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Lecture 3

Human Histology 1-2 Muscle tissue: smooth and striated skeletal muscle tissues. Nerve tissue. General features of Nerve tissue.

LECTURE OUTLINE

- General features of Muscle Tissue. Terminology.
- Smooth and Skeletal Muscle tissues.
- Organization of the Skeletal Muscle.
- Neurons. Classification of neuron types.

LEARNING OUTCOMES

1. list the 3 major muscle types and compare their structure, function, location.
2. define the structure and functions of the Skeletal Muscle.
3. define the relationships among muscle fascicles, muscle fibers, myofibrils, myofilaments.
4. recognize Skeletal muscle in micrographs.
5. list the features of Nerve tissue that distinguish it from other basic tissues.
6. list the nerve tissue cell types and describe the structure, function, location.
7. describe a neuron's organelles in terms of their location, impulse transmission, neuronal repair.
8. recognize the type of nerve tissue cells in micrographs.

The mainfunctionof muscular tissues is to contract, providing the movement. The structural elements of muscular tissues have some general features:
1) the extended form;
2) special organelles – myofibrils and myofilaments in sarcoplasm, lying along the cells or fibers;
3) glycogen and myoglobin inclusions (monomer Hb, red, capable to bind and emit O_2);
4) two-layer sarcolemma (cytolemma covered with the basal membrane).
Classification. There are 2 kinds of muscular tissue: smooth and striated (or cross-striped). The smooth tissue develops from the mesenchyme, except for the specialized kinds developing from the neuroectoderm (the iris muscles) and ectoderm (myoepithelial cells of the glands). The striated tissue develops from the mesoderm; it can be skeletal and cardiac.
CROSS-STRIPED (striated) SKELETAL MUSCULAR TISSUE.It makes up the muscles of the trunk, extremities and head. It contracts deliberatelyand quickly, but gets tired quickly. It

develops from somite myotomes. Their cells turn into myoblasts which multiply and merge into the symplasts – muscular tubules. In their cytoplasm myofibrils are formed, and the basal membrane of sarcolemma is formed above thecytolemma. A part of the myoblasts turns into low-differentiated cells –*myosatellites*. They settle down between the cytolemma and the basal membrane of sarcolemma. A nerve ending connects with each myosymplast. The structure of the myosymplast.Its thickness is 20 microns, the length – from 2 to 12 cm, the number of the nuclei – up to ten thousand (they are oval and lie under sarcolemma). Up to 1000 myofibrils lie in the center along the myosymplast. Between them there is glycogen, myoglobin, mitochondrions and atubule of sarcoplasmic reticulum which deposits Ca-ions. The sarcoplasmic reticulum tubules form circular tanks around the light disks of myofibrils which contact with the cytolemma tubule. It is necessary for the muscle contraction and is called the Tsystem. Myofibrils consist of proteins and myofilaments. Proteins, constructing the myofibril,include 4 groups:
1) contracting proteins – actin and myosin,
2) regulating proteins – troponin and tropomyosin,
3) structural protein – α-actinin,
4) elastic proteins – titin and nebulin.
Myofilaments, constructing the myofibril, consist of chains from actin and myosin. Myosin molecules have myosin bridgesmade of lateral chains with the head composed of ATP (orof the side chains with the head of the ATP). Thin actin molecules are partially blocked with thick myosin molecules. This creates crossstriped fibers in the form of altering dark and light disks. The Light disks contain one kind of proteins – actin, whichdissipates light equally. Therefore, they are called isotropic or I-disks. In the middle of light disks there is a septum – a *telophragma*or aZ-*line*contracted fromα-actininprotein. The Z-line crosses all parallel I-disks and is attached to the cytolemma. It binds the myofilaments into the myofibril. In dark disks actin and myosin are blocked. They dissipate light in different ways, so dark disks possess double refraction and are calledanisotropic or A-disks. In the middle ofan Adisk there is a light H-band without actin. M-line is amesophragmawhichpasses through it. The structural and functional unit of themyofibril is SARCOMERE. It is a section of themyofibril between two Z-lines (an A-disk andtwo halves of I-disks).
The nervous tissue unites the organism into the whole. It consists of neurons and the neuroglia. Neurons accept irritation, form a nervous impulse and transfer it to other cells. Theneuroglia creates conditions for the neuron's life. The NEURON has a body and processes. The body (perikaryon) contains a large light nucleus with nucleoli. The processes are of 2 kinds: dendrites and axons. Dendrites can be numerous; they transfer impulses to the neural body. There is only one axon (neurit) which transfers impulses from the neural body. The cytoplasm has organelles and inclusions of melanin and lipofuscin. The granular endoplasmic reticulum forms basophilic masses called Nissl substance*(basophilic, chromatophilic, tigroid substance*); it is present in the body and dendrites, but never in the axon. It synthesizes enzymes for synapsis. Disintegration of thetigroidsubstance is called tigrolysis; it occurs when the neuron is overexcited. Special neuron organelles are neurofibrils, a complex composed of neurotubules and neurofilaments. Their function is bidirectional intracellular transport of substances. Anterograde transport moves substances from the perikaryon to the synaptic terminals. Retrograde transport returns substances from the processes to the cell body for the control of their integrity.

