

DONETSK STATE MEDICAL UNIVERSITY
named after M. GORKY

DEPARTMENT OF HISTOLOGY,
CYTOLOGY AND EMBRYOLOGY

SPECIAL HISTOLOGY
Part 1

Methodological instructions
for the 2nd year students

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SPECIAL HISTOLOGY

Part 1

LESSON 26	Spinal ganglion. Nerve. Spinal Cord
LESSON 27	Cerebellum. Brainstem
LESSON 28	Central nervous system. Cerebral cortex
LESSON 29	Autonomic nervous system
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METHODOLOGICAL INSTRUCTIONS TO LESSON 26 FOR STUDENTS

THEME: SPINAL GANGLION. NERVE. SPINAL CORD.

PROFESSIONAL MOTIVATION

Sensory nerve cell is the first neuron of each reflex arc. Such cells are predominantly concentrated in the spinal nodes (dorsal root ganglia), which are disposed on the dorsal root of spinal cord near their fusion with anterior one. Nerve ganglia, nerve trunks (peripheral nerves) and nerve endings belong the peripheral nerve system, which works due to the reflectory principle in coordination with central nerve system. central and peripheral portions are interconnected by means of nerves through the synapses.

GENERAL AIM: To know the histophysiology of spinal cord, spinal node and peripheral nerve trunk, to be able to identify structural components of these organs in the specimens.

Final aims:

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

BASIC LEVEL

1. Macroscopic structure of the spinal node and nerve - human anatomy department.
2. Nerve tissue - general histology.
3. Nerve fibers - general histology.

TESTS TO CONTROL BASIC LEVEL of KNOWLEDGE

1. Doctor analyses the organ of nervous system which is located along dorsal root. Name this organ.
 - A. Spinal cord.
 - B. Peripheral nerve.
 - C. Spinal ganglion.
 - D. Autonomic ganglion.
 - E. Brain.

2. In the specimen you can see the tissue which is developed from nerve tube. Which tissue is it?

- A. Muscular.
- B. Nerve.
- C. Connective.
- D. Epithelial.
- E. Blood.

3. In the electron micrograph the nerve fiber is seen. It consists of one axon and myelin sheath. Name this fiber.

- A. Myelinated.
- B. Unmyelinated.
- C. Elastic.
- D. Collagen.
- E. Reticular.

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. Spinal ganglion origin, development, general structure and functional meaning.
2. Morphological and functional peculiarities of spinal node sensory neurons and neuralgia compounds.
3. Peripheral nerve structure and meaning of connective tissue tunics.
4. Degeneration and regeneration of the nerve after the damage.
5. Simple and complex somatic reflex and principal compounds.

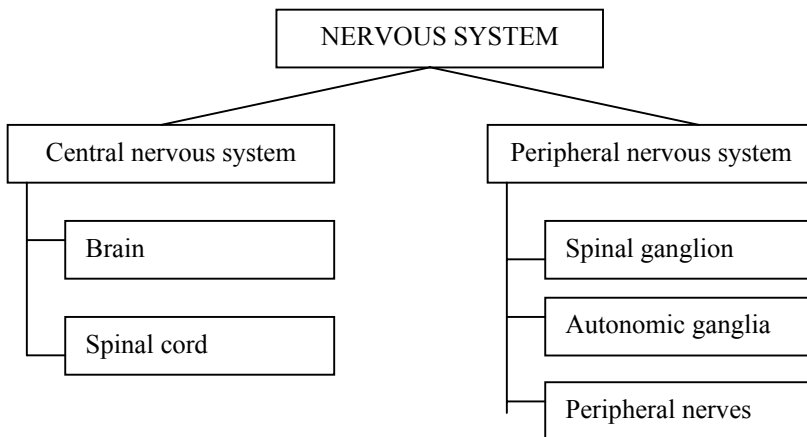
Key words and phrases: spinal node, spinal ganglion, dorsal root ganglion, capsule, fibers, sensory neurons, afferent neuron, pseudounipolar cells, neuroglial cells, mantle cells, multipolar cells, nerve trunk, nerve fibers bundle, glial sheath, Schwann cells, endoneurium, perineurium, epineurium.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 188-189.
2. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 106-109.
3. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 97-99.
4. Ультрaструктура клітин і тканин. Навчальний посібник-атлас. К.С. Волков, Н.В.Пасечка. Тернопіль: Укрмедкнига, 2000. с.

5. Атлас электронной микроскопии по частной гистологии. Э.Ф. Баринов, А.А. Лыков, О.И. Николенко, Н.Н. Бондаренко. – Изд-во Донецкого медицинского университета. Донецк, 1997. – Т. 1 – 228 с.

GENERAL ORGANISATION OF THE NERVOUS SYSTEM



II. For self-control students should fill in these tables.

Table 1.

Morphological and functional characteristic of the different types of neurones.

Morphological type of neuron	Functional type of neuron	Position in the reflex arc

Table 2.

Morphological and functional characteristic of the spinal cord nuclei

Name of the nucleus	Location of the nucleus	Type of neurones in the nucleus	Functional significance

III. Visual aids and material tools:

Students should be able to indicate elements in the electron micrographs:

1. Peripheral nerve cross section.
2. Pseudounipolar neuron of the spinal node.

Charts No:

- 26-1. Spinal node structure.
- 26-2. Pseudounipolar cell.

26-3. Somatic reflex arc.

26-4. Spinal cord.

3. Spinal cord

- Grey matter of spinal cord

- Ependymal cells of central canal

- Multipolar neurons in the spinal cord

Charts No:

26-5. Central nervous system structure

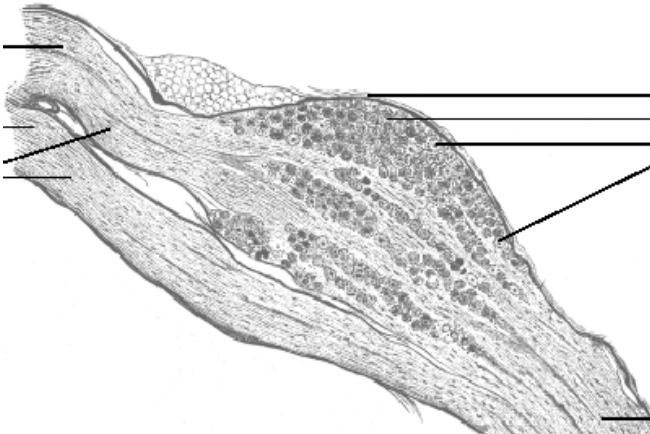
27-6. Horns of the spinal cord

III. Instruction for Students' practical activities:

Students must know and illustrate such histologic specimens:

Specimen 1. Spinal node. Stained with hematoxylin and eosin.

At a low magnification of microscope find anterior and posterior spinal cord roots and on the last one - spinal node, which is covered by the connective



tissue capsule. Distinct (exact) disposition of pericarions and nerve cells processes is the characteristic sign of spinal ganglion. Large pseudounipolar neurons with light vesiclelike nuclei are disposed peripherally right under the capsule. nerve processes occupy the middle part of the node. At a high microscope magnification find the sheath of small glial (mantial) cells with large dark nuclei around the nerve cells. Thin connective tissue layer surrounds the neurons outside. In fibroblasts and fibrocytes you may observe elongated nuclei with heterochromatine.

In transverse section, the central mass of grey matter has the shape of a butterfly, the ventral horns being most prominent and containing the cell bodies of the large lower motor neurons. The dorsal horns are much less prominent and contain the cell bodies of small second order sensory neurons, which relay sensory information to the brain from primary afferent neurons for the modalities of temperature and pain whose cell bodies lie in the dorsal root ganglia. Small lateral horns, which contain the cell bodies of preganglionic, sympathetic efferent neurons, are found in the thoracic and upper lumbar regions corresponding to the level of the sympathetic outflow from the cord. The volume of grey matter is much more extensive in the cervical and lumbar regions corresponding to the great sensory and motor innervation of the limbs and this is reflected in the much greater diameter of the spinal cord in these areas. The central containing CSF and lined with ependymal cells lies in the central commissure of grey matter.

