

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ  
БЕЛОРУССКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ  
КАФЕДРА НОРМАЛЬНОЙ АНАТОМИИ

**Ю. А. ГУСЕВА**

# **АНАТОМИЯ НЕРВНОЙ СИСТЕМЫ И ОРГАНОВ ЧУВСТВ**

## **ANATOMY OF NERVOUS SYSTEM AND SENSORY ORGANS**

Учебно-методическое пособие



Минск БГМУ 2010

УДК 611.8/.88 (811.111) (075.8)  
ББК 56.12 (81.2 Англ – 923)  
Г 96

Рекомендовано Научно-методическим советом университета в качестве  
учебно-методического пособия 26.05.2010 г., протокол № 10

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Перевод на английский язык Ю. А. Гусевой

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Г 96     Анатомия нервной системы и органов чувств = Anatomy of nervous system and  
sensory organs : учеб.-метод. пособие / Ю. А. Гусева ; пер. на англ. яз. Ю. А. Гу-  
сева. – Минск : БГМУ, 2010. – 50 с.

ISBN 978–985–528–238–0.

Представлены материалы по изучению вопросов анатомии нервной системы и органов  
чувств по разделам «Центральная нервная система», «Органы чувств», «Периферическая  
нервная система»

Предназначено для самостоятельной работы англоязычных студентов 1-го курса  
медицинского факультета иностранных учащихся.

**УДК 611.8/.88 (811.111) (075.8)**  
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**ISBN 978–985–528–238–0**

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## Introduction

In the «Anatomy of nervous system and sensory organs» for the practical classes in Human Anatomy for the 2<sup>nd</sup> year students of the medical faculty for foreign students the following topics are presented in English: «Central Nervous System», «Sensory Organs», «Peripheral Nervous System».

In the publication the most difficult points for students understanding are given. It expands the representations about these themes. In each of considered lesson the practical recommendations facilitating mastering of the material are given. Questions for control do possible to use of the recommendations for independent preparation.

The maintenance of this work corresponds with the program and the curriculum in Human Anatomy.

The edition is possible to use by the English-speaking students and is valuable addition to the textbook.

The «Anatomy of nervous system and sensory organs» for the practical classes in Human Anatomy for the 2<sup>nd</sup> year students of the medical faculty for foreign students is composed on the basis of the «Methodical recommendations to the practical training course», 2006 (authors: S. D. Denisov, P. I. Lobko, P. G. Pivchenko, V. V. Rudenok, M. I. Bogdanova, L. A. Davydova, G. P. Dorohovich, G. E. Konopelko, L. D. Chayka, S. P. Jaroshevich). The literacy of the English text is edited under the Head of the Foreign Languages Department M. N. Petrova.

# Nervous system

## Lesson 1

**Theme:** Central Nervous System. Spinal Cord: Development, Topography. External and Internal Structure. Spinal Cord Meninges.

**Purpose of the lesson:**

- to generate the representation about the central nervous system structure, about the neurone as the structurally functional unit of the nervous system;
- to know the source and the basic stages of spinal cord development;
- to be able to tell and show the external structure of the spinal cord and its topography;
- to study the internal structure of the spinal cord;
- to know the locating of the grey matter and white matter structures, the nuclei and the fascicles of the white matter topography;
- to understand the principle of the spinal cord functioning.

**Equipment of the lesson:** a skeleton, a moulage, tables, tablets, museum preparations of the spinal cord, the atlas.

**Development of the human nervous system.** The nervous system develops from external embryonic layer (ectoderm). In the dorsal part of the germ trunk ectoderm cells form medullary (nervous) plate. The medullary plate is gradually transformed into a groove. The neural groove transforms into a tube. The walls of the nervous tube consist of the internal (inner, ependymic), the medial and the external layers. Then the ventral end of the nervous tube thickens and transforms into the cerebrum. The medial and dorsal parts of the nervous tube give rise to the spinal medulla. The spinal cord grows slower than the vertebral column. On the fourth week of the prenatal life three cerebral vesicles (anterior — prosencephalon, the middle — mesencephalon, the posterior — rhombencephalon) separated with the local narrowing of the nervous tube represent the future brain. By the end of the fourth week of development of the anterior cerebral vesicle differentiates into two sections: the future cerebrum (telencephalon) and the future intermediate brain (diencephalon). The posterior cerebral vesicle also is subdivided into the dorsal brain (metencephalon) and the medulla (medulla oblongata). So, by the sixth week of development the brain consists of five cerebral vesicles.

Cavity of the rhombencephalon is transformed into the fourth ventricle of the cerebrum. The vascular plexus of the fourth ventricle is formed by the blood vessels and ependymocytes. In the ventral part of the fourth ventricle there is the opening of the ventricular (Sylvian) aqueduct, which connects the fourth ventricle with the third ventricle of the cerebrum.

The ventral part of the middle cerebral vesicle forms the cerebral peduncles; the dorsal part forms the tectum of the mesencephalon. The lateral wall of the intermediate brain forms the thalamus. The future epiphysis is developed in the dorsal wall of the third ventricle. In the ventral wall of the third ventricle the hypophysis is formed. The cavity of the telencephalon is divided into two parts — the first and the second ventricles. The corpus callosum and the anterior commissure of the cerebrum is developed from the anterior wall of the telencephalon. In the basal region the basal nuclei are formed. Each hemisphere is divided into lobes. Sulci and gyri determinate the hemisphere relief.

**Age features of the spinal cord.** In a newborn child, the spinal cord is 13,6–14,8 cm long; its mass is 5,5 g. The lower end of the spinal cord corresponds to a level of the lower edge of the 2d-lumbar vertebra. The cervical and lumbosacral enlargements are well marked, the central canal in a newborn is wider than in adults. Then the lumen of the central canal is reduced. The volume of the grey and, especially, of the white substance increases quickly, due to the segmentation of the spinal medulla. By the age of the 10 the length of the spinal cord increases twofold as compared to the spinal cord of a newborn child.

**Recommendations.** Studying of the nervous system should be begun with the mastering of the traditional sectioning of the nervous system by the topographical and anatomo-functional principles. The understanding of the value of the neurone as the basic structural and functional unit of the nervous system is very important for the nervous system structure and functions knowledge.

At studying of the theme it is necessary to pay attention to the spinal cord topography in the vertebral canal and its segmentary structure. It is necessary to know the structure of the reflex arch and the neurones bodies locating.

On the museum preparations — to pay attention to the spinal cord enlargments, the locating of the medullary cone and the cauda equinal, the places of the input and the exit of the spinal nerves radialis, the locating of the spinal ganglions.

At studying of the internal structure of the spinal cord it is necessary to pay attention to the formation of the grey matter with the bodies of neurones and their processes, and the formation of the white matter — with the processes of the neurones covered with the white colour myelinic cover. Specify the regularities of the afferent and efferent nuclei topography. Studying of the spinal cord meninges — to pay attention to their locating concerning the spinal cord and vertebral canal, the epidural, subdural and subarachnoidal spaces formation.

## QUESTIONS FOR CONTROL

1. Give the nervous system classification by the topographical and anatomo-functional principles.
2. What does the somatic nervous system, independent (vegetative) nervous system innervate?
3. Characterise the neurone as the structural and the functional unit of the nervous system.
4. Name the basic stages of the spinal cord development in the embryogenesis.
5. Where is the spinal cord located? Where is the level of its superior and inferior borders? Why the spinal cord does not occupy completely the vertebral canal?
6. Name the spinal cord enlargements. What is their formation caused by?
7. What longitudinal excavations (fissures and sulcuses) are available on the spinal cord surface?
8. Explain the concept «a spinal cord segment»? How many segments are allocated in the spinal cord? What way are they designated?
9. Describe the grey and white matters locating in the spinal cord. What are the names of their formations on the longitudinal and horizontal cuts of the spinal cord?
10. Describe the macroscopical formations of the grey matter on the spinal cord cross-section cuts. What segments is the level of the lateral horns location?
11. What nuclei are located in the posterior, anterior and lateral horns of the spinal cord and in intermediate (grey) matter?
12. Describe the afferent and the efferent conducting pathways located in the posterior, anterior and lateral funicles.
13. Name the spinal cord meninges. Where are the epidural, subdural and subarachnoidal spaces located? What is their contents?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

***On the spinal cord tables and tablets:*** 1) the cervical enlargement; 2) the lumbosacral enlargement; 3) the medullary cone; 4) the terminal filum; 5) the anterior median fissure; 6) the posterior median sulcus; 7) the anterolateral sulcus; 8) the posterolateral sulcus; 9) the posterior intermedian sulcus; 10) the anterior radix; 11) the posterior radix; 12) the spinal ganglion; 13) the spinal nerve; 14) the spinal cord segment; 15) the anterior horn; 16) the posterior horn; 17) the lateral horn; 18) the lateral intermediate (grey) matter; 19) the central canal; 20) the anterior funicle; 21) the posterior funicle; 22) the lateral funicle; 23) the proprial fascicles (anterior, lateral and posterior; 24) the gracile fascicle; 25) the cuneate fascicle; 26) the posterior

spinocerebellar tract; 27) the anterior spinocerebellar tract; 28) the lateral spinothalamic tract; 29) the lateral corticospinal tract; 30) the rubrospinal tract; 31) the anterior spinothalamic tract; 32) the anterior corticospinal (pyramid) tract; 33) the tectospinal tract; 34) the reticulospinal tract; 35) the spinal dura mater; 36) the epidural space; 37) the arachnoid mater; 38) the subarachnoid space; 39) the spinal pia mater; 40) the denticulate ligament.

## Lesson 2

**Theme:** Brain: its Development, Parts. Metencephalon. Oblong Brain: its External and Internal Structure. Pons and Cerebellum: its External and Internal structure.

**Purpose of the lesson:**

- to generate the representation about the brain structure as a whole and about the basic stages of its development;
- to know the external and internal structure of the oblong brain, the pons and the cerebellum;
- to be able to show the macroscopical structures of the studied parts of the brain on the preparations.

**Equipment of the lesson:** the brain preparations (the whole and the sagittal cut), tablets, tables, museum preparations.

**The brains** weight in adults is 1100–2000 g. There are five parts in the brain, which are developed from five encephalic vesicles. These parts are the telencephalon, the diencephalon, the mesencephalon, the metencephalon (pons and cerebellum) and the medulla oblongata.

The cerebral hemispheres (hemisphaeriae cerebrales) represent themselves the largest and the most developed part of the cerebrum. The longitudinal cerebral fissure separates the right and left hemispheres from each other.

On the inferior surface of the brain, the right and the left olfactory bulbs, olfactory tracts, olfactory trigone may be distinguished, and behind of them — anterior perforated substance is placed. Also the optic nerves form optic chiasma. A tuber cinereum adjoins to the posterior surface of the optic chiasma. Hypophysis is situated on the infundibulum. Behind of the tuber cinereum there are two round shaped bodies — the mamillary bodies. Behind of them between the cerebral peduncles there is a interpeduncular fossa. The bottom of this fossa is formed by the posterior perforated substance. Backwards the cerebral peduncles continue as the pons of the brain. The lateral parts of the pons form the middle cerebellar peduncle. Downwards the pons the anterior part of the medulla oblongata is situated.

On the medial surface of each hemisphere the sulcus of the corpus callosum can be distinguished. The corpus callosum contains of the body, rostrum and splenium. Under the corpus callosum there is a fornix of the brain. Its anterior part — columns runs to the lamina terminalis, and then in the mamillary bodies. Between the columnae fornicis there is a anterior comissure. The posterior part of the fornix — its crura. Down from the body of the fornix and corpus callosum and behind the columnae fornicis the thalami are situated. Between the rostral end of the thalamus and column fornicis on each side interventricular foramen can be distinguished. It connects the cavity of the third ventricle and the lateral ventricle. Downwards the thalamus there is a hypothalamus. It includes the optic chiasma, tuber cinereum, infundibulum and mamillary body. The thalamencephalon consists of thalamus, epithalamus and metathalamus. The cavity of the thalamencephalon and hypothalamus is third ventricle. The cavity of the pons, cerebellum and the medulla oblongata is the fourth ventricle. Its floor is formed by pons and medulla oblongata and is known as the rhomboid fossa.