Questions for self-control:

1. Define the classification of the muscle tissue.
2. Define groups of protein do myofibrils contain?

3. What is a structural unit of the skeletal muscle?
4. What are the nervous tissue components?
5. Define neuron types.

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Lecture 8

Human Histology 3-4 Hemopoiesis. General features of Hematopoiesis. Blood. Formed elements: Erythrocytes, leukocytes, platelets.

LECTURE OUTLINE

- General features of the Blood.
- Basic cell types. Staining properties. Formed elements.
- Hematopoiesis. Organization of the Skeletal Muscle.
- General features of Hematopoiesis.
- Development of hematopoietic tissues. General structure of mature hematopoietic tissues.

LEARNING OUTCOMES

1. list the name, structure and functions of each formed element in blood.
2. recognize the formed elements in a micrograph of a blood smear.
3. describe the structural and functional characteristics of a stem cell.
4. compare mature circulating blood cells and hematopoietic stem cells.
5. recognize differences in the erythrocytes produced during each phase.

BLOOD refers to the blood systemwhich includes 3 parts: 1 – blood producing organs (the haemopoietic organs make blood cells, the liver – plasma proteins), 2 – peripheral blood and lymph, as well as blood cells in tissues; 3 – blood destroying organs (the spleen and the liver). Blood is an intravascular liquid tissue made up of structural elements and liquid intercellular substance – plasma. In adults blood makes 6–8 % of the body weight, in newborns – 13–15 %, in children till 14 years old – 9 %. The structural blood elements include about 99 % *of erythrocytes, and about 1 % of leukocytes and platelets (thrombocytes)*. In the course of blood analysis the ***hemogram*** is made. The hemogram includes the basic parameters: hematocrit (Ht,the number of formed elements) – 30–35 %, the number of erythrocytes – 4–5,5*1012/l(=per liter of) blood; leukocytes – 3–10*109/l; platelets – 130–400*109/l; There are 2 types of hematopoiesis:
1) embryonic – it is histogenesis, the formation of blood like a tissue;
2) postnatal – it is physiological regeneration, renewal of blood.
EMBRYONIC HEMATOPOIESIS begins in the yolk sac mesenchyme where the first stem cells (SC) which originate the blood cells and vessels are formed. Later SC migrate through the vessels into the

embryo`s body – first into the liver and then into the thymus, spleen, lymph nodes and bone marrow.During the 2nd–3rd weeks of the development the mesenchymal cells form blood islets in the wall of the YOLK SAC. In the islet center the cells lose their processes and differentiate into hematopoietic stem cells. On the islet periphery the cells are flattened and form vascular walls: theendothelial, smooth muscle and connective tissue layers. POST- EMBRYONIC HEMATOPOIESIS. It is physiological regeneration of blood. The bone marrow is the universal hematopoietic organ, which stores SC reserves. In the thymus the T-cells (helpers and suppressors) are formed. In the spleen, lymph nodes and lymphoid follicles of the mucosa the final forms of T- and B-lymphocytes develop. The monophyletic theory The founderof the monophyletic theory, Maksimov, was the first who suggested that all blood cells are formed from SC morphologically similar to small lymphocytes. This was confirmed in the experiments that showed that SC form colonies of various blood cells inthe tissue culture. *SC are pluripotent cells*. They proliferate and form *two major lineages of progenitor polypotent cells (half-stem cells, HSC)* – lymphoid cells (for lymphopoiesis) and myeloid cells (for other blood cells). From these, under the action of colony-stimulating factors (CSF) *7 unipotent progenitor cells* are formed; they are called colony-forming units (CFU):