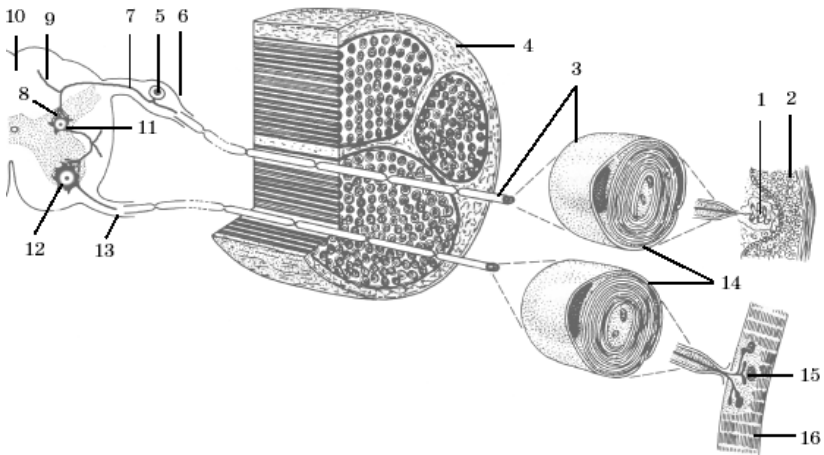
The white matter of the spinal cord consist of ascending tracts of sensory fibers and descending motor tracts; passing up the spinal cord towards the brain, more and more fibers enter and leave the cord so that the volume of white matter increases progressively from the sacral to cervical regions.

Externally, the spiral cord has a deep ventral median fissure but dorsally there is only a shallow dorsal midline sulcus. On each side, a dorso-lateral sulcus marks the line of entry of the dorsal nerve roots.



Illustrate and indicate: 1. Anterior median sulcus; 2. Posterior median septum; 3. Central canal; 4. Ventral (anterior) horn; 5. Dorsal (posterior) horn; 6. Lateral (intermediate) horn; 7. Ventral white column; 8. Lateral white column; 9. Dorsal white column; 10. Multipolar neurons.

Slide 3 Somatic reflex arc (scheme)



Students should draw this scheme in the album and name all structures which are marked by numeral designations.

IV. Real - life situations to be solved:

1. In the specimen of the parenchymatous organ is seen. The parenchyma of this organ is formed by nerve tissue. Which system does this organ belong to?

- A. Endocrine.
- B. Immune.
- C. Nervous.
- D. Digestive.
- E. Circulatory.

2. In the specimen you can see the organ of nervous system. It belongs to central nervous system. Which are the main parts of this organ?

- A. Grey and white matter.
- B. Stroma and parenchyma.
- C. Nerve tube and crest.
- D. Lobes.
- E. Tunicae and layers.

3. In the specimen you can see the organ of the peripheral nerve system. Its parenchyma is formed by pseudounipolar neurons which bodies are surrounded by satellite glial cells and connective tissue. Which organ is it?

- A. Spinal cord.
- B. Sympathetic ganglion.
- C. Parasympathetic ganglion.
- D. Spinal ganglion.

E. Brain stem

4. In the specimen you can see the peripheral nerve. Which structures form the parenchyma of this organ?

- A. Pseudounipolar neurones and myelinated fibers.
- B. Multipolar neurones and unmyelinated fibers.
- C. Myelinated and unmyelinated fibers.
- D. Multipolar neurones and myelinated fibers.
- E. Nerve and epithelial tissues.

5. In the specimen you can see the spinal cord. It is the nuclear type of nerve center. One of the nucleus includes the interneurons of autonomic reflex arc. Name this nucleus.

- A. Proper nucleus of the posterior horn.
- B. Clarke's nucleus.
- C. Intermediate medial nucleus.
- D. Intermediate lateral nucleus.
- E. Proper nucleus of the anterior horn.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 27 FOR STUDENTS

THEME: CEREBELLUM. BRAINSTEM.

PROFESSIONAL MOTIVATION

The cerebellum is an important division of the brain and the highest center of balance and coordination of movements of the body, it promoting muscular tension. It is connected with the brain column by afferent and efferent conductive ways, they forming three pairs of cerebellar limbs. In the nuclei of the column switching of the nervous impulses takes place, they coming from the spinal cord, spinal ganglions to the cerebral hemispheres and the cerebellum and in the opposite direction from the column to the cortex. Functional impairment of the cerebellum may occur in intoxication, for example, alcohol intoxication, infections, and traumas. Cerebral column hemorrhages can result in impairments of the subcortical centers, including respiratory, vasomotor centers, with severe consequences for the patient.

GENERAL AIM: Know the histophysiology structure of the cerebellum and brainstem nuclei, their structure.

Final aims: Students should be able to:

1. Identify the parts of brain stem in the specimens and slides.
2. Explain the functional significance of the different parts of brain stem.
3. Recognise the cerebellum in the specimens and slides.
4. Identify the layers of the cerebellar cortex.
5. Explain the functional peculiarities of cerebellar cortex on the basis of cellular content and relationship with other organs of the nervous system.

BASIC LEVEL

1. Anatomy of nervous system (department of anatomy)
2. Neurons and neuroglia (general histology)

TESTS TO CONTROL THE BASIC LEVEL OF KNOWLEDGE

1. During medical examination doctor estimates the state of the central nervous system organs. Which organs does it include?
 - A. Brain and spinal cord.
 - B. Brain and meninges.
 - C. Spinal cord and spinal ganglion.
 - D. Spinal cord and meninges.
 - E. Autonomic ganglion and spinal cord.
2. In the specimen of the nerve tissue you can see the big stellate cell. It has light round nucleus with nucleolus and basophilic cytoplasm. Name this cell.
 - A. Reticular cell.

- B. Neuron.
- C. Ependymocyte.
- D. Oligodendrocyte.
- E. Glial macrophage.

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

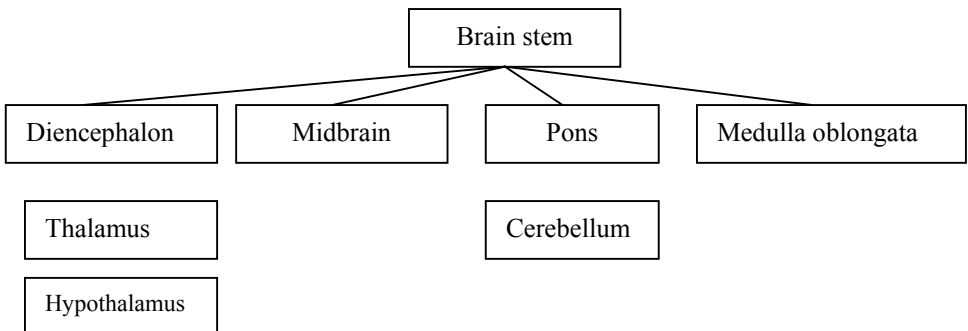
1. Cerebellum: general structure and function.
2. Layers of the gray matter cortex, characteristic of each neuron, which one can find in the cortex.
3. Afferent and efferent tracks of the cerebellum.
4. Main structural peculiarities of the cerebellum grey matter.
5. The structure and role of the reticular formation tube.
6. Thalamus: its main nuclei, function.

Key words and phrases: cerebellum, cortex of gray matter, central core of white matter, afferent fibers, efferent fibers, brainstem, inferior, middle, superior, cerebellar peduncles, medulla, pons, midbrain, deeply convoluted folds or fobia, molecular layer, granule cell layer, purkinje cells, stellate cells, basket cells, Golgi cells.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 190-191.
2. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - p. 312.
3. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 103-105.

PARTS OF THE BRAIN STEM



II. For self-control students should fill in these tables.

Table 1.