**Recommendations.** First of all, it is necessary to make the accurate representation about the sequence of the brain parts as continuations of the spinal cord and about the formations united by the name «the trunk of the brain». At studying of the brain development it is necessary to pay attention to the development source, sequence of the nervous tube head department transformation (the stage of three and five cerebral bubbles, formation of the definitive brain departments, transformation of the cavity of bubbles).

Studying of the oblong brain, the pons and cerebellum is spent under the general scheme: the definition of the localisation, borders, studying of the macroscopical structure. Studying the internal structure of the oblong brain, the pons and the cerebellum, it is required to remember the names and the locating of nuclei, the reticular formation, fascicles of the ascending (sensitive) and descending (motor) nervous fibers.

#### QUESTIONS FOR CONTROL

1. Name: a) the source of brain development, b) the formations at the stage of three and five cerebral bubbles, c) the final structures, originated from the cerebral bubbles walls and cavity.
2. What parts does the brain consist of? What parts does the brain trunk include?
3. Name the borders of the oblong brain on its ventral and dorsal surfaces.
4. Name sulcuses of the oblong brain.
5. Name and show the visible formations on the ventral and dorsal surfaces of the oblong brain.
6. Describe the internal structure of the oblong brain.



7. What cranial nerves nuclei are located in the oblong brain?
8. Name the ascending and descending conducting pathways located in the oblong brain.
9. Describe the borders of the pons, its ventral and dorsal surface.
10. On what parts does the trapezoid body divide the pons?
11. What formations is the grey matter of the pons presented by? What cranial nerves nuclei are located in the pons?
12. What fibers pass in the dorsal and ventral parts of the pons?
13. Describe the external structure of the cerebellum.
14. Name the cerebellum peduncles, their direction and formations connected with them.
15. List cerebellum nuclei.
16. Name and show the cavity of the rhombencephalon.

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

***On the preparations of the whole brain and on the sagittal brain cut:***

- 1) the oblong brain; 2) the pons; 3) the cerebellum; 4) the mesencephalon;
- 5) the intermediate brain; 6) the telencephalon; 7) the metencephalon;
- 8) the brain trunk.

***On the preparations and tables of the oblong brain:*** 1) the borders of the oblong brain; 2) the anterior median fissura; 3) the anterolateral sulcus; 4) the posterolateral sulcus; 5) the posterior median sulcus; 6) the pyramid; 7) the decussation of the pyramids; 8) the oliva; 9) the gracile fascicle; 10) the cuneate fascicle; 11) the gracile tubercle; 12) the cuneate tubercle; 13) the medullar strias of the fourth ventricle; 14) the olivar nucleus; 15) the nuclei of the IX, X, XI, XII pairs cranial nerves; 16) the reticular formation; 17) the medial loop; 18) the corticospinal tract; 19) the inferior peduncles of the cerebellum.

***On the preparations and tables of the pons:*** 1) the pons borders; 2) the ventral and dorsal surfaces of the pons; 3) the basilar sulcus; 4) the trapezoid body; 5) the trapezoid body nuclei; 6) the pons nuclei; 7) the nuclei of the V, VI, VII, VIII pairs of cranial nerves; 8) the reticular formation; 9) the medial loop; 10) the spinal loop; 11) the cortico-nuclear fibers; 12) the corticopontine fibers.

***On the preparations and tables of the cerebellum:*** 1) the ventral and dorsal surfaces; 2) the horizontal fissura; 3) the cerebellum hemispheres; 4) the cerebellum vermis; 5) the fissuras of the cerebellum; 6) the cerebellum leaves; 7) the flocculus; 8) the nodule; 9) the superior, the inferior and the middle peduncles of the cerebellum; 10) the cerebellum cortex; 11) the cerebellum nuclei: the dentate, the emboliform, the globose, the fastigial.

### Lesson 3

**Theme:** Fourth Ventricle. Rhomboid Fossa. Projection of Cranial Nerves Nuclei on the Rhomboid Fossa.

**Purpose of the lesson:**

- to study the structure of the fourth ventricle and the rhomboid fossa;
- to know and to be able to show the projection of the cranial nerves nuclei on the rhomboid fossa.

**Equipment of the lesson:** the brain preparations, tablets, tables, museum preparations.

**The fourth ventricle** is a cavity of derivatives of the rhomboid brain, a cavity of the pons and the medulla oblongata. The bottom of this ventricle is rhomboid fossa. Its formed by the dorsal surface of the pons and the medulla oblongata, divided by the medullary stria of the IV ventricle. The roof of the fourth ventricle is formed by the superior and inferior medullary velum. The choroids membrane adjoins the inferior medullary velum internally. Three apertures (median aperture and two lateral aperture) lead from the fourth ventricle to the subarachnoid space of the cerebrum.

**The rhomboid fossa** is limited by the superior and inferior cerebellar peduncles. It posteroinferior angle leads into the central canal of the spinal cord, and anterosuperior — into the aqueduct of the brain. There are also lateral recesses in the lateral parts of this fossa. Laterally of the median sulcus there is a medial eminence. In the upper part of this eminence there is a small facial colliculus. In the lower part of the rhomboid fossa there are two trigones: trigone of the vagus nerve and trigone of the hypoglossal nerve.

The nuclei of the V–XII pairs of cranial nerves are projected on the rhomboid fossa.

The trigeminus has the following nuclei: the motor nucleus, the sensitive nucleus (its divided into pontine, spinal, mesencephalic nuclei).

The abducent nerve has one motor nucleus (n. nervi abducentis), located in the genu of the facial nerve.

The facial nerve has the motor nucleus (n. nervi facialis), the sensitive solitary nucleus (n. tractus solitarii), the vegetative superior salivatory nucleus (n. salivatorius superior) and lacrimal nucleus.

The vestibulocochlear nerve has two groups of nuclei: cochlear (ventral and dorsal) and vestibular (medial, lateral, superior, inferior).

The glossopharyngeal nerve has three nuclei: the motor (n. ambiguus), the sensitive (n. tractus solitarii) and vegetative (n. salivatorius inferior).

The vagus nerve has three nuclei: the motor ambiguus nucleus (common for the IX,X,XI pair), the sensitive solitary nucleus (common for VII,IX pairs), the parasympathetic dorsal nucleus.

The accessory nerve has one motor nucleus (n. nerve accessorii).  
The hypoglossal nerve has one motor nucleus (n. nerve hypoglossi).

**Recommendations.** At studying of the fourth ventricle first of all it is necessary to examine it on the sagittal brain section; to pay attention to the formations of its roof; to describe the rhomboid fossa — its localisation, borders, the macroscopical structure — on the horizontal section of the metencephalon. At studying of the rhomboid fossa grey matter topography it is necessary to pay attention to the general principle of the cranial nerves nuclei projection (motor, sensitive, vegetative) on the fundus of the fourth ventricle.

#### QUESTIONS FOR CONTROL

1. What structures form the roof of the IV ventricle?
2. What apertures are in the roof of the fourth ventricle located? Specify their appointment.
3. What is the fundus of the fourth ventricle?
4. What structures limit the rhomboid fossa?
5. What eminences and excavations are on the surface of the rhomboid fossa?
6. What cranial nerves nuclei are projected on the rhomboid fossa?
7. What nuclei (motor, sensitive, vegetative) occupy in the rhomboid fossa: the lateral position; medial position?
8. Why are the lateral angles of the rhomboid fossa called the vestibular areas?
9. With what liquor-containing spaces and what way is the fourth ventricle connected?
10. List the nuclei of the V-XII pairs of the cranial nerves. What of them are: motor, sensitive, vegetative?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

**On the brain preparations, moulages, tablets and tables:** 1) the fourth ventricle; 2) the roof of the fourth ventricle; 3) the superior medullar velum; 4) the rhomboid fossa; 5) the superior and inferior cerebellar peduncles; 6) the median sulcus; 7) the facial tubercle; 8) the hypoglossal and vagus nerves triangles; 9) the medial eminence; 10) the vestibular area; 11) the cerebral strias; 12) the lateral recessus.

## Lesson 4

**Theme:** Midbrain (Mesencephalon): its External and Internal Structure. Aqueduct of the Mesencephalon. Rhombencephalon Isthmus. Intermediate Brain: its External and Internal Structure. Third Ventricle.

**Purpose of the lesson:**

- to study the external and internal structure of the midbrain and intermediate brain;
- to know the value of the basic structures which are the parts of these departments of the brain.

**Equipment of the lesson:** the brain preparations, tablets, tables, museum preparations.

**The midbrain** includes a tectum of the midbrain (consisting of four elevations — colliculus superior and colliculus inferior) and peduncles of the cerebrum; the space of the midbrain is aqueduct of the brain. On the transversal section there are the following parts of the midbrain: tectal plate (lamina tecti), tegmentum and base of peduncle (basis pedunculi cerebri). There are subcortical centers of vision and hearing (tr. tectospinalis) in the tectal plate. There are red nuclei, nuclei of the III and IV pairs of cranial nerves, reticular formation in the tegmentum, the ascendant conducting ways (medial loop and lateral loop), some centers of the extrapyramidal system (substantia nigra) are also embedded in it. Corticospinal, corticonuclear, corticopontinus tracts pass the base of cerebral peduncle.

**The intermediate brain** (diencephalon) is situated under hemispheres of the telencephalon. It is divided into thalamencephalon and hypothalamus. Thalamencephalon consists of thalamus, epithalamus (it includes habenulae, trigone of the habenulae, the pineal gland, the habenular commissure, the posterior commissure) and metathalamus (it consists of medial and lateral geniculate bodies).

**The third ventricle** is a cavity of the diencephalon. Its lateral wall is formed of the medial surfaces of thalamus, inferior surface — is the dorsal surface of hypothalamus, anterior wall — is the lamina terminalis and the columns of the fornix and anterior commissure, superior wall — is corpus callosum and its posterior wall — is epithalamus. The third ventricle is connected with the lateral ventricles and cerebral aqueduct.

**Recommendations.** Studying of the midbrain and oblong brain is spent under the general scheme: the definition of the localisation, the borders, the studying of the macroscopical structure. At studying of the midbrain and intermediate brain it is necessary to examine their structures on the sagittal and horizontal sections of the brain, on the basal surface of the brain; the internal

structure is examined on the cross-section sections of the brain. List the structures which are the part of the isthmus of the rhombencephalon. Survey the third ventricle walls and its connections with the lateral and the fourth ventricles of the brain.

### QUESTIONS FOR CONTROL

1. What anatomic formations are the parts of the mesencephalon?
2. What is mesencephalon roof? What structures are included into its structure? Name the function of the superior and inferior colliculus.
3. What are the cerebral peduncles? On what parts are they divided?
4. List the nuclei of the grey matter of the mesencephalon. Where are they located what are their functions?
5. What is the aqueductus of the mesencephalon? What cavities does it connect?
6. What way are the motor and sensitive nuclei distributed in the white matter of the mesencephalon?
7. What is the rhombencephalon isthmus? Name its structures.
8. What parts of the brain are the parts of the intermediate brain?
9. What anatomic formations are the parts of the thalamic brain? Specify the value of each of them.
10. What anatomic formations are the hypothalamus?
11. What is the hypothalamo-hypophysial system? Name its structures and their value.
12. What structures form the walls of the III ventricle? What apertures connect its cavity with other ventricles?
13. What internal secretion glands are the part of the intermediate brain? Specify their hormones value.

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

***On the brain preparations, moulages, tablets and tables:*** 1) the superior and inferior colliculus; 2) the brachium of the superior and inferior colliculus; 3) the cerebral peduncles; 4) the interpeduncular fossa, the posterior perforated substance; 5) the black substance; 6) the tegmentum of the mesencephalon; 7) the basis of the cerebral peduncles; 8) the aqueductus of the mesencephalon; 9) the superior cerebellar peduncles, 10) the superior cerebral velum; 11) the lemniscus triangle; 12) the thalamus, its anterior tubercle and pillow; the medial and superior surfaces, the medullar strias; 13) the interthalamical adhesion; 14) the triangle of the habenula, the habenula, the habenular commissurae; 15) the pineal body; 16) the medial and lateral geniculate bodies; 17) the optic chiasm; 18) the optic tracts; 19) the grey tuber, infundibulum, the pituitary body; 20) the mastoid bodies; 21) the third ventricle.