1) CFU-GM – gives progeny of CFU-M (monocytes) and CFU-Gn
(neutrophiles);
2) CFU-Eo (eosinophiles);
3) CFU-B (basophiles);
4) CFU-Meg (megakaryocytes);
5) CFU-E (erythrocytes);
6) pre-T- cell (T-lymphocyte);
7) pre-B-cell (B-lymphocyte).

Questions for self-control:

1. What main components of blood do you know?
2. What types of leukocytes do you know?
3. What are the functions of granulocytes?
4. What are the functions of agranulocytes?
5. What types of hematopoiesis do you know?
6. What is the basic of the hematopoiesis theory?

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Lecture 11

Human Histology 5-6 Cardiovascular system. General features of the CVS. Blood vessels. Arteries and veins. Microcirculation stream. Arterioles. Capillaries. Venules

Lecture 16

Human Histology 7. Cardiovascular system. Cardiac Muscle muscle tissue. Heart. Layers of the Heart Wall.

LECTURES OUTLINE

- General features of the Circulatory system.
- General features of the Blood vessels.
- Comparison and classification of arteries, veins, blood capillaries.
- General features of the Heart.
- Cardiac skeleton, tunics.
- Cardiac muscle.

LEARNING OUTCOMES

1. name the 3 tunics that make up the walls of cardiovascular system components.
2. know the tissue type in each tunic in wall of blood vessels and heart.
3. list the features of cardiac muscle that distinguish it from other muscle tissues.
4. recognize the vessel types in a micrograph and identify their structural components.
5. distinguish between cardiac muscle and Purkinje fibers
6. identify the endocardium, myocardium, epicardium in micrographs of the heart.

The cardiovascular system consists of the heart, blood and lymphatic vessels. In the organs some portion of blood plasma leaves the vessels for tissues provides them with nutrition, collects metabolic products and turns into the lymph. The lymph passes into lymphatic vessels, is cleared in the lymph nodes and returns to the blood. The vessels develop from the yolk sac mesenchyme at the 2nd–3rd week. Their formation is influenced by hemodynamic conditions, it est the vessel's function, blood pressure and the rate of blood flow. The arteries carry blood from the heart to organs; the pressure in them is high, and the blood flow is rapid. The microcirculation vessels (arterioles, capillaries, venules) are responsible for metabolism between the blood and tissues; the blood flow rate is slowed down, the pressure is low. The veins carry blood from organs to the heart; the pressure is still low, the blood flow rate is slow. All vessels are lined with inner endothelium. It is a continuous layer of squamous cells on the basal membrane. The ARTERIES are of the large, medium and small size. By structure they can be elastic, mixed, or muscular. The vessel walls have 3 concentric tunics: 1) the internal tunica intima of 3 layers – endothelium, subendothelial layer of the loose connective tissue and the internal elastic membrane, 2) the middle tunica media of smooth myocytes and elastic fibers, 3) the external tunica adventitia of the loose connective tissue with nerves and vessels, and the external elastic membrane. The VEINS can be small, medium and large; by structure they are muscular and non-muscular. The microcirculatory blood stream provides metabolism and protective reactions. They include vessels less than 100 microns in diameter. They are arterioles, capillaries and venules. *Arterioles* are short, d=50–100 microns, and regulate the blood supply of organs. The wall structure is like that in arteries, but all sheaths are thin. In the tunica media myocyte bundles are circular. The adventitia has non-differentiated cells and labrocytes. *Capillaries* are from

4,5–7 to 20–40 microns in diameter. The HEART pumps blood and lymph like a pump. Its walls have 3 tunics: endocardium, myocardium, and epicardium. The myocardium and epicardium develop from the myoepicardial plate of the mesoderm visceral layer. The endocardium develops at the 3rd week from the mesenchyme, like a vessel. It consists of 4 layers: 1) the endothelium layer made of large cells on the thick basal membrane; 2) the subendothelial layer, like in the aorta, 3) the musculoelastic layer of smooth myocytes and elastic fibers; 4) the external connective tissue layer with fine vessels. The myocardium contains 3 types of cardiomyocytes: 1) contracting typical; 2)conductive atypical; 3) secretory endocrine.