Characteristic of different parts of the brain stem

Part of the brain stem	Morphological features	Functional significance

Table 2

Morphological features and cellular content of the cerebellar cortex

Layers of the cerebellar cortex	Types of the neurons	Functional significance of the neurones

III. Visual aids and material tools:

Students should be able to indicate elements in the electron micrographs:

1. Stellate and basket cells of the molecular layer.
2. Purkinje cells.
3. Granule cell layer: Golgi cells.

Charts No:

28-1. Central nervous system support tissues and structures

28-2. Layer of cerebellum cortex

28-3. Relationships between axons and dendrites of cerebellum neurons

28-4. Components of brainstem

IV. Instruction for students' practical activities

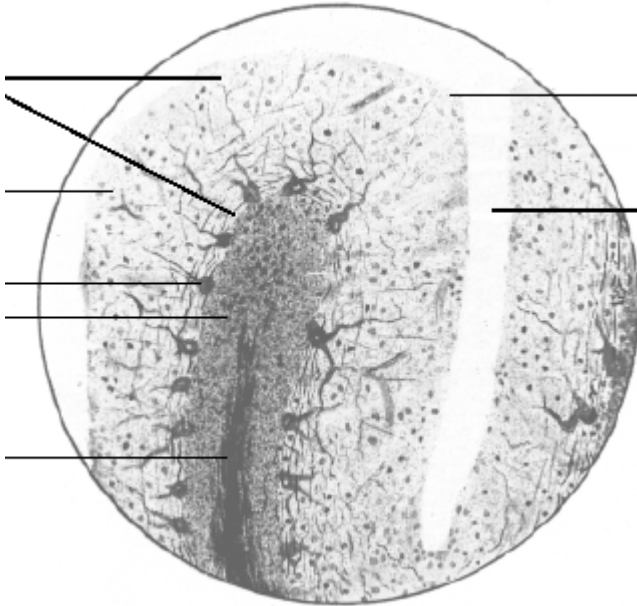
Students must know and illustrate such histological specimens:

Specimen 1. Cerebellum.

Silver impregnation

As seen in specimen, the cerebellum cortex forms a series of deeply convoluted folds or folia supported by a branching central medulla of white matter. The cortex is seen to consist of three layers, an outer layer containing relatively few cells (the so-called molecular-layer), an extremely cellular inner layer (the so-called granule layer) and a single intervening layer of huge neurons called Purkinje cells. The Purkinje cells have huge cell bodies, a relatively fine axon extending down through the granule cell layer, and an extensively branching dendritic system, which arborises into the outer molecular layer.

The deep granule cell layer of the cortex contains numerous small neurons, the non-myelinated axons of which pass outwards to the molecular layer where they bifurcate to run parallel to the surface to synapse with the dendrites of Purkinje cells; each granule cell synapses with several hundred Purkinje cells. There are three other types of small neurons in the cerebellar cortex, namely, stellate cells and basket cells scattered in the outer molecular layer and Golgi cells scattered in the superficial part of the granule cell layer.



Illustrate and indicate: I. Cerebellar cortex: 1. Molecular layer; 2. Single layer of huge neurons: a) Purkinje cells. 3. Granule cell layer; II. White matter.

IV. Real - life situations to be solved:

1. In the specimen you can see an organ of the central nervous system. It has grey and white matter. Grey matter covers the white matter and forms cortex, which includes 3 layers. Which organ is in the specimen?

- A. Cerebral cortex.
- B. Cerebellar cortex.
- C. Spinal cord.
- D. Retina.
- E. Spinal ganglion.

2. In the specimen you can see the cerebellar cortex. Which morphological type of neurones is unique to this organ?

- A. Pear-shaped.
- B. Corbifer.
- C. Horizontal.
- D. Pyramidal.
- E. Bipolar.

3. In the specimen you can see the cerebellar cortex. In which layer the Purkinje cells are located?

- A. Molecular.
- B. Pyramidal.
- C. External granular.
- D. Internal granular.
- E. Ganglionic.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 28 FOR STUDENTS

THEME: CENTRAL NERVOUS SYSTEM. CEREBRAL CORTEX.

PROFESSIONAL MOTIVATION

The location and degree of development of the human brain is the result of millions of years of evolution. Both functionally and structurally the primary centers for control and regulation of all nervous system function have become centralized in a process called encephalization. In lower animals the spinal cord has a great degree in independence from the brain, while in the human spinal cord function is directly under the regulation of the brain. The functional development of the brain distinguishes humans from lower animals, but anatomic differences are not as apparent. If we compare our brain with that of other primates, we can find the same basic structures in both; however, upon closer study, we find there are marked differences in degrees of development. This developmental change is in the form of more extensive neuron tracts in the human brain and a much greater degree of synaptic connections between neuron cell bodies.

GENERAL AIM: Know the structural organization of cerebral cortex and can to determine all neurons cell types in specimens and electron micrographs.

Final aims: Students should be able to:

1. Recognise the cerebral cortex.
2. Identify the layers of the cerebral cortex.
3. Interpret the cytoarchitecture of the cerebral cortex.
4. Explain the differences between sensory and motor cortex.

BASIC LEVEL

1. General organisation of central nerve system (department of anatomy).
2. Functional organisation of the cerebral cortex (anatomy)

TESTS TO CONTROL THE BASIC LEVEL KNOWLEDGE

1. The nervous system includes central and peripheral parts. Which are the main components of the central part of this system?
 - A. Stroma and parenchyma.
 - B. Cords and layers.
 - C. Tunicae and layers.
 - D. Grey and white matter.
 - E. Neurones and vessels.

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. Embryonic origin, structural and functional characteristics of the central nerve system.
2. Cytoarchitecture and myeloarchitecture of cerebral cortex.
3. Morphofunctional characteristic of cerebral cortex neurons.
4. The agranular and granular types of cerebral cortex.
5. Describe the blood – brain barrier in terms of its structural correlates and its function.

Key words and phrases: central nervous system, white matter, gray matter, cerebral hemispheres, neocortex, plexiform (molecular layer), outer granular layer, pyramidal cell layer, inner granular layer, ganglionic layer, multiform cell layer, pyramidal cells (Betz cells), stellate (granule) cells, cells of Martinotti, fusiform cells, horizontal cells of Cajal, supporting neuroglia cell, astrocytes, oligodendrocytes, multipolar neurons, motor neurons, sensory neurons, interneuron, cytoarchitecture, myeloarchitecture, agranular cerebral cortex, granular cerebral cortex, blood – brain barrier.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, p. 191.
2. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 314-315.
3. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 105-107.

II. For self-control students should fill in this table:

Table 1

Cytoarchitecture of the cerebral cortex

Layers of the cerebral cortex	Types of the neurons	Functional significance

III. Visual aids and material tools:

Students should be able to indicate elements in the electron micrographs:

1. Stellate cells of outer granular layer
2. Pyramidal neurons on ganglionic layer
3. Supporting neuroglial cells: astrocytes
4. Oligodendroglia

Charts No:

29-1. Central nerve system support tissues and structures

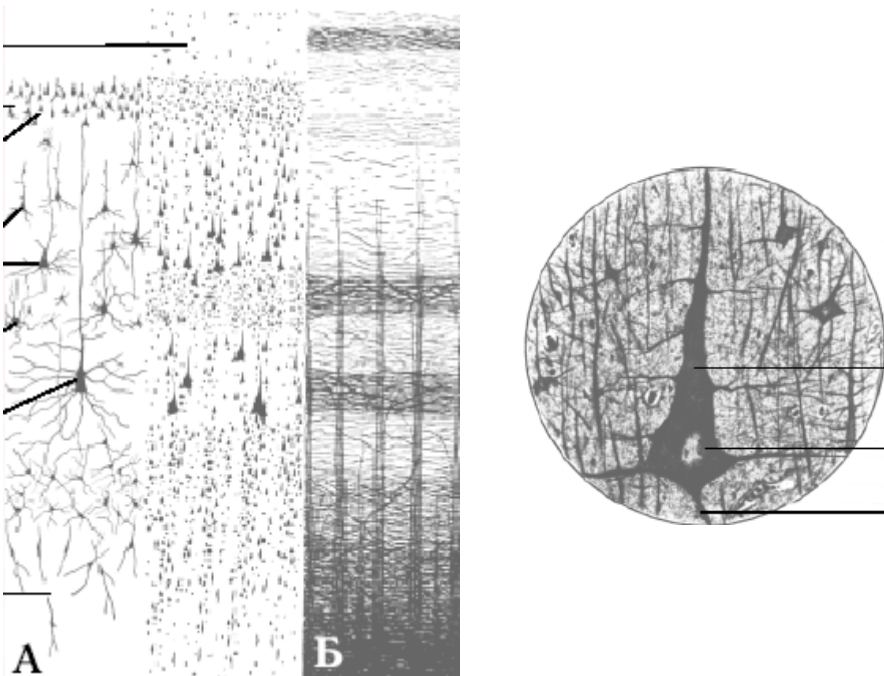
- 29-2. Neurone cell types in the cerebral cortex
- 29-3. Grey matter and white matter
- 29-4. Diagram of motor pathways between the cerebral cortex, one of the subcortical relay centers and lower motor neurons in the spinal cord

IV. Students' practical activities:

Students must know and illustrate such histologic specimens:

Specimen 1. Cerebral cortex.