## Lesson 5

**Theme:** Telencephalon: Grooves and Gyruzes of Superio-lateral, Medial and Inferior Surfaces of the Hemispheres. Localisation of the Functions in the Cortex of the Brain Hemispheres. Olfactory Brain.

**Purpose of the lesson:**

- to study the location of the brain hemispheres grooves and gyruzes, the formations of the olfactory brain;
- to be able to show these formations on the preparations, tables, tablets;
- to know the location of the functions in the cortex of hemispheres.

**Equipment of the lesson:** the brain preparations, tablets, tables, museum preparations.

**The telencephalon** consists of two hemispheres separated by the longitudinal cerebral fissure. The corpus callosum, the anterior and the posterior commissures and the commissure of the fornix connect both hemispheres. The cavity of the telencephalon is lateral ventricles. There are superio-lateral, medial and inferior surfaces of the hemispheres. In the cortex of the postcentral gyrus there is the cortical analysator of general sensibility, the cortical motor center is in the precentral gyrus, the nucleus of the acoustic analysator is in the superior temporal gyrus, the nucleus of the olfactory analysator — in the uncus, the visual — is around of calcarine sulcus.

**The olfactory brain** consists of central (gyrus fornicatus, hippocampus, gyrus dentatus, uncus) and peripheral (olfactory bulb, olfactory tract, olfactory triangle, anterior perforated substance) parts.

**Recommendations.** Studying of the grooves and gyruzes of the telencephalon cortex should be begun with the main, constant grooves which are the natural borders between the lobes of hemispheres — frontal, parietal, temporal; then it is possible to start treating of the grooves and gyruzes in each lobe. At studying of the gyruzes of the basal surface it is necessary to notice, that the border between the lateral occipitotemporal gyrus and the inferior temporal gyrus is the inferior (inferio-lateral) edge of hemispheres.

### QUESTIONS FOR CONTROL

1. Describe the general plan of the telencephalon structure: the grey and white matter location, the cavity.
2. What are the surfaces of the hemispheres, their edges and poles?
3. List the lobes of the hemispheres cortex. What grooves are differentiated on the frontal, parietal, temporal, occipital lobes of the hemispheres surface?
4. Where are the nuclei of the cortical ends of the following analysators localised:
  - 1) the general and proprioceptive sensitivity;

- 2) the motor analysator;
  - 3) the acoustic analysator;
  - 4) the visual analysator;
  - 5) the olfactory and gustatory analysators?
5. What functional disorders arise at the lesion of the hemispheres cortex in the calcarine groove area?
6. What structures are the part of the olfactory brain?
7. What is the limbic system of the brain? What structures of the telencephalon are included into its structure? Specify the value of the limbic system.

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

***On the brain preparations and tables:*** 1) the olfactory brain formations: the olfactory bulb, the olfactory tract, the olfactory triangle, the anterior perforated substance; 2) the hemispheres; 3) the longitudinal fissure of the big brain; 4) the transverse fissure of the big brain; 5) the frontal pole; 6) the occipital pole; 7) the temporal pole; 8) the superior (superiomedial) edge; 9) the inferior (inferiolateral) edge; 10) the medial (inferiomedial) edge; 11) the superiolateral surface of the hemisphere; 12) the medial surface of the hemisphere; 13) the inferior surface of the hemisphere.

***The superiolateral surface of the hemisphere:*** 1) the frontal lobe; 2) the parietal lobe; 3) the temporal lobe; 4) the occipital lobe; 5) the islet; 6) the central groove; 7) the lateral groove; 8) the precentral groove; 9) the superior frontal groove; 10) the inferior frontal groove; 11) the precentral gyrus; 12) the superior frontal gyrus; 13) the medial frontal gyrus; 14) the inferior frontal gyrus; 15) the parietooccipital groove; 16) the postcentral groove; 17) the intraparietal groove; 18) the postcentral gyrus; 19) the superior parietal lobe; 20) the inferior parietal lobe; 21) the transverse occipital groove; 22) the lateral groove; 23) the superior temporal groove; 24) the inferior temporal groove; 25) the superior temporal gyrus; 26) the medial temporal gyrus; 27) the inferior temporal gyrus.

***The medial surface of the hemisphere:*** 1) the corpus colosum groove; 2) the hippocampus groove; 3) the cingular groove; 4) the subparietal groove; 5) the calcarine groove; 6) the cingular gyrus; 7) the isthmus of the cingular gyrus; 8) the parahippocampal gyrus; 9) the superior frontal gyrus; 10) the paracentral lobe; 11) the precuneus; 12) the cuneus; 13) the lingual gyrus.

***The inferior surface of the hemisphere:*** 1) the olfactory groove; 2) the direct gyrus; 3) orbital grooves; 4) the orbital gyruses; 5) the occipitotemporal groove; 6) the lateral occipitotemporal gyrus;

7) the medial occipitotemporal gyrus; 8) the lingual gyrus; 9) the nasal groove; 10) the parahippocampal gyrus; 11) the uncus; 12) the fornicatus gyrus.

## Lesson 6

**Theme:** Lateral Ventricles. Basal Nuclei and White Matter of the Telencephalon.

**Purpose of the lesson:**

- to study the lateral ventricles structure;
- to study the structure, topography and the basal nuclei value;
- to study the white matter of hemispheres: the associative, the commissural and projective fibers.

**Equipment of the lesson:** the brain preparations, tablets, tables, museum preparations.

In each **lateral ventricle** there are anterior, posterior, inferior horns and central part. The central part is formed by corpus callosum superiorly, body of the caudate nucleus inferiorly, the body of fornix medially. The anterior horn is formed by septum pellucidum medially, caput nuclei caudate laterally and inferiorly, corpus callosum superiorly, anteriorly and inferiorly. The inferior horn is formed by hippocampus medially, and white matter of the brain from other sides. The posterior horn is formed by tapetum.

**The basal nuclei** are the following nuclei: corpus striatum (consists of the caudate nucleus and the lentiform nucleus), claustrum, amigdaloid body.

**Recommendations.** For the lateral ventricles treating — to use the horizontal and sagittal brain sections. At studying of the material — to pay attention to the ventricles parts, locations of each of them, ventricles walls and to the interventricular foramens. The basal nuclei are examined on the horizontal sections of the brain. It is necessary to pay attention to their name, the topography and the value. At studying of white matter of hemispheres — to consider the associative, commissural and projective fibers, to pay attention to the internal capsule, the corpus collosum, the fornix.

### QUESTIONS FOR CONTROL

1. How many lateral ventricles are in the telencephalon?
2. What parts does the lateral ventricle consist of? What structures can be seen on its walls? What is its roof formed?
3. 3 Where is the vascular plexus of the lateral ventricle located? What is its value?
4. What apertures are the lateral ventricle connected with the third ventricle by?



5. What are the basal nuclei of the telencephalon? List them.
6. Name the functions of the basal nuclei.
7. What structures are the parts of the striopallidal system? What is its value?
8. What groups of fibers are distinguished in the white matter of the telencephalon?
9. What does it mean — the associative, commissural and projective fibers?
10. What is the corpus collosum? What parts are distinguished in it?
11. What is the internal capsule? What parts are distinguished in it?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

***On the brain preparations, moulages, tablets and tables:*** 1) the lateral ventricles and their parts; 2) the interventricular foramens; 3) the vascular plexus of the lateral ventricles; 4) the caudate nucleus; 5) the lentiform nucleus; 6) the claustrum; 7) the internal capsule, the external capsule and the extremal capsule; 8) the islet cortex; 9) the corpus collosum and its parts; 10) the fornix, the fornix columns and crus; 11) the calcarine spur; 12) the hippocampus; 13) the collateral eminence; 14) the tapetum, 5) the terminal stria.

## Lesson 7

**Theme:** Meninges of the Brain. Cerebrospinal Fluid: its Formation and Outflow Ways. Places of the Cranial Nerves Outcoming on the Basis of the Brain and their Outcoming (Incoming) from the Skull Cavity.

**Purpose of the lesson:**

- to study the structure and location of the cerebral dura mater, the arachnoid mater and the pia mater;
- to know the intermeningeal spaces, their names and their contents;
- to study the places of formation and the outflow ways of the cerebrospinal fluid;
- to know and to be able to show the places of the cranial nerves outcoming on the basis of the brain and their outcoming (incoming) from the skull cavity.

**Equipment of the lesson:** the brain preparations, a skull, tablets, tables, museum preparations.

The brain is enveloped by three **meninges** (membranes): the dura mater, the arachnoid mater and the pia mater. The dura mater forms four septa that partially divide the cranial cavity into subdivisions. These septa are falx cerebri, tentorium cerebelli, falx cerebelli and the diaphragma sellae.

The dura mater contains several reservoirs collecting blood from the brain — sinuses of the dura mater: the transverse, sigmoid, superior sagittal, inferior sagittal, occipital, cavernous, intercavernous, sphenoparietal, rectus, superior and inferior petrosal sinuses. Blood drains from the sinuses into the internal jugular vein, vertebral venous plexuses and superficial veins of head.

The epidural space is absent. The subdural space contains serous fluid. The subarachnoid space forms cisterns: the cerebello-medullary, interpeduncular, prechiasmatic cisterns and the cistern of the lateral fossa. The subarachnoid space is connected with the ventricles of the brain by three openings: the median aperture and two lateral apertures of the roof of the fourth ventricle.

**Cerebrospinal fluid** is secreted into the ventricles of brain by the choroid plexuses; it injected into the subarachnoid space passes into the arachnoid granulations and their villi and thence into the venous sinuses of the dura by osmosis.

**Recommendations.** For the cerebral meninges studying — to use the sagittal cuts of the skull with the saved cerebral dura mater, and also museum preparations and moulages. At studying of the cerebral dura mater — to pay attention to its processes, sinuses, their structure and value. At studying of the arachnoid mater — to pay attention to its location, prominences, subarachnoid space and the cisterns. It is necessary to repeat the cranial nerves, to study the places of their outcoming on the basis of the brain, and the corresponding apertures, fissuras, canals on the basis of the skull.

#### QUESTIONS FOR CONTROL

1. Name the meninges of the brain.
2. Name the processes of the cerebral dura mater. Describe the locating of each of them concerning of the brain parts.
3. Name the sinuses of the cerebral dura mater. Where does each sinus fall in?
4. What is the subarachnoid space of the brain, the cisterns? Where is each cistern located?
5. Where is the cerebrospinal fluid formed and what way does it arrive in the subarachnoid space? Where does it flow off from the subarachnoid space?
6. What function is the arachnoid mater granulations carried out?
7. Name the places of the I–XII pairs cranial nerves outcoming (incoming) on the basis of the brain.
8. Name the places of the I–XII pairs cranial nerves outcoming (incoming) from the skull cavity.

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

1) the cerebral dura mater; 2) the falx cerebri, the cerebellar falx; 3) the cerebellar tentorium; 4) the diaphragm sellae; 5) the superior sagittal sinus; 6) the inferior sagittal sinus; 7) the straight sinus; 8) the transverse sinus; 9) the sigmoid sinus; 10) the cavernous sinus; 11) the superior and inferior petrous sinus; 12) the arachnoid mater; 13) the arachnoid mater granulations; 14) the pia mater; 15) the subarachnoid space of the brain; 16) the cerebello-medullary cistern; 17) the cistern of the lateral fossa; 18) the optic chiasmatis cistern; 19) the interpeduncular cistern; 20) the places of the I–XII pairs cranial nerves outcoming (incoming) on the basis of the brain; 21) the places of the I–XII pairs cranial nerves outcoming (incoming) from the skull cavity.

## **Lesson 8**

**Theme:** Conductive Tracts of the Brain and Spinal Cord.

**Purpose of the lesson:**

- to make the integrated representation about the conductive tracts of the sensitive and motor signals in the central nervous system;
- to study the conductive tracts of the painful, temperature and tactile sensitivity, proprioceptive sensitivity of cortical and cerebellar directions;
- to study the motor conductive tracts: the corticonuclear, the lateral and anterior corticospinal, the rubrospinal.