Questions for self-control:

1. What organs belong to the cardiovascular system?
2. Name the tunics of the blood vessels wall.
3. What are the types of arteries by the size and structure of the wall?
4. What are the types of veins by the size and structure of the wall?
5. List the microvasculature vessels.
6. Name the heart tunics.
7. What are the types of cardiomyocytes?

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Lecture 20

Human Histology 8-9 Lymphoid system. General features of the Lymphoid system. Thymus. Lymphoid system. Lymph Nodes. Spleen.

LECTURE OUTLINE

- General features of the Lymphoid System.
- Cells of the Lymphoid System. Lymphoid nodules.
- Thymus.
- Lymph nodes.
- Spleen

LEARNING OUTCOMES

1. define the distinguishing features of the lymphoid organs.
2. define the names, locations, functions of the cells, tissues, organs of the lymphoid system.
3. identify the structure of spleen, thymus and lymph nodes in a microscopic
4. specimen.

5. recognize the cells, tissues of the thymus in micrographs.
6. recognize the cells, tissues of the lymph nodes in micrographs.
7. recognize the cells, tissues of the spleen in micrographs.

The organs of immunogenesis have a reticular stroma of the connective tissue, or reticular epithelium, and perform three functions: 1) formation of blood cells, 2) blood or lymph depot, 3) protection (as the result of phagocytosis and the formation of immune cells). There are central and peripheral organs. Central organs are red bone marrow and thymus; they contain stem cells and continuously form blood cells. The peripheral organs are spleen, lymph nodes and lymphoid formations of the mucous membranes. They do not contain stem cells but they form mature lymphocytes and plasmocytes when an antigen appears in the body. Thymus (thymus gland, T) is responsible for the cellular immunity. It performs 2 functions: 1) hematopoietic – it forms T-helpers and T-suppressors; 2)endocrine – thymic stromal cells secrete thymic hormones. When the thymus is removed, the immune system is suppressed, an infection spreads rapidly, but a transplanted tissue does not die off. The thymus develops from the ectoderm of the pharyngeal section of the gut at the 4–5th week. At the 7th week it is populated by lymphocytes. The thymus is covered with the connective tissue capsule and consists of lobes separated by the septa of interlobular connective tissue. Each lobe has a dark cortex and a light medulla. The stroma is composed of the squamous reticular epithelium. Its basal layer lies under the lobular capsule and the surface layers, in the center of the lobe. The epithelial cells with large processes are called oxyphils. The stromal epithelium secretes hormones: thymosins into the blood and thymopoietin into the thymic tissue. They activate the reproduction of lymphocytes and functions of mature lymphocytes. T-lymphocytes are called thymocytes. They lie between the stromal epithelial cells. Lymph nodes develop from mesenchyme during the 3rd month; they begin myelopoiesis. From the 4th month B-lymphocytes move into the nodes, form dark cortex and bright medulla. Then T-lymphocytes move into the nodes, myelopoiesis decreases, lymphopoiesis increases. A lymph node is bean-shaped, d=0,5–1 cm, located along the lymph vessels, covered with the connective tissue capsule, the trabeculae depart from it. There is a network of reticulum between lymph nodes. Lymphoid cells and macrophages are placed in the network hinges. Spleen performs five functions: 1) hematopoietic, 2) immune protection, 3)blood depot, 4) hemolytic, 5) absorbing iron from erythrocytes. At the 5th week of development the mesenchyme of the dorsal mesentery forms the spleen germ from the reticular tissue. Then at the 12th week macrophages and B-lymphocytes appear in the germ; they group and form follicles of the white pulp. By the 6th month the red pulp is formed between them. By the 5th month all blood cells have been formed in the spleen. After birth only lymphopoiesis takes place.
The spleen is covered with the mesothelium and has a connective tissue capsule and trabeculae with smooth muscle cells. It is a support-contractile apparatus through which the deposited blood is expelled into the general circulation. Between the trabeculae the stroma from the reticular tissue is placed. The stroma with lymphoid cells and erythrocytes forms the white and red pulp.