Stained by hematoxyline and eosin.



The cerebral hemispheres consist of a convoluted cortex of grey matter overlying the central medullary mass of white matter which conveys fibers between different parts of the cortex and to and from other parts of the central nervous system. The neurons are arranged into six layers, the layers differing in characteristic neurone morphology, size and population density. The layers merge with one another rather than being highly demarcated and vary somewhat from one region of the cortex to another depending on cortical thickness and function. Specimen illustrates the typical layered appearance of the cerebral cortex, the more detailed characteristics of each layer being as follows:

1. Plexiform (molecular) layer. This most superficial layer mainly contains dendrites and axons of cortical neurons making synapses with one another; the sparse nuclei are those of neuroglia and occasional horizontal cells of Cajal.

Horizontal cells of Cajal are small and spindle-shaped but oriented parallel to the surface. They are the least common cell type and are only found in the most superficial layer where their axons pass laterally to synapse with the dendrites of pyramidal cells.

2. Outer granular layer. A dense population of small pyramidal cells and stellate cells make up this thin layer which also contains various axons and dendrites connections from deeper layer.

Stellate (granule) cells are small neurons with a short vertical axon and several short branching dendrites giving the cell body the shape of star. With routine histological methods the cells look like small granules giving rise to their alternative name.

3. Pyramidal cell layer. Pyramidal cells of moderate size predominate in this broad layer, the cells increasing in size deeper in the layer.

Pyramidal cells have pyramid-shape cell bodies, the apex being directed towards the cortical surface. A thin axon arises from the base of the cell and passes into the underlying white matter, though in the case of small superficially located cells, the axon may synapse in the deep layers of the cortex. From the apex, a thick branching dendrite passes towards the surface where it has a prolific array of fine dendrites branches. In addition, short dendrites arise from the edges of the base and ramify laterally. The size of pyramidal cells varies from small to large, the smallest tending to lie more superficially.

4. Inner granular layer. This narrow layer consists mainly of densely packed stellate cells.

5. Ganglionic layer. Large pyramidal cells and smaller numbers of stellate cells and cells of Martinotti make up this layer, the name of the layer originating from the huge pyramidal (ganglion) Betz cells of the motor cortex.

6. Multiform cell layer. So named on account of the wide variety of differing morphological forms found in this layer, the layer contains numerous small pyramidal cells and cells of Martinotti, as well as stellate cells especially superficially, and fusiform cells in the deeper part.

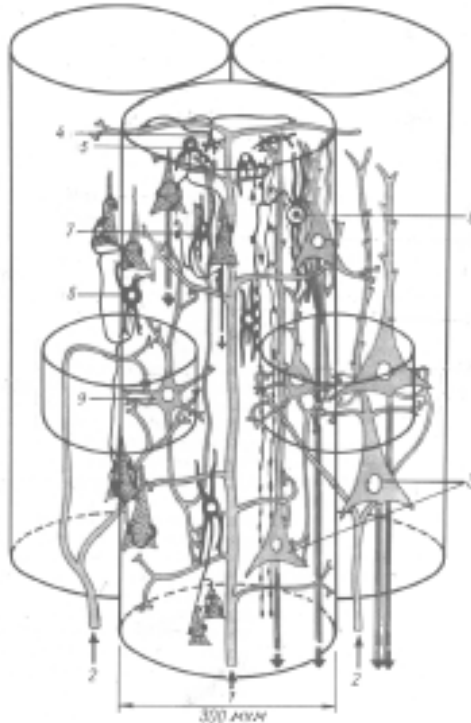
Cells of Martinotti are small polygonal cells with a few short dendrites and the axon extending toward the surface and bifurcating to run horizontally, most commonly in the most superficial layer.

Fusiform cells are spindle-shaped cells oriented at right angles to the surface. The axon arises from the side of the cell body and passes superficially. Dendrites extend from each end of the cell body branching so as to pass vertically into deeper and more superficial layers.

In addition to neurons, the cortex contains supporting neuroglial cells i.e. astrocytes, oligodendrocytes and microglia.

Illustrate and indicate: I. Cerebral cortex: 1. Plexiform (molecular) layer; 2. Outer granular layer; 3. Pyramidal cell layer; 4. Inner granular layer; 5. Ganglionic layer; 6. Multiform cell layer; II. White matter.

Slide 2. Module organisation of the cerebral cortex



Draw and identify the different types of the neurons: pyramidal cells (Betz cells), stellate (granule) cells, cells of Martinotti, fusiform cells, horizontal cells of Cajal, supporting neuroglia cell, astrocytes, oligodendrocytes, multipolar neurons, motor neurons, sensory neurons, interneuron,

V. Real – life situations to be solved

1. In the specimen you can see an organ of the central nervous system. It has grey and white matter. Grey matter covers the white matter and forms cortex, which includes 6 layers. Which organ is in the specimen?

- *A. Cerebral cortex.
 - B. Cerebellar cortex.
 - C. Spinal cord.
 - D. Retina.
 - E. Spinal ganglion.
2. In the specimen you can see the cerebral cortex. Which layers does it have?
- A. Molecular, ganglionic and granular.
 - B. Molecular, granular, pyramidal, ganglionic.
 - *C. Molecular, external granular, pyramidal, internal granular, ganglionic and multipolar.
 - D. External granular, pyramidal, internal granular, ganglionic and multipolar.
 - E. Molecular, external granular, internal granular, ganglionic and multipolar.
3. In the specimen you can see the cerebral cortex. Which morphological type of neurones is unique to this organ?
- A. Pear-shaped.
 - B. Corbifer.
 - C. Horizontal.
 - *D. Pyramidal.
 - E. Bipolar.
4. In the specimen you can see the cerebral cortex. In which layer the huge pyramidal cells are located?
- A. Molecular.
 - B. Pyramidal.
 - C. External granular.
 - D. Internal granular.
 - *E. Ganglionic.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 29 FOR STUDENTS

THEME: AUTONOMIC NERVOUS SYSTEM. MENINGES. BLOOD-BRAIN BARRIER.

PROFESSIONAL MOTIVATION

Unlike of somatic nervous system, which innervates the soma of the human body, autonomic nervous system is a specific part of nervous system, which innervates the inner organs, vessels and glands. Moreover, due to its physiologic and morphologic signs it is subdivided into sympathetic and parasympathetic ones, which have generally opposite regulatory influence onto the organs and systems activity. As a rule vegetative nervous system is not controlled by our consciousness (unlike the somatic one) that's why it is named «autonomic».

GENERAL AIM: Know the structural peculiarities of the autonomic nerve system and to be able to identify its morphologic compartments in the specimens. Interpret the structure and functions of the meninges and barriers.

Final aims: Students should be able to:

1. Recognise the different meninges and their tissues.
2. Identify the structures of blood-brain barrier.
3. Explain the structural and functional organisation of the choroid plexus.
4. Recognise the autonomic ganglion in the specimens.
5. Differentiate the sympathetic and parasympathetic ganglia in the specimens and slides.
6. Interpret the organisation of the autonomic reflex arc.

BASIC LEVEL

1. Nerve tissue – general histology.
2. Spinal cord - special histology.

TESTS TO CONTROL THE BASIC LEVEL OF KNOWLEDGE

1. In the specimen you can see the nerve tissue. Which are the components of this tissue?

- A. Cells and fibres.
- B. Only cells.
- C. Neurons and glial cells.
- D. Muscle fibres.
- E. neurones and fibres.

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. Autonomic nervous system general morphofunctional characteristic. Classification.
2. Nervous system sympathetic portion. Disposition of the central nuclei and peripheral (extramural) ganglia.
3. Types of the autonomic ganglia neurons.
4. Structural particularities of the pre- and postganglionic fibers.
5. Parasympathetic portion of the autonomic nervous system. Central nuclei disposition and intramural ganglia particularities.
6. Autonomic reflectory ark specific feature, its morphologic compartments.

