug in American psychiatry. It blocks the reuptake of released serotonin, thus prolonging serotonin activity at synapses.
15. What is the effect of emotions on gastric motility?
Emotions can alter gastric motility by acting through the autonomic nerves to influence the degree of gastric smooth muscle excitability. Even though the effect of emotions on gastric motility varies from one person to another and is not always predictable, sadness and fear generally tend to decrease motility, whereas anger and aggression tend to increase it. In addition to emotional influences, intense pain from any part of the body tends to inhibit motility, not just in the stomach but throughout the digestive tract. This response is brought about by increased sympathetic activity.
16. What is James-Lange theory of emotion?
Proposed independently by psychologist William James and physiologist Carl Lange. The James-Lange theory of emotion suggested that emotions occur as a result of physiological reactions to events. In other words, this theory proposes that people have a physiological response to environmental stimuli and that their interpretation of that physical response then results in an emotional experience. According to this theory, witnessing an external stimulus leads to a physiological response. Your emotional reaction depends on how you interpret those physical reactions. Example: suppose you are walking in the woods and you see a grizzly bear. You begin to tremble and your heart begins to race. The James-Lange theory proposes that you will interpret your physical reactions and conclude that you are frightened ("I am trembling. Therefore, I am afraid.")
17. What is Cannon-Bard theory of emotion?
The Cannon-Bard theory of emotion (or **thalamic theory of emotion**) states that stimulating events trigger feelings and physical reactions that occur at the same time. For example, seeing a snake might prompt both the feeling of fear (an emotional response) and a racing heartbeat (a physical reaction). Cannon-Bard suggests that both of these reactions occur simultaneously and independently. In other words, the physical reaction isn't dependent on the emotional reaction, and vice versa. Cannon-Bard proposes that both of these reactions originate simultaneously in the thalamus.
18. What is Schachter-Singer theory of emotion?
According to the Schachter-Singer theory emotions are a result of two factors:
physical processes in the body (such as activation of the sympathetic nervous system, for example) which researchers refer to as "physiological arousal." These changes can include things like having your heart start beating faster, sweating, or trembling;
cognitive process, in which people try to interpret this physiological response by looking at their surrounding environment to see what could be causing them to feel this

way.

Examples of MCQs

1. Primary emotions are to the_____pathway as secondary emotions are to the _____pathway.
a) mild, intense;
b) hard, soft;
c)fast, slow;
d) pleasant, unpleasant;
e) -.
2. When faced with a stressful situation, men are likely to respond with the:
a) fight or flight response;
b) hurt then help response;
c) fist and knees response;
d) tend and befriend response;
e) -.
3. The phenomenon of misattribution of arousal (e.g. thinking you are in love when really you are just scared) is best explained by which theory of emotion?
a) the James-Lange theory;
b) the two-factor theory;
c) the Cannon-Bard theory;
d) the wishful thinking theory;
e) autonomic theory.
4. Which of the following is classed as a basic emotion?
a) guilt;
b) shame;
c) jealousy;
d) disgust.
5. The facial feedback hypothesis refers to:
a) the movements of our facial muscles can trigger emotions;
b) we can judge someone else's mood by looking at their face;
c) once we know how we are feeling; we change our facial expression;
d) some people disguise their emotions if they look in a mirror.
6. The ability to control one's emotions is known as:
a) facial feedback;
b) interpersonal intelligence;
c) emotional regulation;
d) emotional contingency;
e) autonomic response.
7. People who are experiencing high levels of arousal from one event tend to experience unrelated emotions more strongly too. This is called:

a) general adaptation syndrome;
b) spreading activation;
c) the Cannon-Bard hypothesis;
d) excitation transfer;
e) evolutionary theory.
8. Both the slow and fast emotional pathways are controlled by the:
a) thalamus;
b) hypothalamus;
c) frontal cortex;
d) amygdala;
e) Broca's area.
9. According to the Cannon-Bard theory of emotion:
a) emotional experience and physiological arousal occur at the same time;
b) emotional experience precedes physiological arousal;
c) physiological arousal precedes emotional experience;
d) we cannot experience different emotions;
e) emotions have no biological or evolutionary basis.
10. According to the James-Lange theory of emotion:
a) emotional experience and physiological arousal occur at the same time;
b) emotional experience precedes physiological arousal;
c) physiological arousal precedes emotional experience;
d) we cannot experience different emotions;
e) emotions have no biological or evolutionary basis.
11. According to the two-factor theory of emotion, emotion equals:
a) arousal plus cognition;
b) arousal plus intelligence;
c) attribution plus explanation;
d) attribution plus cognition.
12. Identify the correct statement from the below:
a) emotions have no biological or evolutionary basis;
b) **emotions involve both the CNS and the ANS**;
c) in the brain, only subcortical brain mechanisms are implicated in mediating emotion;
d) sham rage is so called because a strong stimulus can cause a release of autonomic responses (such as sweating and increasing blood pressure) that are normally only elicited by weak stimuli.
13. Patients with Huntington's disease have difficulties recognizing when others are feeling disgust. What brain region`s damage in Huntington's disease likely results in this severe deficit, due to its important role in the recognition of the facial expression associated with disgust?
a) hippocampus;
b) insula;

c) amygdala;
d) basal ganglia;
e) frontal cortex.

14. The most common basis for differentiating between emotion and motivation assumes that the emotion is aroused by_____and that motivation is aroused by__.
a) instincts, drives;
b) drives, instincts;
c) internal events, external events;
d) external events, internal events.

15. If you see a lion in your living room, you will experience extreme arousal; if you see the same lion at the zoo, no such panic occurs. This illustrates____:
a) cannon`s theory;
b) the facial feedback hypothesis;
c) the James-Lange theory;
d) the role of cognitive appraisal on emotions;
e) evolutionary theory.

16. Cognitive appraisals are largely responsible for what aspect of emotions?
a) determining the physiological response to the emotion
b) differentiating emotions
c) differentiating facial expressions
d) determining all behavioral responses
e) facial feedback

17. Studies of people attempting to identify emotional reactions in photographs of individuals from other cultures have shown that:
a) it is difficult to judge the emotions of people from a different culture
b) certain facial expressions have a universal meaning
c) emotional expression within cultural groups varies as much as between groups
d) there are wide cultural variations in expressions of the same emotion
e) emotions have no biological or evolutionary basis

Recommended literature

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