Questions for self-control:

1. What are the functions of the reticular stroma of haemopoietic organs?
2. What are the central and peripheral organs of haemopoiesis and immunogenesis?

3. What cells are formed in the red bone marrow?
4. What cells are formed in the thymus?
5. Name the T- and B-dependent zones in the peripheral haemopoietic organs.
6. What spleen functions do you know?
7. What zones has the spleen follicle?

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Lecture 23

Human Histology 10-11 Histology of the supporting cells of the nerve tissue (neuroglia). Histology of the Nervous System Peripheral Nervous System. Ganglia. Spinal cord

LECTURE OUTLINE

- nerve system general morphofunctional characteristic
- sources of origin
- structural and functional classification
- neuroglia – micro - and macroglia. gliocytes.
- peripheral nerve system. nerve truncs structure.
- dorsal root ganglion
- spinal cord

LEARNING OUTCOMES

1. Investigate the organs of nervous system in the specimens according to key features of structure.
2. Identify and classify the peripheral and central organs of nervous system.
3. Recognize the spinal ganglion in the specimens on the basis of key morphological features.
4. Determine the general structure of the peripheral nerve.
5. Identify the spinal cord and its horns in the specimen
6. Define the structural and functional significances of different nuclei.

The neuroglia consists of micro- and macroglia. The microgliais small macrophages with multibranch short processes. When the tissue is damaged they are involved, and the cells become ordinary macrophages (called granular spheres). The macroglia includes 3 kinds of cells:
1) ependymocytes cover the central canal of the spinal cord and brain ventricles. The cells have cilia in the apical part for the brain liquor circulation and long processes in the basal part to support the brain cells; 2) astrocytes are small cells with processes and a light nucleus, whose functions are supporting,

trophic and protective. Plasmatic astrocytes are placed in the grey matter of the brain and have short branchy processes. Fibrous astrocytes are placed in the white matter and have long smooth processes. The astrocytes contact with the capillaries by processes and form thehemato-encephalon barrier possessing selective permeability; 3) oligodendrocytes form sheaths of neurons on the periphery. Satellite gliocytes form capsules around the neuron bodies in the ganglions. Lemmocytesform Schwann sheaths around the neuron processes in the nerves. These cells carry out 5 functions: trophic, protective, phagocytosis of disintegration products, participation in the transfer of the nerve impulse and in nerve regeneration. The nerve fiber is a neuron process (the axialone), surrounded withlemmocytes which form the Schwann sheath around the process. It acts as an electrical isolator and protects the process from damages. The Schwann sheath can be myelinated and non-myelinated. Non-myelinated fibers are thin, 1–2 microns, the impulse passes slowly, 1–2 m/s. Lemmocytes cover the axial cylinder by means of their processes which close and form mesaxon (the dual membrane). Lemmocytes often form arope likethe fibers covering some axial cylinders which are separated only by a thin layer of the lemmocyte cytoplasm. So, the non-myelinated Schwann sheath does not create electrical isolation. Therefore, distribution of the nerve impulse on the neighboring fibers and its generalization are possible. The myelinated fiber is thick, up to 20 microns;there is only one axial cylinder. The lemmocyte processes grow, extend, and the mesaxon is wound spirally on the axial cylinder, forming the myelinated layer. The lemmocyte cytoplasm and thenucleus are pushed aside to the periphery forming the neurilemma. The axial cylinder and lemmocytes grow with different rates, and slanting fissures are visible in the myelinated layer. These are the sites of myelin stratification; they are called myelin clefts (Schmidt – Lantermann’sincisures). On impregnating with osmium myelin is black. The myelin layer has small parts lacking myelin where the lemmocytes connect witheach other; these parts are called Ranvier`s nodes (or nodal gaps). The myelin consists of fat (phospholipids) and creates good electrical isolation; the impulse is transferred precisely to destination. Under the myelin the acting potential cannot arise. The impulse arises only in Ranvier`s nodes jumping through the myelin. Therefore, the rate of its movement is high – 100 km/s. The structure of the nerve. The nerve consists of bundles of myelinated and non-myelinated nerve fibers. Large nerves unite many bundles of fibers and are covered with the epineurium made of the connective tissue with vessels. Each bundle of fibers is covered with dense perineurium. Inside the bundle thin fibers of theloose connective tissue with capillaries form the endoneurium. Under the perineurium there is a fissure with liquid called the perineural space. It communicates with the brain liquor and can be «the infectiongate» which can invade the brain. The spinal cord. It is developed from the body part of the neural tube and lies in the vertebral canal, connected with the periphery by 31 pairs of mixed spinal nerves. The spinal cord is a long white cord divided into two halves by the ventral median fissure and the dorsal white commissure (from pia mater and gliocytes). The ventral and dorsal roots go out from the surface of the spinal cord. The spinal cord is segmented. The segment is a part of the spinal cord with two pairs of roots. There is dark grey matter in the center (on the slice it is shaped like a butterfly). The grey matter consists of the neuron bodies forming the functional centers of the spinal cord called neural nuclei. The neuron processes form a light white matter around the grey matter. The grey matter forms short and massive anterior horns, thin and long posterior horns and an intermediate zone between them which has lateral horns in the interval between the 8th cervical and 2nd lumbar segments. The right and left halves of the grey matter are connected with the central canal lined with the ependima and containing the liquor by the grey commissure. The grey matter horns divide the white matter into 3 pairs of funiculi: ventral, lateral and dorsal.