Key words and phrases: Autonomic, vegetative, intramural, extramural, thoraco-lumbal, cranio-sacral, preganglionic fiber, myelinated, postganglionic fiber, unmyelinated, Golgi cells, sympathetic portion, parasympathetic portion.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 178-180.
2. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - p. 109.
3. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – p. 96.

II. For self-control students should fill in these tables:

Table 1.

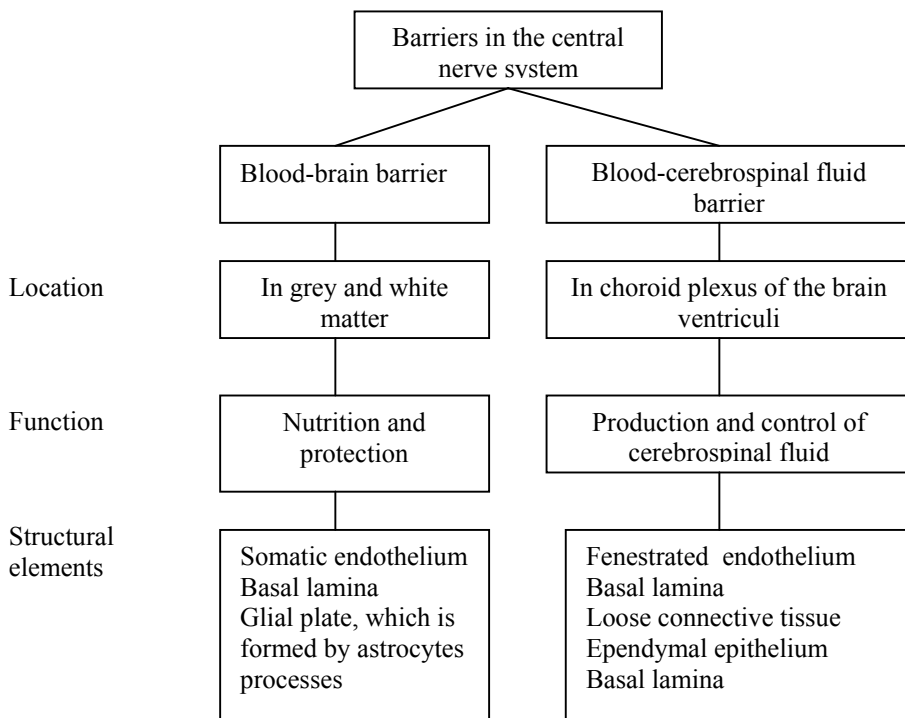
Characteristic of meninges

Name of meninges	Morphological features	Functions

Table 2

Differences between spinal and autonomic ganglia

Feature	Spinal ganglion	Autonomic ganglion
Location of neurons		
Type of neurons		
Prevail type of the fibres		
Fuction		



II. Visual Aids and Material Tools:

Students should be able to indicate elements in the electron micrographs:

1. Myelinated nerve fiber.
2. Unmyelinated nerve fiber.

Charts No:

- 30-1. Autonomic nervous system.
- 30-2. Sympathetic nervous system.
- 30-3. Parasympathetic nervous system.

III. Students' practical activities

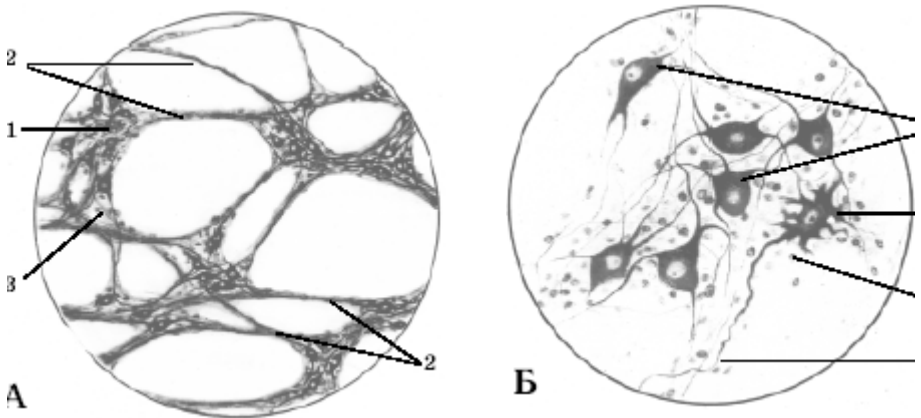
Students must know and illustrate such histologic specimens:

Specimen 1. Intramural nervous plexus.

Stained with silver impregnation.

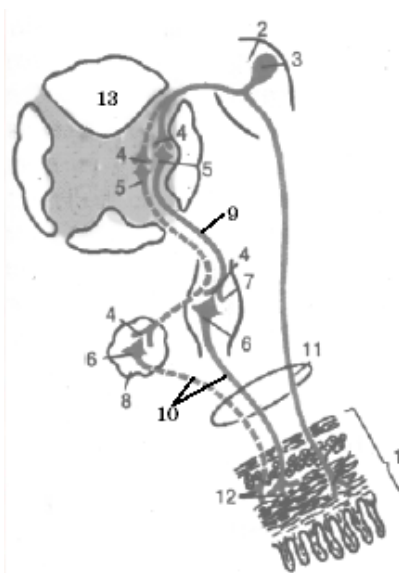
At a low magnification in the muscular tunic of the intestine find the nervous plexus, which consists of the intramural ganglia and nerve fibers. In the ganglia watch two types of nervous cells (Dogel cells). Cells of the first type have short dendrites and long axon; the other cells have almost equal sized processes. At

a high magnification find the glial cells nuclei, which surround the nervous cells body.



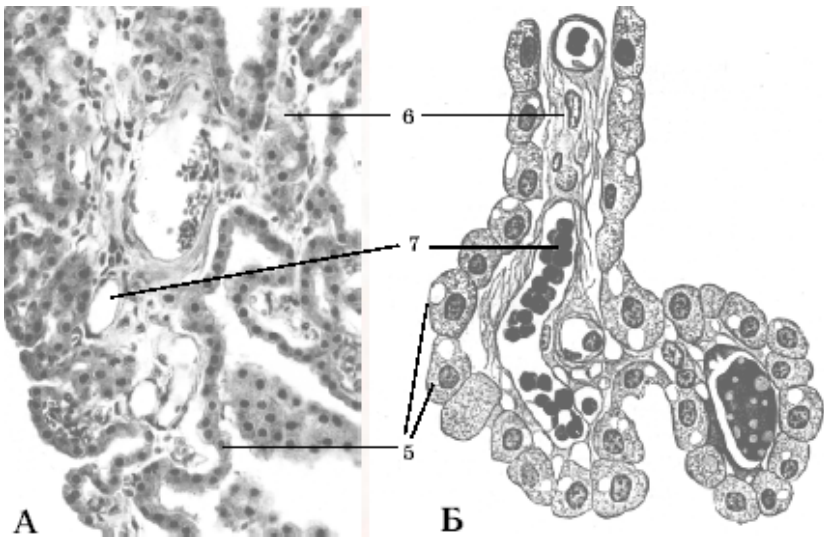
Illustrate and indicate: 1. Multipolar neurons: a) Dogel cells I; b) Dogel cells II. 2. Nerve fibers. 3. Glial cells nuclei.

Slide 2. Autonomic reflex arc.



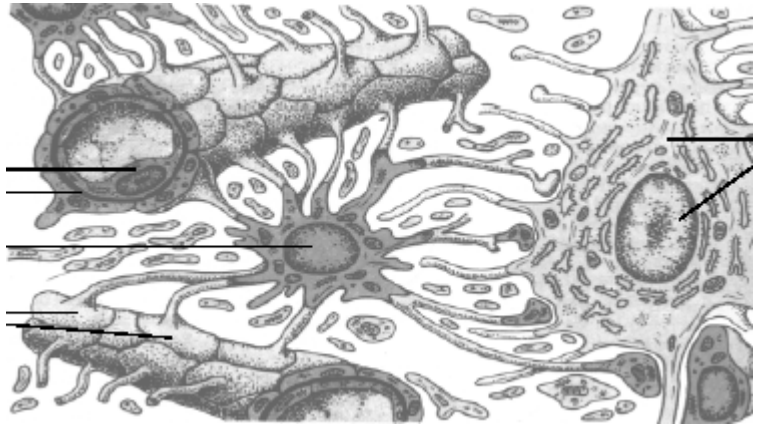
Draw this scheme and indicate the names of all components.