**Equipment of the lesson:** the brain preparations, tablets, tables, museum preparations head and a spinal cord.

**Conductive tracts** are the fascicles of nerve fibres, that are situated in a certain place in the grey and white matters of the brain and the spinal cord and they connect different functional centers of the central nervous system and conduct the same for every fibres impulses.

There are association, commissural and projection fibres.

Association fibres connect different functional centers within the same hemisphere. They are of two kinds: short and long association fibres. Short association fibers connect different parts of the grey substance within the same lobe of the brain (arcuate fibers). Long association fibers connect the grey substance of different lobes of the same hemisphere (the superior longitudinal fascicle, the inferior longitudinal fascicle, the uncinata fascicle).

Commissural fibres connect analogous centers of the right and left halves of the brain (the corpus callosum, the anterior and posterior commissures).

Projection fibres connect different nucleuses of the spinal cord with the brain; nuclei of the truncus cerebri with the cerebral cortex, the basal nuclei with nucleuses of the cerebral truncus and the spinal cord. They include

ascending and descending tracts. The ascending tracts convey nerve impulses from the spinal cord and cerebral trunci to the cerebral and cortical centers. They are divided into exteroceptive, proprioceptive and interoceptive. Descending tracts conduct impulses from the cortex, subcortical centers, and nuclei of the brainstem to the motor nuclei of the trunci of cerebrum and the spinal cord.

**Recommendations.** Studying of the conductive tracts of the central nervous system should be begun with the repetition of the reflex arch structure. At studying of the sensitive conductive tracts — to pay attention on the location of the 1<sup>st</sup> neurone, the course of its peripheric and central processus, the location of the 2<sup>nd</sup>, 3<sup>rd</sup> neurones, the course of their fibers, the place of localisation of the cortical end of the analysator. At studying of the motor conductive tracts — to pay attention on the location of the 1<sup>st</sup> neurone of the conductive tract, the course of its fibers, the location of the 2<sup>nd</sup> neurone and the course of its fibers.

### QUESTIONS FOR CONTROL

1. What is the conductive tracts of the brain and of the spinal cord? What groups of the conductive tracts are distinguished?
2. What are the associative tracts? Give the examples of these ways.
3. What are the commissural tracts? Give the examples of these ways.
4. What are the projective tracts? On what groups are they divided?
5. What are the conductive sensitive tracts spending impulses from the environment, internal space, from the muscles, tendons, joints, ligaments called?
6. Where do the conductive tracts of the dermal sensitivity begin and finish? In what parts of the central nervous system are the neurones of these tracts located?
7. Where do the proprioceptive tracts of the cortical direction begin and finish? In what departments of the central nervous system are the neurones of these ways? Where is the decussation of these ways?
8. What does it mean — the medial loop?
9. Where do the proprioceptive tracts of the cerebellar direction begin and finish? Where are the neurones of these ways located?
10. List the descending conductive tracts. What impulses do they spend?
11. Where does the pyramidal tract begin and finish? In what parts of the central nervous system there is a decussation of the lateral and anterior pyramidal tracts?
12. Where does the corticonuclear tract begin and finish?
13. What tracts are the extrapyramidal tracts? What function do they carry out?
14. Where does the rubrospinal tract begin and finish?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

**On the tables:** the locations of the neurones and the course of each of the studied conductive tract fibers.

## Lesson 9

**Theme:** Sensory Organs. General Integument. Skin, the Derivative Skins. Visual Organ: Structure of the Eyeball.

**Purpose of the lesson:**

- to generate the general representations about the sensory organs — their value, communication with the central nervous system;
- to study the structure and functions of the skin and its derivatives — the hair, fingernails, sebaceous glands, sweat glands and mammary gland;
- to study the eyeball structure: its covers and the eye nucleus.

**Equipment of the lesson:** the wet preparation of the bull eye, the table, tablets, museum preparations.

**Esthesiology** — the doctrine about the sensory organs.

The sensory organs or analysators are instruments by means of which the nervous system receives impulses from the environment as well as from the organs and perceives these stimuli in the form of sensation. Every analysator consists of three parts:

- the receptor which changes the energy of the stimulus into a nervous process;
- the conductor which conveys the nervous excitation;
- the cortical part of the analyser where the excitation is perceived as a sensation.

Sensory receptors can be classified according to their location: exteroceptors, proprioceptors, interoceptors.

The sensory organs include the visual apparatus, the auditory and vestibular apparatus, the organ of smell, the organ of taste and the integument.

**Recommendations.** First of all at studying of the sensory organs, it is necessary to understand, that all sense organs carry out the role of the peripheric link of the analysator, i. e. perceive the external influence and transform it to the nervous impulse which arrives in the corresponding nervous centre by the conductive tracts. At skin studying it is necessary to pay attention to its functions, to the epidermis and derma structure. Studying of the skins derivative, it is necessary to examine the basic details of the structure of the hair; the fingernail; the sebaceous, sweat and mammary glands on the tables, tablets, drawings in the atlas. Having studied the skin structure, it is

expedient to recollect ways of carrying out of the painful, temperature and tactile sensitivity from the skin. Eye studying — to begin with treating of the general plan of its structure, to study the eyeball: its poles, the axis of the myopic and hypermetropic people. Study the covers of the eyeball, their part, feature of the structure and value of each of them. Study the internal part of the eyeball: the chambers, the lens, the vitreous body.

### QUESTIONS FOR CONTROL

1. What anatomic formations are called the sensory organs?
2. Name the skin layers. What structures form the skin drawing (crests and grooves)?
3. List the skin appendages. Name the hair and fingernail parts.
4. Name the skin glands. Where are (in what places) the ducts of the skin glands opened?
5. Describe the mammary gland structure. What is the lactiferous sine and how it is settled down in relation to the mammary gland lobes?
6. Describe the general plan of the visual organ structure.
7. Name the poles of the eyeball, the eyeball axis. What are the external and internal axes of the eyeball? Specify the norm sizes of the internal axes of the eyeball, in the myopic and hypermetropic eyes.
8. The fibrous tunic of the eyeball: its structure, parts, value of each of them.
9. The vascular tunic of the eyeball: its structure, parts, value of each of them.
10. What is the pupil? Name the muscles changing the size of the pupil.
11. The internal tunic of the eyeball: its layers, parts, features of their structure. What is the blind spot and the central fossa of the retina?
12. What formations are concerned to the refractive spaces of the eyeball?
13. The aqueous humor of the eyeball: its value, the place of the formation, the outflow tract. Why in the case of the mydriasis caused by the atropine use, the ophthalmotonus rising is possible?
14. What is the accommodation? What way is it carried out? Why does the accommodation decrease with the years?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

***On the eye preparations, moulages, tablets:*** 1) the eyeball; 2) the optic nerve; 3) the fibrous tunic, the sclera, the cornea; 4) the vascular tunic, the choroids, the ciliary body, the iris; 5) the internal tunic of the eyeball; 6) the vitreous body; 7) the lens, the zonula ciliaris; 8) the eyeball chambers, the iridocorneal angle.

## Lesson 10

**Theme:** Accessory Visual Organs. Conductive Tract of the Optic Analysator.

**Purpose of the lesson:**

- to study the structure of the accessory visual organs: the orbit muscles and fascias, eyelids, the conjunctiva, the lacrimal apparatus;
- to study the conductive tract of the optic analysator.

**Equipment of the lesson:** the wet preparation of the bull eye, the table, tablets, museum preparations.

**The accessory visual apparatus** includes the extraocular muscles, faciae, eyebrows, eyelids, conjunctiva and lacrimal apparatus.

The extraocular muscles include an elevator of the upper eyelid, four recti (superior, inferior, medial and lateral) and two oblique muscles (superior and inferior), orbital muscle. The orbital muscle is located in the inferior orbital fissure and influences on the position of the eyeball in the orbit (the increased tonus of this muscle — exophthalmos, the decreased tonus — enophthalmos; and it influences on the outflow of the venous blood from orbit).

The lacrimal apparatus comprises the main lacrimal gland and accessory lacrimal glands; lacrimal lake, lacrimal canaliculi, lacrimal sac, nasolacrimal duct.

The conductive tract of the optic analysator consists of four neurons and their fibers. The first neuron — the bodies of rods and cones of retina, the second — bipolar cells of retina, the third — gangliose cells of retina. The nerve fibers of gangliose cells of retina form optic nerve. It has four parts: intrascleral, intraorbital, intracanal, intracranial. Both optic nerves make optic chiasma. Then the nerve fibers are called the optic tract. Each optic tract reaches the subcortical visual centers (the fourth neuron): pulvinar of thalami, lateral geniculate body, superior colliculus of the midbrain. The axons of neurons of pulvinar of thalami and lateral geniculate body go to the occipital lobe (the calcarine sulcus). The reflex pathway proceeds from the retina to the superior colliculus of the midbrain (unconscious movements of the eye).

**Recommendations.** At studying of the accessory visual organs:

- to pay attention to the protective function of the orbit fascias, of the conjunctiva and the lacrimal apparatus;
- to study the locating, places of the beginning and the attachment of the eyeball muscles, their function;
- to study the conductive tract of the optic analysator.

## QUESTIONS FOR CONTROL

1. Name the eyeball muscles. Specify their beginning, the attachment and functions.
2. List the formations located in the orbit behind of the eyeball.
3. What are the eyelids? What muscles provide the movements of the eyelids?
4. What is the conjunctiva, fornixes of the conjunctiva, the conjunctival sac?
5. List all formations of the lacrimal apparatus. Where is each of them located?
6. Tell about the conductive tract of the optic analyser.

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

*On the eye preparations, moulages, tablets:* 1) the eyeball muscles; 2) the eyelids; 3) the lacrimal gland; 4) the lacrimal stream; 5) the lacrimal lake; 6) the lacrimal canaliculus; 7) the lacrimal sac; 8) the nasolacrimal duct; 9) the fornixes of the conjunctiva.

## Lesson 11

**Theme:** Organ of Hearing and Gravitation. External and Middle Ear.

**Purpose of the lesson:**

- to generate the representation about the general plan of the hearing and gravitation organ structure;
- to study the structure of the external ear and middle ear, the structure and value of their anatomic formations.

**Equipment of the lesson:** the skull, the temporal bone, the wet preparation of the external ear, moulages, tablets, tables, the atlas, museum preparations.

**The external ear** comprises the auricle and the external acoustic meatus. The auricle projects from the side of the head to collect sound waves.

The external acoustic meatus leads inwards from the auricle to conduct vibrations to the tympanic membrane. It has cartilaginous and osseous parts. It contacts with temporomandibular joint anteriorly, parotid gland inferiorly, base of the skull superiorly and mastoid process — posteriorly. The tympanic membrane is located at the junctions of the external and middle ear.

**The middle ear** consists of tympanic cavity (it contains a train of movable ossicles and two muscles) and the auditory tube through which it communicates with the nasopharynx. Six walls are distinguished in the tympanic cavity: tegmental, jugular, membranous, labyrinthic, carotid and mastoid walls.



A chain of ossicles (malleus, incus, stapes) transfers sound waves across the tympanic cavity from the tympanic membrane to the fenestra vestibule.

**Recommendations.** It is necessary:

- to study the general plan of the hearing and gravitation organ structure, pay attention to its sectioning on three parts bounded anatomically and functionally: the external, the middle ear and the internal ear;
- to study the external ear: the structure and value of the auricle and the external acoustic meatus;
- to pay attention to the structure, the locating and the value of the tympanic membrane;
- to study the middle ear: the tympanic cavity — the walls, the structure of the ossicles and their bonds, the middle ear muscles; the auditory tube — the structure and the parts;
- to pay attention to the value of their formations which are the parts of the middle ear;
- to learn to show the studied formations on the anatomic preparations, moulages, tablets.