Questions for self-control:

1. What are the nervous tissue components?
2. Describe the classification of the neuroglia.
3. What are the functions of the neuroglia?
4. What neuron types do you know?

5. What kinds of nerve fibers do you know?
6. What synapses kinds do you know?

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Lecture 27

Human Histology 12 Histology of the nervous system Central nervous system. Brain. Cortex. Cerebellum. Overview of the meninges, ventricles, cerebrospinal fluid and blood supply

LECTURE OUTLINE

- Embrionic origin, structural and functional characteristics of the central nerve system.
- Cytoarchitecture and myeloarchitecture of cerebral cortex.
- Morphofunctional characteristic of cerebral cortex neurons.
- The agranular and granular types of cerebral cortex.
- The blood – brain barrier in terms of its structural correlates and its function.

LEARNING OUTCOMES

1. Identify the layers of the cerebellar cortex.
2. Recognise the cerebellum in the specimens and slides.
3. Explain the functional peculiarities of cerebellar cortex on the basis of cellular content and relationship with other organs of the nervous system.
4. Recognise the cerebral cortex.
5. Identify the layers of the cerebral cortex.
6. Interpret the cytoarchitecture of the cerebral cortex.
7. Explain the differences between sensory and motor cortex.
8. Describe the agranular and granular types of cerebral cortex.
9. Describe the blood – brain barrier in terms of its structural correlates and its function.