Specimen 3. Choroid plexus of the IVth brain ventriculus.
Stained by H&E.



Draw this structure at high magnification and designate all structural components.

Slide 4. Blood-brain barrier (scheme)



Analyse this figure and indicate all components of the blood-brain barrier.

V. Real – life situations to be solved

1. In the specimen you can see the brain, which is covered by meninges. Which are they?
*A. Dura mater, arachnoidea, pia mater.
B. Fibrous, choroidea and retina.
C. Inner and outer.
D. Internal, media and external.
E. Dura mater, pia mater.
2. In the electron microphotograph you can see the structures of blood-brain barrier. Which type of capillary takes place in this barrier formation?
*A. Somatic.
B. Fenestrated.
C. Sinusoidal.
D. Lymphatic.
E. Bile.
3. In the specimen you can see the choroid plexus. Which meninges forms this structure?
A. Dura mater.
B. Retina.
C. Arachnoidea..
D. Internal.
*E. Pia mater.

4. In the specimen you can see the sympathetic ganglion. Which tissue forms the parenchyma of this organ?

- A. Epithelial.
- B. Nervous and epithelial.
- C. Loose and dense connective tissue.
- *D. Nervous
- E. Myelinated nerve fibres and glial cells.

5. In the specimen you can see the sympathetic ganglion. Which structural elements form the parenchyma of this organ?

- *A. Multipolar neurons, unmyelinated nerve fibres and glial cells.
- B. Pseudounipolar neurons, nerve fibres and glial cells.
- C. Loose and dense connective tissue.
- D. Myelinated and unmyelinated nerve fibres.
- E. Myelinated nerve fibres and glial cells.

6. In the specimen you can see the sympathetic ganglion. Which neurone of autonomic reflexory arch is located here?

- A. Afferent.
- *B. Efferent.
- C. Interneuron.
- D. Secretory.
- E. Mixed.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 30 FOR STUDENTS

THEME: SENSE ORGANS. THE EYE.

PROFESSIONAL MOTIVATION

The central nervous system receives some information as for the outside world and the inner state of the organism with the aid of senses. The sensations resulted from this information reflect something existing regardless of our consciousness - the objective reality of everything around us. Needless to say, without our sense organs we would be completely helpless and unable to survive for any appreciable length in time. Doctors of many specialities such as oculists, otorhinolaryngologists, neurologists, psychiatrists need deep knowledge of the structure and functions of the sense organs. The knowledge of morphofunctional peculiarities of the recipient's organs are also necessary for pediatricians and therapists for preventing unfavourable influence of the environment on the histophysiology of the sense organs.

GENERAL AIM: To study histophysiology of the eye and can to identify in specimens and electron micrographs basic tissues that make up the globe of the eye.

Final aims: Students should be able to:

1. Explain the organisation of the analyser.
2. Interpret the general features of the receptor zones.
3. Describe the general structure of the eye globe.
4. Identify the parts of tunica fibrosa (sclera and cornea) in the specimen.
5. Interpret the functional properties of the choroid derivatives.
6. Recognise the retina and its layers.
7. Differentiate the rods and cones in the electron micrographs.

BASIC LEVEL

1. Basic knowledge of special sense organs (department of anatomy).
2. Optic diagram of the eye (department of anatomy).

TESTS TO CONTROL BASIC LEVEL KNOWLEDGE

1. In human organism there are several analyser. Which is the peripheral part of this system?
 - A. Cerebral cortex regions.
 - B. Cerebellar cortex regions.
 - C. Organs of special senses.
 - D. Peripheral nerve.
 - E. Parts of brain stem.

2. Doctor analyse the function of organ of vision. Which is object of the investigation.

- A. Anterior chamber.
- B. Eye globe.
- C. Parenchymatous organ.
- D. Inner ear.
- E. Nasal cavity.

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. Classifications of sensory receptors. List the receptors that fit into each class.
2. Description of general features of the sense organs.
3. The major steps in the embryonic development of the eye.
4. 3 compartments in the eye, give the boundaries of each.
5. 3 basic tunics that make up the globe of the eye. List the major components of each, in order from anterior to posterior.
6. Description of sclera in terms of its predominant tissue type, its vascularity and the proportion of the eye it covers.
7. 5 layers of the cornea and description of composition of each.
8. Comparison of the rods and cones in terms of their visual acuity in bright and low light.

Key words and phrases: sense organs, tunica fibrosa, cornea, limbus, sclera, choroid, ciliary body, iris, retina, pigmented epithelium, photoreceptive cells, rods and cones, visual pigment iodopsin, bipolar cells, ganglion cells, horizontal cells, supporting cells, muller cells, fovea centralis, optic disc, optic nerve, vitreous body, lens, accommodation, bulbar conjunctiva, palpebral conjunctiva, eyelids (palpebrae), orbicularis oculi muscles, lacrimal glands, lysozyme, amacrine cells, acrimal apparatus.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 470-488.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 315-333.
3. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 318-329.
4. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 339-345.

II. For self-control students should fill in these tables:

Table 1.

Characteristics of the eye globe tunicae

Tunica	Parts of this tunica	Morphological features	Functional significance

Table 2.

Functional apparatus of the eye.

Apparatus	Components	Functional significance

Table 3.

Structural and cellular organisation of the retina layers.

Layer of the retina	Components

III. Visual Aids and Material Tools:

Students should be able to indicate elements in the electron micrographs:

1. Photoreceptor neurons of the neural retina: rods
2. Photoreceptor neurons of the neural retina: cones

Charts No:

- 31-1. Gross relationships of the parts of the eye
- 31-2. Corneal epithelium
- 31-3. Limbus of the human eye
- 31-4. Layers of the retina
- 31-5. Structure of photoreceptive cells

IV. Students' Practical Activities

Students must know and illustrate such histologic specimens:

Specimen 1. Cornea.

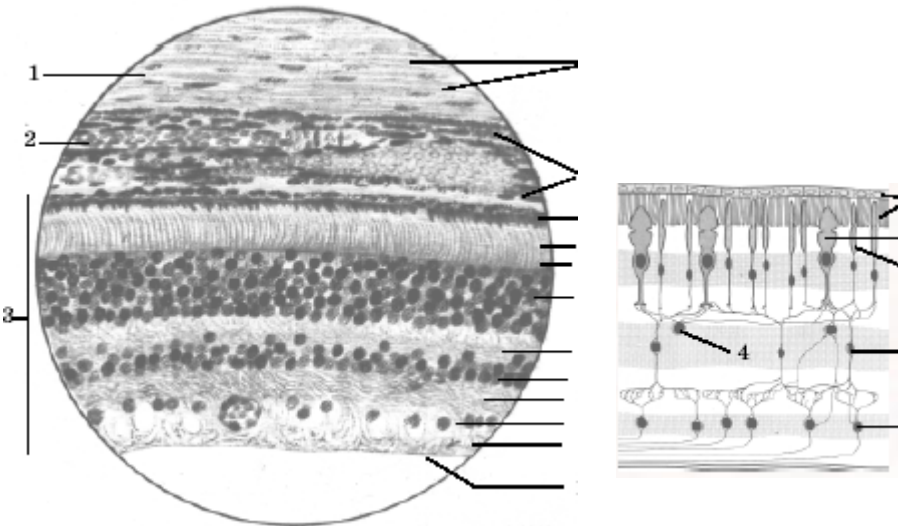
Heamatoxylin and Eosin.

The cornea is an avascular structure consisting of five layers. The outer surface is lined by stratified squamous epithelium about five cells thick which is not normally keratinised. This epithelium is supported by a specialised basement membrane known as Bowman's membrane which is particularly prominent in man. The bulk of the cornea, the substantia propria, consists of a highly regular form of dense collagenous connective tissue forming thin lamellae. Fibroblasts and occasional leucocytes are scattered in the ground substance between the lamellae. The inner surface of the cornea is lined by a layer of flattened endothelial cells

which are supported by a very thick elastic basement membrane known as Descemet's membrane.