#### QUESTIONS FOR CONTROL

1. What parts does the ear consist of?
2. What formations does the external ear include? Specify the functions of each of them.
3. What is the auricle?
4. Name the acoustic meatus parts. Specify its direction, features of the skin structure.
5. What is the tympanic membrane? Where is it located? Specify its value.
6. What formations does the middle ear include?
7. Name the walls of the tympanic cavity. What formations are located on them?
8. What way are the mastoid processus cells connected with the tympanic cavity?
9. Name the acoustical ossicles, their parts.
10. What way are the auditory ossicles connected with each other, with the tympanic membrane and with the osseus labyrinthus?
11. Where are the stapedius muscle and the tensor tympani muscle located?
12. What functions are the chain of the auditory acoustical ossicles and the middle ear muscles carried out?
13. What parts does the auditory tube have? Where are its apertures located? Specify the value of the auditory tube.

14. What muscles at their contractions promote the air entering into the tympanic cavity?

15. What features of the external ear and the auditory tube structure cause more frequent inflammation of the middle ear at children?

16. Why in the cases of the inflammatory process in the external acoustic meatus is the chewing painful?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

***On the anatomic preparations:*** 1) the auricle, the helix, the antihelix, the tragus, the antitragus, the lobulus; 2) the external acoustic meatus; 3) the tympanic membrane; 4) the tympanic cavity and its walls: the tegmental, the jugular, the labyrinthic, the mastoid, the carotid and the membranous; 5) the fenestra vestibule and the fenestra cochleae; 6) the malleus, its head, the handle, the lateral and anterior processes; 7) the incus, its body, the short and long legs, the lenticular process; 8) the stapes, its head, the anterior and posterior legs, the footplate (the basis of stapes); 9) the tensor tympani muscle; 10) the stapedius muscle; 11) the auditory tube, its parts, the apertures.

## Lesson 12

**Theme:** Internal Ear. Conductive Tracts of Vestibular and Acoustic Analysators.

**Purpose of the lesson:**

– to generate the integrated representation about the internal ear structure, the locating of the osseus and membranous labyrinths;

– to study the structure of the acoustic analysator conductive tract: the locating of the neurones, the fibers course, the locating of the subcortical and cortical centres;

– to study the conductive tract structure of the vestibular analysator.

**Equipment of the lesson:** the skull, the temporal bone, the osteal labyrinth, the moulages, the tablets, the tables, the atlas, the museum preparations.

**The internal ear** includes the osseus labyrinthus, a complex series of cavities in the petrosal part of the temporal bone, and the contained membranous labyrinth, a corresponding complex set of interconnected membranous sacs and ducts.

There are three semicircular canals: anterior, posterior and lateral. The anterior part of the labyrinth is cochlea. It has modiolus with a spiral canal around of it. There are three longitudinal canals within the cochlea: the cochlear duct, scala vestibuli and scala tympani.

The membranous labyrinth includes: the utricle and saccule, three semicircular ducts, the cochlear duct.

There are two types of the vestibular receptors: otolithic (in the maculae of utricle and saccule) and ampullar (in ampullary crests). The conductive tract of vestibular analysator begins with the first neuron — cells of the vestibular ganglion. Their axons pass with the cochlear division of the vestibulocochlear nerve through the porus acusticus internus into cranial cavity to the vestibular nuclei of the pons. The fibers of these nuclei go to cerebellum, spinal cord, nuclei of cranial nerves, thalamus and further to the cerebral cortex of the temporal and parietal lobes.

The first neuron of the auditory analysator is bipolar neuron of the spiral ganglion. The second — the ventral and dorsal cochlear nuclei of rhomboid fossa. The fibers of the ventral nucleus form the trapezoid body and become part of the lateral lemniscus of the opposite side. The fibers of the dorsal nucleus form striae medullares. The lateral lemniscus goes to the subcortical centers of hearing: the inferior colliculus of the midbrain (reflexory), medial geniculate body and from the neurons of this body — to the superior temporal gyrus.

**Recommendations.** At studying of the osseus labyrinth, it is necessary to pay attention to the structure of its parts, their locating in the temporal bone pyramid. At studying of the membranous labyrinth, it is necessary to pay attention to the structure and value of its parts, the locations of the acoustic and vestibular analysators conductive tracts receptors.

#### QUESTIONS FOR CONTROL

1. What formations are concerned to the internal ear?
2. Name the parts of the osseous labyrinth.
3. Describe the vestibule structure. What are the names of the apertures on its lateral wall? What is each of them closed by? What are the fossas on its medial wall called?
4. Describe the cochlea structure.
5. Describe the structure and the locating of the osseous semicircular canals.
6. What parts of the membranous labyrinth are located in the vestibule, in the semicircular canals and in the cochlea? What way are they connected with each other?
7. What spaces are filled with endo- and perilymphe?
8. Where are the receptor cells of the vestibular (stato-kinetic) analysator located?
9. What separates the scala vestibule from the scala tympani? Where are they connected with each other? With what formations they are connected?

10. Name the walls of the cochlear duct. What is the basilar membrane?
11. What is the spiral organ? Specify its value.
12. Describe the way of the sound pathway from the external ear to the receptor cells of the spiral organ.
13. Describe the conductive tract of the acoustic analysator. Name the subcortical centres of the hearing, the cortical centre.
14. Describe the conductive tract of the vestibular analysator. Why at its irritation are the vomiting and other vegetative reactions possible?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

**On the moulages and tablets:** 1) the osseous labyrinth, its vestibule, semicircular canals (anterior, posterior, lateral), the cochlea; 2) the cochlear duct and its walls; 3) the scala vestibuli and scala tympani, the spiral organ; 4) the membranous labyrinth, the elliptic saccule, the spherical saccule, the duct of the elliptic and spherical saccules, the endolymphatic duct, the endolymphatic sac; 5) the semicircular ducts: anterior, posterior, lateral.

### **Lesson 13–14**

**Theme:** Central Nervous System. Sensory Organs. The Final Lesson.

**Purpose of the lesson:** to examine the mastering of the studied material, the deepening, the fastening and correction of knowledge.

**Equipment of the lesson:** the brain preparations, the skull, the skull with the cerebral dura mater, the eyeball (opened), the wet preparation of the ear, the table, the moulages.

### **QUESTIONS FOR CONTROL**

1. Nervous system and its functions. The classification of the nervous system by the topographical and anatomo-functional principles.
2. Neurone as the structurally functional unit of the nervous system. The representation about the neurones bodies and processes participation in the formation of the grey and white matter of the central nervous system and structural elements of the peripheric nervous system.
3. Simple and complex reflex arches structure.
4. Central nervous system. The spinal cord: the development, the topography and the external structure.
5. Internal structure of the spinal cord.
6. Spinal cord meninges.
7. Brain, its parts. The brain development: the cerebral bubbles and their derivatives. The anomalies of the development.

8. Telencephalon. The cerebral hemispheres: their surfaces, lobes, grooves and gyri.
9. Olfactory brain: the central and peripheral part. The limbic system.
10. The localisation of functions in the cerebral hemispheres cortex.
11. White matter of the telencephalon: the associative, the commissural and projective fibers. The internal capsule.
12. Intermediate brain: its topography, parts, the external and internal structure. The third ventricle.
13. Mesencephalon: its topography, the external and internal structure. The mesencephalon aqueductus.
14. Metencephalon. The pons: its topography, the external and internal structure.
15. Cerebellum: its topography, the external and internal structure.
16. Oblong brain: its topography, the external and internal structure.
17. Rhomboid fossa: its borders, its structure, the projection of the cranial nerves nuclei to its surface.
18. The fourth ventricle: its topography, its structure. The production and outflow ways of the cerebrospinal fluid.
19. Conductive tracts of the central nervous system, their general characteristic.
20. Conductive tracts of the exteroceptive sensitivity (painful, temperature, tactile).
21. Conductive tracts of the proprioceptive sensitivity of the cerebellar and cortical directions. The medial loop.
22. Motor conductive tracts (pyramid and extrapyramid).
23. Reticular formation: its structure, its topography and value.
24. Meninges of brain.
25. The cerebral dura mater sinuses: their structure, the topography and value. The communication with the head external veins.
26. Organ of hearing and balance (organum vestibulocochleare): its general characteristic.
27. External ear: the auricle and the external acoustic meatus, the tympanic membrane.
28. Middle ear: the tympanic cavity, the auditory ossicles, the auditory tube.
29. Internal ear: its osseous and membranaceous labyrinths.
30. Development and age features of the hearing and balance organ.
31. Visual organ: its general characteristic. Eyeball. Eyeball meninges, their structure and value.
32. Refractive spaces of the eyeball. Eyeball chambers. Aqueous humor: its value, formation, outflow ways.
33. Accessory eye structures.

## Lesson 15

**Theme:** Peripheral Nervous System. Cranial Nerves: 0, I, II, III, IV, VI Pairs. Organ of Smell.

**Purpose of the lesson:**

- to study the nuclei of III, IV, VI pairs cranial nerves, their topography and functions, their branches, their fibrous structure and the innervated muscles;
- to study the structure and functions of the olfactory (I) and optic (II) nerves;
- to pay attention to the terminal (0) nerve and its function;
- to be able to find the studied structures on the anatomic preparations and other manuals.

**Equipment of the lesson:** the brain preparations, the skull, the neurologic head and neck preparation (the sagittal cut), the tables, the moulages and brain tablets, the museum preparations.

**Peripheral nervous system** comprises the afferent fibres which connect the sensory organs and central nervous system, and the efferent fibres which connect the central nervous system to the effector apparatus. It includes the thirteen pairs of cranial nerves which arise from the brain and the thirty one spinal nerves which arise from spinal cord.

**The cranial nerves** innervate all organs of the head. Their innervations of the neck extends down to the larynx. The vagus nerve also innervates internal organs of the thoracic and abdominal cavities (up to the transverse colon). Cranial nerves are subdivided into several groups. Nerves of the sensory organs (the terminal — 0 pair, olfactory — I pair, optic — II pair, vestibulocochlear — VIII pair) nerves. The group of nerves that innervate the muscles of the eyeball — includes the oculomotor — III pair, trochlear — IV pair and abducent — VI pair nerves. These nerves contain somatic motor fibers. The hypoglossal nerve — XII pair also contains motor fibers. It accommodates muscles of the tongue. The third group of cranial nerves (nerves of the branchial arches) contains the trigeminal — V pair, facial — VII pair, glossopharyngeal — IX pair, vagus — X pair and accessory — XI pair cranial nerves. Some of the cranial nerves (III, VII, IX, X pairs) contain vegetative parasympathetic fibers.

**The terminal nerve** is a paired small nerve, which is closely associated with olfactory nerves. Each terminal nerve runs along the medial side of the corresponding olfactory tract, and its branches traverse the cribriform plate of the ethmoid bone, and are distributed to the nasal mucous membrane. Centrally the nerve is connected to the brain closely to the anterior perforated substance and septal areas.

**The olfactory nerves** are made up of axons of olfactory cells, located in the mucosal tunic of the olfactory region of the nasal cavity. The nerves pass through the openings of the cribriform plate of the ethmoid bone to the olfactory bulb of the brain.

**The optic nerve** contains axons of ganglionic neurocytes of the eyes retina. It passes through the sclera to the optic canal. In the medial cranial fossa right and left optic nerves unite and form incomplete optic chiasm and after the optic tracts are formed.

**The oculomotor nerve** comes out of the medial surface of the cerebral peduncle, passes along the cavernous sinus wall and enters the orbit through the superior orbital fissure. It is divided into superior (for innervation of the elevator muscle of the upper eyelid and superior rectus muscle) and inferior branches (for innervation of the inferior and medial rectus muscles and inferior oblique muscle). The inferior branch contains the vegetative parasympathetic fibers to the ciliary ganglion.

**The trochlear nerve** comes out of the midbrain behind the tectal plate, then passes through the cavernous sinus wall and enters the orbit through the superior orbital wall and innervates the superior oblique muscle.

**The abducent nerve** is located by the posterior margin of the pons, between the pyramid of the medulla oblongata. It passes through the cavernous sinus and then through the superior orbital fissure to the orbit and innervates the lateral rectus muscle.