The brain consists of the trunk and the pallium (both the trunk and the pallium develop from 3 brain bubbles). The trunk consists of the medulla oblongata, the pons, the mesencephalon, the thalamus and the basal ganglia of the end brain. The grey matter is placed in the center as nuclei. The pallium is composed of the cerebral and cerebellar cortex. The cerebellum. It is the main center of balance and movement coordination. It has the form of two hemispheres. On their surface the most part of the grey matter forms the cerebellar cortex with sulci and gyri, the smaller part forms nuclei in the white matter in the middle of the cerebellum. The dentate nucleus transfers the information to the cerebral cortex and to the spinal cord; other nuclei transfer the impulse to the spinal cord. The cerebellar cortex has 3 layers. The external molecular layer is light, has inhibitory neurons and neuron processes of all layers. The middle ganglionic layer consists of one layer of large efferent neurons – piriform Purkinje neurons (the size is 35–60 microns). The internal granular layer is dark; it contains synaptic complexes «Cerebellum glomeruli» and 10 billion fine neurons. There are 3 groups of them: 1 – exciting cells-grains with a large dense nucleus and little cytoplasm, 2 – inhibitory Golgi cells of the second type with a short axon, 3) associative neurons – horizontal and Golgi cells of the first type with a long axon, connect the cortex sites. 2 kinds of afferent tracts come to the cerebellum: the moss fibers from the cerebral cortex and the climbing fibers from the spinal cord and the organ of balance. The climbing fibers pass into the molecular layer, climb along the dendrites of the Purkinje cells and excite them. The moss fibers come into the granular layer and branchlike moss. They form exciting synapses with the dendrites of the cells-grains which branch like a bird's foot. These synapse complexes form «the cerebellum glomeruli». The axons of the cells-grains go from them into the molecular layer, divide like T and excite all cortex neurons. The excited inhibitory neurons take part in processing the information and inhibit the piriform Purkinje neurons. The Purkinje cells collect the information and transfer it to the cerebellum nuclei. The inhibitory neurons are of 4 kinds. 3 kinds of them lie in the molecular layer: 1 – basket neurons which form baskets around the bodies of the Purkinje cells; 2, 3 – fine and large stellate neurons which form inhibitory synapses with their dendrites. In the granular layer the 4th kind of the inhibitory neurons lies. It is Golgi cells of the 2nd type, their short axons enter the cerebellum glomeruli and inhibit the transfer of impulses from the moss fibers onto the cells-grains. Thus, they can inhibit the excitation of the Purkinje cells. Each Purkinje`s cell forms up to 60 thousand synapses. The inhibitory neurons can strengthen or block the exciting impulses, that leads to the inhibition or counter inhibition of the Purkinje cells. An intense impulse inhibits the Purkinje cells, blocks their inhibiting influence on the dentate nucleus. The nucleus neurons become excited and inhibit the pyramids of the cerebral cortex that leads to the counter inhibition of the motor neurons of the spinal cord, and a movement is made. And on the contrary, a weak impulse disinhibits the Purkinje cells, and a movement is not made. By the same principle the majority of reflexes work including the higher nervous activity. The cerebral cortex. The thickness of the cerebral cortex is 3 to 5 mm, it contains 14 to 17 billion neurons, all of them are multipolar, have different forms, pyramids prevail. They have the top and lateral dendrites, the axon passes from the basis of the cell. The pyramids can be small – 10 to 12 microns, middlesized – 20 to 30 microns, greater – 40 to 80 microns, and huge – 120 microns. New synapses are formed on the process terminals in the form of thorns and swellings, in nutritional disorder they die, but they remain near the perikaryon, that is why old men have long-term memory but no short-term memory. THE STRUCTURE. The cerebral cortex has cell- and myeloarchitectonics, or the certain arrangement of fibers and cells forming the cortical areas – the centers of the higher nervous activity. The cortical neurons lie in 6 layers: 1 – the molecular layer, external, contains fine neurons and many processes of neurons from all layers forming the tangential plexus; 2 – the external granular layer composed of fine inhibitory neurons; 3 – the pyramidal layer, the widest, pyramids are of different size. The top dendrite goes into the molecular layer, the lateral dendrites branch in their own layer and form a plexus – external Bajarge's strip, the axons form radial rays and make up the cortico-cortical and pyramidal tracts; 4 – the internal granular layer contains echinate stellate neurons, accepting excitation from the thalamo-cortical tracts; 5 – the ganglionar layer composed of huge pyramids – Besth's cells (120 microns). Their axons form the pyramidal tracts, and the lateral dendrites form the internal Bajarge's strip in the same layer; 6 – the layer of polymorphic cells, their axons compose the pyramidal ways. There are 2 types of cortex zones: 1 – granular type with well developed granular layers – the sensory zones where the higher analysis of information is performed; 2 – agranular type where pyramidal layers are well developed – these are motor zones.

Questions for self-control:

1. What functional parts does the nervous system have?
2. What organs does the central nervous system include?
3. What organs does the peripheral nervous system include?
4. What is the grey and white matter of the spinal cord?
5. What components make up the spinal ganglion?
6. Name the layers of the cerebellar cortex.
7. Name the layers of the cerebral cortex.
8. What is a structural and functional unit of the cortex?

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