Illustrate and indicate: 1.Stratified squamous epithelium. 2.Bowman's membrane. 3.Substantia propria. 4.Descemet's membrane. 5.Layer of flattened endothelial cells.

Specimen 2. Wall of the eye.
Heamatoxylin and Eosin.



The three layers of the wall of the eye are illustrated in this specimen. The inner photosensitive retina is a multi-layered structure, the outermost limit of which is defined by a layer of pigmented epithelial cells.

The choroid is a layer of loose, highly vascular connective tissue lying between the sclera externally and the retina internally. The choroid and retina are separated by a thin membrane known as Bruch's membrane which probably represents the basement membrane of the pigmented epithelium. The choroid contains numerous large, heavily pigmented melanocytes which confer the dense pigmentation characteristic of the choroid. The pigment absorbs light rays passing through the retina and prevents interference due to light reflection.

The sclera consists of dense fibro-elastic connective tissue, the fibres of which are arranged in bundles parallel to the surface. This layer contains little ground substance and few fibroblasts. The sclera varies in thickness, being thickest posteriorly and thinnest at the coronal equator of the globe.

Retina is made up of three basic cell types, neurons, pigmented epithelial cells and neurone support cells. Histologically, the retina is traditionally divided

into 10 distinct histological layers. The outermost layer (1) consists of the pigmented epithelial cells forming a single layer resting on Bruch's membrane which separates them from the choroid superficially. Rod and cone processes of the photoreceptor cells comprise the next layer (2) with a thin eosinophilic structure known as the outer limiting membrane (3) separating them from a layer of densely packed nuclei described as the outer nuclear layer (4). The outer nuclear layer contains the cell bodies of the rod and cone photoreceptors. The almost featureless layer deep to this is known as the outer plexiform layer (5) and contains synaptic connections between the short axons of the photoreceptor cells and integrating neurones, the cell bodies of which lie in the inner nuclear layer (6). In the inner plexiform layer (7), the integrating neurones make synaptic connections with dendrites of neurones whose axons form the optic tract. The cell bodies of the optic tract neurones (sometimes called ganglion cells) comprise the ganglion cell layer (8). Deep to this is the layer of afferent fibres (9) passing towards the optic disc to form the optic nerve. Finally, the inner limiting membrane (10) demarcates the innermost aspect of the retina from the vitreous body.

Illustrate and indicate: I. Sclera. II. Choroid. III. Retina: 1. Single layer of pigmented epithelial cells. 2. Rod and cone photoreceptor layer. 3. Outer limiting membrane. 4. Outer nuclear layer. 5. Outer plexiform layer. 6. Inner nuclear layer. 7. Inner plexiform layer. 8. Ganglion cell layer. 9. Layer of afferent fibers. 10. Inner limiting membrane.

V. Real - life situations to be solved

1. In the specimen you can see the eye globe. Its wall is composed of three concentric layers. Which are they?

A. Tunica intima, tunica media, tunica adventitia.

B. Mucosa, submucosa and adventitia.

C. Mucosa, cartilaginous, adventitia.

*D. Tunica fibrosa, the vascular layer and the retina.

E. Mucosa, muscularis and adventitia.

2. In the specimen of the eye globe wall you can see the external layer (tunica fibrosa). Which structures does it include?

*A. Sclera and cornea.

B. Choroid, ciliary body and iris.

C. Pigmented epithelium and retina proper.

D. Sclera and iris.

E. Sclera and ciliary body.

3. In the specimen of eye globe you can see a space between cornea on the one side and iris with lens on the another side. Which fluid does this space contain?

A. Blood.

- B. Lymph.
- C. Cerebro-spinal fluid.
- *D. Aqueous humor.
- E. Tissue fluid.

4. In the specimen of eye globe wall you can see a part of tunica fibrosa, which doesn't have vessels. Which structure is in the specimen?

- A. Sclera.
- B. Iris.
- C. Ciliary body.
- D. Retina.
- *E. Cornea.

5. In the specimen you can see the retina of the posterior part of the eye. It includes photosensitive neurons. Which are they?

- A. Horizontal and bipolar.
- B. Ganglionar and amacrine.
- C. Bipolar and ganglionar.
- *D. Rods and cones.
- E. Horizontal and Muller cells.

6. In the specimen of the eye wall you can see the retina. Which tissues does it include?

- A. Loose connective and nervous.
- *B. Pigmented epithelium and nervous.
- C. Nervous and loose connective.
- D. Smooth muscle and epithelial.
- E. Nervous and smooth muscle.

7. In the electron microphotograph of the retina you can see the rod. Which photopigment does this cell have?

- A. Iodopsine.
- *B. Rodopsine.
- C. Melanin.
- D. Bilirubin.
- E. Verdoglobin.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 31 FOR STUDENTS

THEME: AUDIOVESTIBULAR ORGAN

PROFESSIONAL MOTIVATION

Audiovestibular organ is the perypheral portion of the audio and vestibular analisators, which possesses the second place after visual system by the information percieved from outside. The receptor cells of these organs are secondary sensory, because at first special sensoepithelial cells percept the irritation and then transmit them to the bipolar neurons. For future doctors of differentt specialities, especially for neurologists and otolaryngologists, the knowledge of audio and vestibular disorders are necessary very much.

GENERAL AIM: Know the microscopic structure and functions of audiovestibular organ. Be able to identify compartments of the membranous labyrinth walls and spiral Corti's organ.

Final aims: Students should be able to:

1. Identify the parts of the inner ear.
2. Recognize the receptor zone of the auditory system.
3. Interpret the cellular content and functions of the Corti organ.
4. Recognize the macula and cristae of the vestibular apparatus.
5. Identify the different sensoepithelial cells of the vestibular apparatus.

BASIC LEVEL

1. Macroscopic structure of the ear - human anatomy department.
2. Tissues - general histology.

TESTS TO CONTROL THE BASIC LEVEL KNOWLEDGE

1. Doctor analyze the function of the auditory system. Which are the anatomical parts of this system.
 - A. Anterior and posterior chambers.
 - B. External, middle and inner ear.
 - C. Upper, middle and lower part of ear.
 - D. Tympanic cavity and auditory tube.
 - E. Vestibulum and semicircular canals.
2. In some organs of the special senses receptor zones are formed by epithelial tissue. Which are the components of this tissue?
 - A. Only cells on basal membrane.
 - B. Cells and extracellular matrix.
 - C. Neurones and glial cells.
 - D. Neurones and fibres.
 - E. blood cells and plasma.

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. General characteristic features of the audiovestibular organ: the external, middle and internal ear.
2. Ultrastructure and functions of the tympanic membrane.
3. Bone and membranous labyrinth of the internal ear.
4. Vestibular portion of the membranous labyrinth - vestibular organ.
5. Ampullary crests, spots of the utricle and saccule: disposition, ultrastructure and functions.
6. The hearing organ. Membranous labyrinth of the cochlea.
7. Spiral Corti's organ: disposition and functions.
8. Cells components of the Corti's organ. Supporting cells: types, structure and disposition.
9. Receptor cells of the Corti's organ: types and ultrastructure.
10. Audiovestibular organ histophysiology.

Key words and phrases: audiovestibular organ, external ear, middle ear, internal ear, tympanic membrane, bone labyrinth, membranous labyrinth, ampullary crests, sensory spots, utricle, saccule, cochlea, vestibular membrane, basilar membrane, stria vascularis, Corti's organ, receptor cell, pillar cell, supporting cell, phalangeal cell, Hensen supporting cells, Claudius border cells, tectorial membrane, spiral limbus, spiral ganglion.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 488-496.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. - 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 333-345.
3. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 330-341
Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. - pp. 346-349

II. For self-training students should fill in these tables:

Table 1.

Characteristic of the receptor zones of the auditory and vestibular apparatus.

Receptor zone	Location	Morphological characteristic	Functional significance

Table 2.