**Recommendations.** The cranial nerves studying should be begun with the mastering of the somatic and vegetative reflex arches structure principles: the generality and differences in the structure of the sensitive and motor link, the topography of neurones (sensitive, intermediate and motor). It is necessary to acquire, that in the cases of the complex and simple reflex arches the sensitive link of the reflex can be formed by one cranial nerve, and motor — by the another one. It is necessary to repeat the cranial nerves nuclei topography in the cerebral trunk, and also their functions (motor, sensitive, vegetative) to give the functional characteristic of the cranial nerve as a whole — motor, sensitive or mixed. It is necessary to mean, that in part of one cranial nerve the nervous fibers belonging to the different cranial nerves can pass. By the origin I and II cranial nerves pairs are the derivatives of the anterior cerebral bubble. The others (III–XII pairs) have nuclei in the cerebral trunk — «true» cranial nerves. III, IV, VI pairs are intended for the eyeball internal and external muscles innervation, they pass in the cavernous sinus and enter into the orbit through the superior orbital fissura. It is necessary to pay attention to the sensitive and motor link of the pupillary (reaction to light) and accommodative reflexes.

## QUESTIONS FOR CONTROL

1. Where are the bodies of the cells which processes form the olfactory nerves located?
2. What cells processes form the optic nerve?
3. What fibrous structure does the third cranial nerve have?
4. What nuclei are belonged to the third cranial nerve? Describe their functions and topography.
5. Where do the preganglionic parasympathetic nervous fibers begin?
6. Where do the postganglionic parasympathetic nervous fibers begin?
7. What muscles are innervated by the third cranial nerve?
8. What smooth muscular formations do the third cranial nerve branches go to?
9. In the structure of what third cranial nerve branch do the postganglionic parasympathetic fibers go?
10. Name the trochlear nerve nucleus, specify its topography and the place of the exit of the nerve from the brain.
11. What does the trochlear nerve innervate?
12. Name the abducent nerve nucleus, specify its topography and the place of the exit of the nerve from the brain.
13. What does the abducent nerve innervate?
14. What cranial nerve passes in the interpeduncular cystem?
15. What nerves pass through the cavernous sinus?
16. What nerves pass through the superior orbital fissura?
17. Where is the the ciliary ganglion located?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

***On the moulages and tablets:*** 1) the olfactory nerve; 2) the optic nerve and the optic chiasm; 3) the oculomotor nerve; 4) the superior branch of the oculomotor nerve; 5) the inferior branch of the oculomotor nerve; 6) the ciliary ganglion; 7) the trochlear nerve; 8) the abducent nerve; 9) the cavernous sinus.

## Lesson 16

**Theme:** Trigeminal (V) Nerve.

**Purpose of the lesson:**

- to study the trigeminal (V) nerve nuclei, their topography and the functions; their branches, their fibrous structure, the innervated structures;
- to be able to find the studied structures on the anatomic preparations and other manuals.



**Equipment of the lesson:** the brain preparations, the skull, the angioneurologic head and neck preparations (the sagittal cut), the tables, the moulages and brain tablets, the museum preparations.

**The trigeminal nerve** innervates the skin of the face, the mucosal tunic of the nose, its sinuses and the oral cavity, the anterior  $\frac{2}{3}$  of the tongue, the teeth, the masseteric muscles, muscles of the bottom of the oral cavity, tensor of tympanic membrane and of the soft palate. The trigeminal nerve comes out of the brain (pons) at the form of two roots: a motor and sensory. The nerve has three large branches: the ophthalmic nerve (it goes to orbit through the superior orbital fissure and is divided into frontal, nasociliary and lacrimal nerves), the maxillary nerve (it exits through the round foramen to the pterygopalatine fossa and is divided into the infraorbital and zygomatic nerves and gives the ganglionic branches to the parasympathetic pterygopalatine ganglion) and the mandibular nerve (it leaves the cranial cavity through the oval foramen and is divided into its motor branches — the masseteric nerve, the deep temporal nerve, nerves of the lateral and medial pterygoid muscles, to the tensor tympani muscle and to the tensor veli palatine muscle; and sensitive branches — the meningeal branch, the buccal, auriculotemporal and lingual nerves).

**Recommendations.** It is necessary to pay attention to the locating and functions of nuclei, the trigeminal ganglion topography, the course of the optic nerve (the cavernous sinus and the superior orbital fissure), of the maxillary nerve (the round foramen), of the mandibular nerve (the oval forame), and the distribution of their branches in the topographical areas — the head organs (the nerve of the first visceral arch). It is necessary to be able to close the reflex arch of the conjunctival and corneal reflexes.

#### QUESTIONS FOR CONTROL

1. Name the trigeminal nerve nuclei, specify their functions and describe the topography.
2. What fibrous structure does the ophthalmic, the maxillary and the mandibular nerves have?
3. What branches is the optic nerve divided on?
4. What anatomic structures do the frontal, nasociliary and lacrimal nerves innervate?
5. What branches is the maxillary nerve divided on?
6. What does the infraorbital nerve innervate?
7. What branches innervate the teeth of the upper jaw?
8. Name the nerves following to the paranasal sinuses.
9. What nerves innervate the mucosa layer of the soft palate?
10. What branches is the mandibular nerve divided on?

11. What muscles are innervated by the motor branches of the mandibular nerve?
12. What is innervated by the inferior alveolar, buccal, auriculotemporal and lingual nerve?
13. What feature of the course does the auriculotemporal nerve have?
14. What branches are the lower jaw teeth innervated by?
15. What is the face skin innervated by? Describe the points of the trigeminal nerve branches exit on the face.

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

**On the moulages and tablets:** 1) the trigeminal nerve; 2) the trigeminal ganglion; 3) the optic nerve; 4) the maxillary nerve; 5) the mandibular nerve; 6) the frontal nerve, the supraorbital nerve; 7) the lacrimal nerve; 8) the nasociliary nerve; 9) the ciliary ganglion; 10) the infraorbital nerve, the superior alveolar nerves (anterior, middle and posterior), the superior dental plexus; 11) the zygomatic nerve; 12) the pterygopalatine ganglion; 13) the greater and smaller palatine nerves; 14) the posterior nasal nerves; 15) the inferior alveolar nerve; 16) the lingual nerve; 17) the auriculotemporal nerve; 18) the buccal nerve; 19) the mylohyoid nerve; 20) the mental nerve; 21) the submandibular and otic ganglion.

## Lesson 17

**Theme:** Facial (VII pair) and Vestibulocochlear (VIII pair) Nerves.

**Purpose of the lesson:** to study the facial and vestibulocochlear nerves nuclei, their topography and functions, their branches and their fibrous structure, the innervated structures.

**Equipment of the lesson:** the brain preparations, the skull, the angioneurologic head and neck preparation (the sagittal cut), the tables, the museum preparations.

**The facial nerve** unites two nerves — the properly facial and intermediate nerves. It comes out at the posterior margin of the pons and enters the internal acoustic meatus, in the facial canal and leaves this canal through the stylomastoid foramen. The facial nerve gives the following branches: the greater petrosal nerve, the communicating branch with the tympanic plexus, the stapedius nerve, the chorda tympani, the posterior auricular and superior auricular nerves, the branches for the posterior belly of the digastrics and for the mylohyoid muscles and for all mimic muscles.

**The vestibulocochlear nerve** comes out on the ventral surface of the brain behind the pons. Its vestibular part conducts impulses from the static

apparatus laid out in the vestibule and semicircular canals of the labyrinth of the internal ear. Its cochlear part conducts acoustic impulses from the spiral organ in the cochlea which receives acoustic stimuli.

**Recommendations.** It is necessary:

- to pay attention to the including of the intermediate nerve in the facial nerve structure, and to the sensitive and vegetative (nucl. solitarius, nucl. salivatorius superior and nucl. lacrimalis) nuclei of the intermediate nerve;
- to pay attention to the nerves (VII and VIII pairs) roots exit from the brain, to the course of VII pair nerve in the facial canal, to the sequence and places of their branches origin;
- to pay attention to the distribution of the somatic motor branches and fibers of the intermediate nerve in the head areas and organs;
- to underline the value of the facial nerve for the mimic muscles of the head innervations;
- to specify, that VIII pair nerve spends the sensitivity from the hearing and gravitation organ.

#### QUESTIONS FOR CONTROL

1. Name the nuclei of the facial nerve. What are their functions? Where are they located?
2. Name the parts and fibrous structure of the facial nerve.
3. Where does the facial nerve go from the brain and from the skull cavity?
4. Describe the course of the facial nerve in the facial canal.
5. Describe the sequence the facial nerve branches originating in the facial canal and their fibrous structure.
6. List the sensitive ganglion and the vegetative parasympathetic ganglions belonging to the intermediate nerve. Where are they located?
7. Describe the course of the greater petrosal nerve. On what vegetative ganglion cells are its fibers “switched”?
8. Describe the course of the chorda tympani. What is its fibrous structure? What anatomic structures does it innervate? On what vegetative ganglion cells are its fibers “switched”?
9. Name the muscular branches of the facial nerve and list the muscles, which are innervated by them.
10. Name the nerves in which structure the postganglionic parasympathetic fibers from the pterygopalatine ganglion pass. What anatomic formations are innervated by them?
11. Where does the VIII pair of cranial nerves go on the basis of the brain and in the skull?
12. List the nuclei and the ganglions belonging to the VIII pair of cranial nerves.

13. Name the VIII pair of cranial nerves roots and the structures to which they are referred.

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

**On the moulages and tablets:** 1) the facial nerve; 2) the facial nerve canal; 3) the petrotympanic fissure; 4) the chorda tympani; 5) the greater petrosal nerve hiatus; 6) the pterygoid canal; 7) the greater petrosal nerve; 8) the pterygopalatine fossa; 9) the greater palatine canal; 10) the lesser palatine canal; 11) the parotid plexus; 12) the stapedius nerve; 13) the temporal branches of the facial nerve; 14) the zygomatic branches of the facial nerve; 15) the buccal branches of the facial nerve; 16) the cervical branch of the facial nerve; 17) the lower jaw marginal brach of the facial nerve; 18) the vestibulocochlear cranial nerve; 19) the vestibular ganglion; 20) the spiral ganglion of the cochlea.

### Lesson 18

**Theme:** Glossopharyngeal (IX pair) and Vagus (X pair) Nerves. Taste Organ.

**Purpose of the lesson:** to study nuclei of the IX and X pairs of the cranial nerves, their topography, their functions, their branches and their fibrous structure, the formations, which are innervated by them.

**Equipment of the lesson:** the brain preparations, the skull, the angioneurologic head and neck preparation (the sagittal cut), the tables, the museum preparations.

**The glossopharyngeal nerve** exits from the medulla oblongata behind of olive, then leads to the jugular foramen. Its branches: the tympanic nerve, the lesser petrosal nerve, the carotid branch, the pharyngeal branch, the stylopharyngeal branch and tonsillar branches.

**The vagus nerve** innervates the meninges, the organs of the abdomen. On the fibers of the vagus nerve there are impulses which slow the heart beat down, narrow the branches, speed the peristaltic waves up, relax the sphincters of the intestines, intensify the secretion of the glands. The vagus nerve passes from medulla oblongata behind of olive, goes through the jugular foramen and in its cranial, cervical and thoracic parts gives the following branches: the meningeal branch, the auricular branch, the pharyngeal branch, the superior cervical cardiac branches, the superior laryngeal nerve, the recurrent laryngeal nerve, the bronchial branches, the oesophageal branches. The abdominal part of the vagus nerve consists of anterior and posterior vagal trunks. They innervate

oesophagus, stomach, liver, lesser and greater omentum, spleen, pancreas, small intestine, large intestine up to the level of the descending colon.

**Recommendations.** It is necessary:

- to pay attention to the topography and functions of the IX and X pairs of cranial nerves nuclei, to the course and distribution of the branches in the innervated organs;
- to pay attention to the topography of the vagus nerve and its branches on the neck, in the mediastinum, in the abdominal cavity, to the course of the left and right recurrence laryngeal nerves, to the distribution of their final branches;
- to know the influences of the parasympathetic innervation activity on the internal organs.

### QUESTIONS FOR CONTROL

1. List the nuclei of the glossopharyngeal nerve and their functions.
2. Where does the glossopharyngeal nerve go on the basis of the brain and in the skull?
3. List the branches of the glossopharyngeal nerve and the anatomic structures, which are innervated by them.
4. What are the features of the tympanic nerve course and fibrous structure?
5. What are the features of lesser petrosal nerve course and fibrous structure?
6. Name the nerves in which structure the postganglionic parasympathetic fibers from the otic ganglion pass.
7. List the nuclei of the vagus nerve. What are their functions?
8. Where does the vagus nerve go from the brain and from the skull cavity?
9. Name the vagus nerve branches, their fibrous structure and anatomic formations, which are innervated by them.
10. Describe the course of the left and right recurrence laryngeal nerves and list the anatomic formations, which are innervated by them.
11. What are the features of the vagus nerve passage on the neck, in the thoracic and abdominal cavities?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

**On the moulages and tablets:** 1) the glossopharyngeal nerve; 2) the tympanic nerve, the tympanic plexus; 3) the lesser petrosal nerve; 4) the pharyngeal, the tonsillar, the lingual branches, the sinus branch, the stylopharyngeal muscle branch; 5) the vagus nerve; 6) the pharyngeal

branches, the pharyngeal plexus; 7) the superior and inferior cervical cardiac branches; 8) the superior laryngeal nerve; 9) the recurrence laryngeal nerve, the inferior laryngeal nerve; 10) the thoracic cardiac branches, the bronchial branches, the esophageal plexus; 11) the anterior and posterior vagal trunks; 12) the anterior and posterior gastric branches, the anterior and posterior gastric plexuses,

## Lesson 19

**Theme:** Accessory (XI Pair) and Hypoglossal (XII Pair) Nerves.

**Purpose of the lesson:** to study the nuclei of the accessory (XI pair) and the hypoglossal (XII pair) nerves, their topography and the functions, their branches, their fibrous structure and formations, which are innervated by them.

**Equipment of the lesson:** the brain preparations, the skull, the angioneurologic head and neck preparation (the sagittal cut), the tables, the museum preparations.

**The accessory nerve** is formed by outgrowths of the motor nucleus, which are located in the operculum of medulla oblongata and the spinal cord. Its cranial roots exit from the posterolateral sulcus of medulla oblongata, behind of olive. Its cerebrospinal roots appear from the posterior lateral sulcus of the spinal cord, arise through foramen magnum into the cavity of the skull and unite with the cranial roots. The nerve exits from jugular foramen and gives internal (enters into vagus nerve) and external (innervates sternocleidomastoid and trapezoid muscles) branches. The accessory nerve departs connective branches to the anterior branches of the III and IV cervical nerves, to the hypoglossal nerve.

**The hypoglossal nerve** is formed by fibers of the motor nucleus innervating the sublingual musculature and the same muscles of the neck. The nerve exits through the sulcus between pyramid and the olive, follows anteriorly and laterally into the hypoglossal canal in the occipital bone. The nerve innervates the muscles of the tongue. It also joins with I and II cerebrospinal nerves and forms the deep cervical ansa for innervations mm. omohyoideus, sternothyroideus and stylohyoideus.

**Recommendations.** It is necessary:

- to pay attention to the XI and XII nerves exit from the brain and the skull, to the distribution in the topographical areas and muscles;
- to pay attention to the formation and topography of the cervical loop, to the IX, X, XI pairs of cranial nerves (nerves of vagal group) formation, and also to the formation and course of the corticonuclear tract fibers.

## QUESTIONS FOR CONTROL

1. Name the accessory nerve nuclei. Where are they located? What are their functions?
2. Where does the accessory nerve go on the basis of the brain and from the skull?
3. Name the parts of the accessory nerve and the structure, which are innervated by the branches of these parts.
4. What nuclei belong to the hypoglossal nerve? Describe their topography and functions.
5. Where does the hypoglossal nerve go from the brain and from the skull?
6. What muscles are innervated by the hypoglossal nerve?
7. What roots form the cervical loop?
8. What muscles are innervated by the cervical loop branches?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

*On the moulages and tablets:* 1) the accessory nerve, the internal and external branches; 2) the hypoglossal nerve, the anterior root, the cervical loop.

## Lesson 20

**Theme:** Spinal nerves: posterior and anterior branches of spinal nerves. Cervical plexus.

**Purpose of the lesson:**

- to study structure of spinal nerves, division them into branches, sources of formation of cervical plexus, its branches;
- to be able to show the studied structures on anatomic preparations.

**Equipment of the lesson:** the angioneurological corpse, the tables, the moulages, the tablets, the schemes, the museum preparations.

Each **spinal nerve** begins from motor and sensory roots. The ventral (motor) roots of the spinal nerves consist of axons of the motor neurons, the bodies of which are situated in the anterior horn of the spinal cord. The dorsal (sensory) ganglions are formed by the central outgrowths of the pseudounipolar cells, the bodies of which is spinal ganglion. Each posterior root has ampulla of the spinal ganglion. The ventral and dorsal roots form the trunk of the spinal nerve. The spinal nerve after exiting the intervertebral foramina give off to several branches: ventral, dorsal and meningeal branches as well as the white connective branch (it contains preganglionic sympathetic fibres, following to the ganglions of the sympathetic trunk). The ventral branches of the spinal nerves preserve their original metameric structure only in

the thoracic segments (nn. intercostales). In the other segments connected with the limbs in the development of which the segmentary character is lost, the nerves arising from the anterior spinal branches interwind, and the following nervous plexuses are formed: cervical, branchial and lumbosacral.

**Recommendations.** It is necessary

- to pay attention to formation and topography of spinal nerves (roots — posterior and anterior), division into branches;
- to notice the region of innervations of posterior branches;
- to pay attention to features of anterior branches;
- to know a source of formation of a cervical plexus, its branches, their distribution in topographical areas.

### QUESTIONS FOR CONTROL

1. How are spinal nerves formed?
2. Where do spinal nerves pass?
3. How many pairs spinal nerves do you know?
4. What groups of spinal nerves do you know? How many nerves are included into each group?
5. What branches do spinal nerves have?
6. What is a source of formation of plexuses?
7. What plexuses do you know?
8. How is the cervical plexus formed?
9. What branches does the cervical plexus have and what do they innervate?
10. How the cervical loop is formed? What does it innervate?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

**On the corpse, moulages and tablets:** 1) spinal nerves; 2) anterior root; 3) posterior root; 4) spinal ganglion; 5) a trunk of a spinal nerve; 6) anterior branch; 7) posterior branch; 8) grey and white connecting branches; 9) a meningeal branch; 10) cervical nerves; 11) suboccipital nerve; 12) the big occipital nerve; 13) a cervical plexus; 14) a cervical loop, the superior and inferior roots; 15) a transverse nerve of a neck; 16) supraclavicular nerves; 17) the big auricular nerve; 18) a small occipital nerve; 19) a phrenic nerve.

### Lesson 21

**Theme:** Brachial Plexus.

**Purpose of the lesson:**

- to study the sources of the formation and the branches of the brachial plexus;



– to be able to show the studied structures on the anatomic preparations and other manuals.

**Equipment of the lesson:** the angioneurological corpse, the tables, the moulages, the tablets, the schemes, the museum preparations.

**Brachial plexus** is formed from the anterior branches of the four lower cervical spinal nerves. There are the supraclavicular and infraclavicular parts in the plexus by topographical sign. Long and short branches move away from the brachial plexus. They innervate bones and soft tissues of the thoracic girdle. The long branches innervate the upper limb.

The short branches of the brachial plexus contain the dorsal scapular nerve, long thoracic, subclavian, suprascapular, thoracodorsal, lateral and medial pectoral nerves, axillary nerve. Muscular branches innervate serratus muscles and m. splenius cervicis.

The long branches of the brachial plexus diverge from the lateral, medial and posterior bundles of the subclavicle part of the brachial plexus. Long branches contain musculocutaneous, median, ulnar nerve, a medial cutaneous nerve of an arm, a medial cutaneous nerve of a forearm and radial nerve.

**Recommendations.** It is necessary to pay attention to the formation sources and the topography of the trunks, parts and branches of the humeral plexus; to know the upper extremity skin and muscles innervation.

#### QUESTIONS FOR CONTROL

1. Name the sources of the humeral plexus formation.
2. What trunks, fascicles and parts does the humeral plexus have?
3. List the branches of the humeral plexus supraclavicular part. What do they innervate?
4. What fascicles does the subclavial part of the humeral plexus have?
5. List the nerves departing from the humeral plexus each fascicle.
6. What nerves is the shoulder skin innervated by?
7. What nerves are the shoulder muscles innervated by?
8. What nerves are the forearm muscles innervated by?
9. What nerves is the shoulder and forearm skin innervated by?
10. What nerves is the brush skin innervated by?
11. What nerves are the brush muscles innervated by?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

**On the corpse, moulages and tablets:** 1) the brachial plexus; 2) the superior, middle and inferior trunks; 3) the supraclavicular part of the brachial plexus; 4) the dorsal scapular nerve; 5) the long thoracic nerve;

6) the subclavian nerve; 7) the suprascapular nerve; 8) the subscapular, thoracodorsal nerves; 9) the lateral and medial thoracic nerves; 10) the axillary nerve; 11) the subclavian part of the brachial plexus; 12) the lateral, medial, posterior fascicles; 13) the musculocutaneous nerve; 14) the medial cutaneous nerve of the arm; 15) the medial cutaneous nerve of the forearm; 16) the median nerve, the medial and lateral roots; 17) the ulnar nerve; 18) the radial nerve.

## Lesson 22

**Theme:** Anterior Branches of the Thoracic Nerves. Lumbar Plexus.

**Purpose of the lesson:**

– to study the structure, the innervation area of the anterior branches of the thoracic nerves (intercostal), the sources of their formation, the lumbar plexus branches;

– to be able to show the studied structures on the anatomic preparations and other manuals.

**Equipment of the lesson:** the angioneurological corpse, the tables, the moulages, the tablets, the schemes, the museum preparations.

**Anterior branches of the thoracic spinal nerves** preserve segmental structure. The upper 11 pairs of them are called intercostals nerves, the 12<sup>th</sup> branch — subcostal nerve. Intercostal nerves innervate all muscles and the skin of the lateral and anterior parts of the thoracic and abdominal walls, parietal pleura and peritoneum, mammary gland.

Muscular branches innervate: external and internal intercostals muscles, subcostales, levatores costarum, transversus thoracis and serratus posterior superior muscles; external and internal oblique muscles, transverses and rectus abdominis muscles.

Every intercostal nerve gives the anterior and lateral cutaneous branches.

**The lumbar plexus** is formed from the anterior branches of the three upper spinal nerves and from a part of the anterior branch of the 12<sup>th</sup> thoracic and anterior branch of the 4<sup>th</sup> lumbar spinal nerves. Muscular branches, iliohypogastric nerve, ilioinguinal nerve, genitofemoral nerves, lateral cutaneous nerve of thigh, obturator and femoral nerves are the branches of the lumbar plexus. Muscular branches take their rise from all anterior branches and go to the quadratus lumborum, psoas major and minor muscles and mm. intertransversarii lateralis lumborum.

**Recommendations.** It is necessary:

– to pay attention to the sources of the thoracic nerves anterior branches and the lumbar plexus formation and distribution;

- to know the innervation of the thoracic and abdominal cavities walls muscles and skin;
- to pay attention to the participation of the lumbar plexus branches in the lower extremity innervation.

### QUESTIONS FOR CONTROL

1. What are the intercostal nerves?
2. What do the intercostal nerves innervate?
3. Name the sources of the lumbar plexus formation.
4. What branches does the lumbar plexus have? What do they innervate?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

***On the corpse, moulages and tablets:*** 1) the thoracic nerves; 2) the anterior branches (intercostal nerves), the subcostal nerve; 3) the anterior and lateral cutaneous branches, the lateral and medial branches of the mammary gland; 4) the lumbar nerves; 5) the lumbar plexus; 6) the iliohypogastric nerve; 7) the ilioinguinal nerve; 8) the genitofemoral nerve; 9) the lateral cutaneous nerve of the thigh; 10) the obturator nerve; 11) the femoral nerve; 12) the saphenous nerve.

### Lesson 23

**Theme:** Sacral and Coccygeal Plexuses.

**Purpose of the lesson:**

- to study the structure, the sources of the formation and the branches of the sacral and of the coccygeal plexuses;
- to be able to show the studied structures on the anatomic preparations and other manuals.

**Equipment of the lesson:** the angioneurological corpse, the tables, the moulages, the tablets, the schemes, the museum preparations.

**The sacral plexus** is built of a part of the anterior branch of the fourth and fifth lumbar and of the first-third sacral spinal nerves. There are short and long branches. The short rami end in the pelvic zone. The long rami run down to the muscles, joints, bones and the skin of the free lower extremity.

The short branches are obturator internus and piriformis nerves, a nerve to quadratus femoris muscle and superior and inferior gluteal and pudendal nerves.

The long branches are the posterior cutaneous femoral nerve and sciatic nerve.

**The coccygeal plexus** is formed of the fibres of the anterior branches of the fourth-fifth sacral spinal nerves and the anterior branch of the coccygeal spinal nerve. The anococcygeal nerves, branching from the plexus, run on the anterior surface of the coccygeal muscle. They innervate the skin in the coccygeal area and anal orifice. The muscular branches innervate the coccygeal muscle and the posterior part of the levator ani muscle.

**Recommendations.** It is necessary to pay attention to the formation sources, the topography and the distribution of the sacral and coccygeal plexuses branches; to know the lower extremity muscles and skin innervation.

#### QUESTIONS FOR CONTROL

1. What way is the sacral plexus formed?
2. Name the short branches of the sacral plexus. What do they innervate?
3. What long branches of the sacral plexus do you know?
4. What branches does the sciatic nerve have?
5. What is the source of the coccygeal plexus?
6. What nerves of the coccygeal plexus do you know?
7. What nerves are the lower extremity girdle muscles innervated by?
8. What nerves is the genitals and perineum skin innervated by?
9. Name the nerves participating in the thigh skin innervation.
10. What nerves are the thigh muscles innervated by?
11. What nerves is the leg skin innervated by?
12. What nerves are the leg muscles innervated by?
13. What nerves is the foot skin innervated by?
14. What nerves are the foot muscles innervated by?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

**On the corpse, moulages and tablets:** 1) the sacral plexus; 2) the superior gluteal nerve; 3) the inferior gluteal nerve; 4) the posterior cutaneous nerve of thigh; 5) the sciatic nerve; 6) the general fibular nerve; 7) the superficial and deep fibular nerves; 8) the tibial nerve; 9) the medial and lateral sural cutaneous nerves; 10) the sural nerve; 11) the medial plantar nerve; 12) the lateral plantar nerve; 13) the pudendal nerve; 14) the coccygeal plexus; 15) the anococcygeal nerves.

#### Lesson 24

**Theme:** Autonomic (Vegetative) Nervous System. General Principles of Structure. Sympathetic and Parasympathetic Parts of the Autonomic Nervous System.

**Purpose of the lesson:**

- to study the structure of the central and peripheral parts of the sympathetic and parasympathetic parts of the autonomic nervous system;
- to know its difference from the somatic nervous system in the structural and functional aspects.

**Equipment of the lesson:** the museum preparations, the tables.

**The autonomic nervous system** is a part of the nervous system, which controls functions of internal organs, glands, vessels, and carries out the trophic adaptation for all the body parts.

This system is not under the conscious control. However, it is subordinated to the spinal cord, cerebellum, hypothalamus, basal nuclei, limbic system, reticular formation, cerebral cortex.

The vegetative nervous system is divided into central and peripheral parts.

The central part includes: parasympathetic nuclei of the III, VII, IX, X pairs of cranial nerves; parasympathetic sacral nuclei; sympathetic nucleus of the lateral intermediate trunk of the VIII cervical, all thoracic and two superior lumbar segments of the spinal cord.

The peripheral part of this system includes: vegetative nerves, rami, nervous fibres, exiting from the brain and spinal cord; vegetative visceral plexuses; ganglia of the vegetative plexuses; sympathetic trunk with its ganglia, interganglionic branches, rami communicantes and sympathetic nerves; peripheral parasympathetic ganglia of the vegetative nervous system, nerve endings.

The sympathetic part of the vegetative nervous system includes: intermediolateral nucleus in the lateral column of the spinal cord of the VIII cervical, all thoracic and two superior lumbar segments, right and left sympathetic trunks, rami communicantes, ganglions of the vegetative plexuses, sympathetic fibres.

The parasympathetic part is divided into cranial (nuclei of the III, VII, IX, X pairs of cranial nerves and pelvic (parasympathetic sacral nuclei) parts.

**Recommendations.** It is necessary:

- to pay attention to the autonomic nervous system reflex arch structure;
- to understand the structure and topography of the sympathetic and parasympathetic nervous system centres in the spinal cord and in the brain on tables and drawings;
- to acquire features of the structural organisation of the autonomic nervous system sympathetic part (white and grey connecting branches, ganglions, plexuses);
- to study the structure of the sympathetic trunk and prevertebral nervous plexuses;

– to know the topography of ganglions of the abdominal and pelvic cavities basic nervous plexuses.

### QUESTIONS FOR CONTROL

1. What is the vegetative (autonomic) nervous system?
2. What do the reflex arches of the autonomic and somatic nervous system differ from each other?
3. What parts does the autonomic nervous system consist of?
4. What are autonomic nervous system structure and topography centres features?
5. What is the peripheric part of the autonomic nervous system characterised?
6. What functional parts are allocated in the peripheric part of the autonomic nervous system?
7. Describe the sympathetic trunk structure.
8. What are the white and grey connecting branches?
9. Name the prevertebral plexuses and areas of their innervation.

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

*On the moulages and tablets:* 1) the parts of the sympathetic trunk (cervical, thoracic, lumbar, sacral); 2) the sympathetic trunk ganglions and the branches departing from them; 3) the greater and lesser splanchnic nerves; 4) the prevertebral plexuses ganglions (celiac, superior and inferior mesenteric, pelvic); 5) the nervous plexuses of the abdominal and pelvic cavities; 6) the ciliary, the pterygopalatine, the submandibular and otic ganglions; 7) the pelvic splanchnic nerves.

### Lesson 25

**Theme:** Innervation of the Internal Organs.

**Purpose of the lesson:** to study the anatomic sources of the thoracic, abdominal and pelvic cavities internal organs innervation.

**Equipment of the lesson:** the museum preparations, the tables.

**The vegetative plexuses** of the abdominal cavity and the pelvis consist of vegetative ganglia and nerve fascicles connecting them. One of the largest vegetative plexuses of the abdominal cavity is the abdominal aortic plexus, coeliac plexus, superior mesenteric plexus, inferior mesenteric plexus. In the pelvis there are superior and inferior hypogastric plexuses.

The sources of the **sympathetic innervations** of organs are intermediolateral nucleuses in the lateral column of the spinal cord from

the VIII cervical segment to the second lumbar. Sympathetic trunk consists of 20–25 ganglions, connected with interganglionic branches. It has four sections: cervical, thoracic, lumbar and sacral.

The sources of the **parasympathetic innervations** of organs are vegetative nuclei and parasympathetic fibers of the III, VII, IX, X pairs of cranial nerves, as well as the ciliary, pterygopalatine, submandibular, sublingual, otic and other ganglia and their branches. Its pelvic part consists of the sacral parasympathetic nuclei of the II, III and IV sacral segments of the spinal cord, the pelvic splanchnic nerves and the parasympathetic pelvic nerves and their branches. Axons of the sacral parasympathetic nuclei exit from the spinal cord within the anterior roots, then proceeding within the anterior branches of the sacral spinal nerves. They come to the lower hypogastric plexus and to the ganglia of the vegetative plexuses located next to the internal organs of the minor pelvis cavity.

**Recommendations.** It is necessary:

- to pay attention to the structure of the nervous plexuses of the thoracic, abdominal and pelvic cavities organs;
- to be guided in the topography of ganglions;
- to know the sources of the sympathetic and parasympathetic innervation of organs;
- to be able to show the pulmonary, cardiac, celiac, abdominal aortal, renal, adrenal, pelvic plexuses, and also plexuses of the of intestinal arteries on the museum preparations.

#### QUESTIONS FOR CONTROL

1. What plexuses innervate the thoracic cavity organs?
2. What basic plexuses of the abdominal cavity provide the abdominal cavity organs innervation?
3. Name the sources of the small pelvis organs innervation.
4. What are the sources of the abdominal cavity organs parasympathetic innervation?

**The list of the anatomic formations which the student should know and be able to show on preparations and visual aids:**

**On the moulages and tablets:** 1) the pulmonary, esophageal, cardiac, gastric, hepatic, pancreatic, adrenal, renal, testicular, ovarical plexuses; 2) the intestinal nervous plexuses; 3) the colic nervous plexuses; 4) the vesical, uterovaginal, rectal plexuses.

## Lesson 26–27

**Theme:** Peripheral Nervous System. The Final Lesson.

**Purpose of the lesson:** to control of the studied material mastering, the deeping, the fastening and correction of the knowledge.

**Equipment of the lesson:** the brain preparations, the skull, the angioneurological head and neck preparation (the sagittal cut), the angioneurological corpse, the tables, the moulages, the tablets, the schemes, the museum preparations.

### POINTS FOR DISCUSSION

1. Spinal nerve: its formation, topography, branches and the innervation areas.
2. Cervical plexus: its formation, topography, branches and innervation areas.
3. Brachial plexus: its formation, topography, the supra- and subclavial parts. The short branches of the brachial plexus: their topography and innervation areas.
4. Long branches of the brachial plexus: their topography and innervation areas.
5. Upper extremity skin innervation.
6. Intercostal nerves: their formation, topography, branches and the innervation areas.
7. Lumbar plexus: its formation, topography, branches and innervation areas.
8. Sacral plexus: its formation and topography. The short branches of the sacral plexus, the innervation areas.
9. Long branches of the sacral plexus: their topography, branches and innervation areas.
10. Lower extremity skin innervation.
11. Terminal nerve (0). The olfactory nerves (I). The conductive tract of the olfactory analyzer.
12. Optic nerve (II). The conductive tract of the visual analyser.
13. Oculomotor (III), trochlear (IV), abducent (VI) nerves: their formation, topography and the innervation areas.
14. Trigeminal nerve (V), its formation, topography, branches and the innervation areas.
15. Facial nerve (VII): its formation, topography, branches and innervation areas. The intermediate nerve, its formation, branches and the innervation areas
16. Vestibulocochlear nerve ((VIII): its formation, topography. The conductive tract of an acoustic analyzer and of the gravitation analyser.



17. Glossopharyngeal nerve (IX): its formation, topography, branches and the innervation areas.
18. Taste organ. The conductive tract of the gustatory analyser.
19. Vagus nerve (X): its formation, topography, branches and the innervation areas.
20. Accessory (XI) and hypoglossal (XII) nerves: their formation, topography, branches and the innervation areas.
21. General characteristic of the nervous system autonomic part: its structure, the value. The differences of the autonomic and somatic nervous system, the differences of their reflex arches.
22. Parasympathetic part of the autonomic nervous system: the central and peripheral parts.
23. Sympathetic part of the autonomic nervous system: the central and peripheral parts.
24. Cervical part of the sympathetic trunk: its topography, ganglions, branches and the innervation areas.
25. Thoracic part of the sympathetic trunk: its topography, ganglions, branches and the innervation areas.
26. Lumbar and sacral parts of the sympathetic trunk: their topography, ganglions, branches and the innervation areas.
27. Sympathetic plexuses of the thoracic, abdominal and pelvic cavities: the ganglions, branches and the innervation areas.

Учебное издание

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И ОРГАНОВ ЧУВСТВ**

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AND SENSORY ORGANS**

Учебно-методическое пособие на английском языке

Ответственный за выпуск П. Г. Пивченко  
В авторской редакции  
Компьютерная верстка Н. М. Федорцовой

Подписано в печать 28.05.10. Формат 60×84/16. Бумага писчая «Кюм Люкс».

Печать офсетная. Гарнитура «Times».

Усл. печ. л. 3,02. Уч.-изд. л. 2,73. Тираж 30 экз. Заказ 601.

Издатель и полиграфическое исполнение:  
учреждение образования «Белорусский государственный медицинский университет».  
ЛИ № 02330/0494330 от 16.03.2009.  
ЛП № 02330/0150484 от 25.02.2009.  
Ул. Ленинградская, 6, 220006, Минск.