Structure of the membranous labyrinth of the cochlea

Wall of the membranous labyrinth	Structural components	Functional significance

III. Visual Aids and Material Tools:

Charts No:

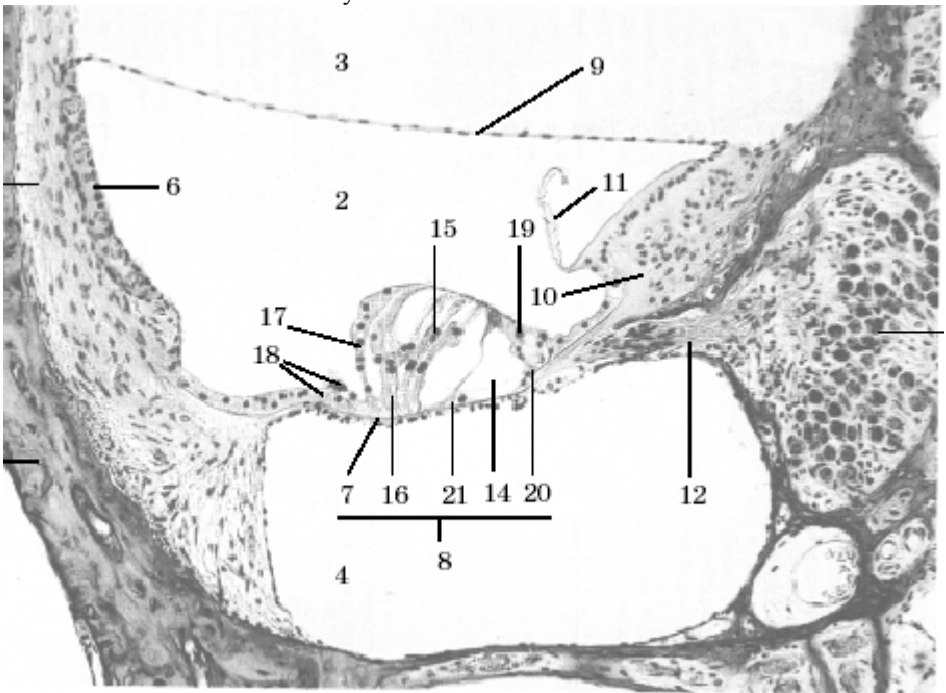
- 32-1. Audiovestibular organ sensory cells structure.
- 32-2. Audiovestibular organ sensory spots structure.
- 32-3. Structure of the ampullary crists.
- 32-4. Membranous labyrinth of the cochlea.
- 32-5. Scheme of the Corti's organ.

IV. Students' practical activities:

Students must know and illustrate such histologic specimens:

Specimen 1. Organ of Corti.

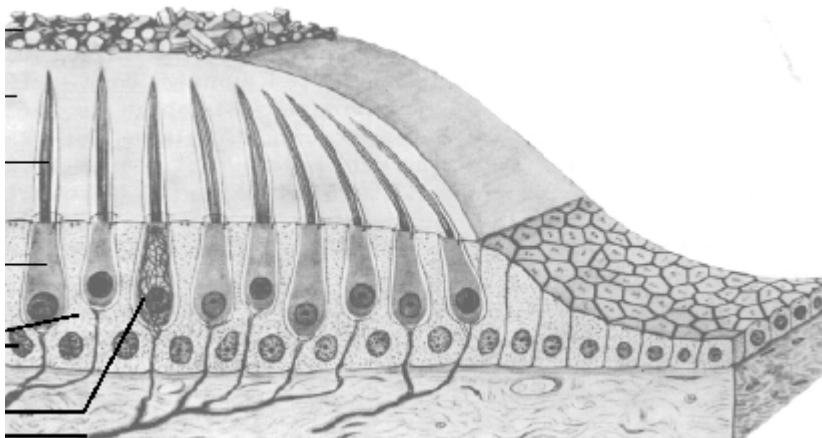
Stained with haematoxylin and eosin.



At a high magnification one can see the Corti's organ, which is disposed on the low wall of the membranous labyrinth (basilar lamina) and consists of two types of the cells: sensory (receptors) and supporting. Due to the topography spiral organ cells are divided into the inner and outer groups, boarded by the inner tunnel, which is made of pillar cells. Ciliary cells are the receptory apparatus of Corti's organ; they rest on the supporting cells. The outer supporting cells include phalangeal cells of Deiters (3-5 rows), outer supporting Hensen cells lie lateraly and then boarder Claudius cells are disposed. There are inner phalangeal cells inside from the inner pillar cells. All the supporting cells are resting on the basilar membrane. Inner sensory cells are oval-shaped and lie in one row. Outer sensory cells are cilindrcal-shaped and are organized into 3-5 rows. Tectorial membrane lie up to the spiral organ and it is connected with limbus.

Illustrate and indicate: 1. Basilar membrane. 2. Pillar cells. 3. Tunnel of Corti. 4. Inner sensory cells. 5. Outer sensory cells. 6. Outer phalangeal cells. 7. Inner phalangeal cells. 8. Outer supporting Hensen cells. 9. Outer boarder Claudius cells. 10. . 11. Spiral limbus. 12. Spiral ganglion.

Slide 2. Macula of the vesibuum (scheme)



Draw this figure in the album and designate all structural components.

V. Real – life situations to be solved

1. In the specimen of the inner ear you can see the macula. Which stimuli does this structure respond to?

- A. Light.
- B. Sound wave.
- *C. Linear accelerations.
- D. Angular accelerations.

- E. Chemical molecules.
2. In the specimen of the inner ear you can see the crista. Which stimuli does this structure respond to?
- A. Light.
 - B. Sound wave.
 - C. Linear accelerations.
 - *D. Angular accelerations.
 - E. Chemical molecules.
3. In the specimen of the inner ear you can see the organ of Corti in the cochlear duct. Which stimuli does this structure respond to?
- A. Light.
 - *B. Sound wave.
 - C. Linear accelerations.
 - D. Angular accelerations.
 - E. Chemical molecules.
4. In the specimen of the inner ear you can see the macula. In which part of membranous labyrinth is this structure located?
- A. Cochlear duct.
 - B. Semicircular ducts.
 - *C. Utricle and saccule.
 - D. Scala vestibuli.
 - E. Scala tympani.
5. In the specimen of the inner ear you can see the crista. In which part of membranous labyrinth is this structure located?
- A. Cochlear duct.
 - *B. Semicircular ducts.
 - C. Utricle and saccule.
 - D. Scala vestibuli.
 - E. Scala tympani.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 32 FOR STUDENTS

THEME: SPECIAL SENSES. DEVELOPMENT, STRUCTURE AND HISTOPHYSIOLOGY OF THE OLFACTORY REGION OF THE NASAL CAVITY, TASTE BUDS AND SPECIALIZED PERIPHERAL RECEPTORS.

PROFESSIONAL MOTIVATION

The nervous tissue is an absolutely especial tissue that forms the nervous system. The last one can receive stimuli from both internal and external environments; these are then analysed and integrated to produce appropriate co-ordinated responses in various effector organs. Nervous tissue integrates and co-ordinates organs functions within the human body due to the nervous fibres connecting all the structures in human body.

GENERAL AIM: Know the microscopic structure and functions of olfactory, taste and touch organs. Be able to identify types of cells and nerve endings in the specimens.

Final aims: Students should be able to:

1. Identify the olfactory epithelium.
2. Recognize the different types of cells in olfactory epithelium.
3. Identifu the taste buds.
4. Interpret the cellular content taste bud.
4. Recognize the different types of nerve endings in the skin and other organs.

BASIC LEVEL

1. Nervous system anatomy (school biology, human anatomy department).
2. Tissues - general histology.

TESTS TO CONTROL THE BASIC LEVEL KNOWLEDGE

1. Doctor analyze the function of the taste analysator. Which is the location of the peripheral part of this analyzer?
 - A. Nasal cavity.
 - B. External, middle and inner ear.
 - C. Upper, middle and lower part of ear.
 - D. Tympanic cavity and auditory tube.
 - E. Papillae of the tongue.
2. In some organs of the special senses receptor zones are formed by epithelial tissue. Which are the components of this tissue?
 - A. Only cells on basal membrane.
 - B. Cells and extracellular matrix.
 - C. Neurones and glial cells.
 - D. Neurones and fibres.

E. Blood cells and plasma.

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. Understand the overall structure of the sense organs.
2. Recognize the olfactory region of the nasal cavity.
3. Understand the organization and cell types of the olfactory epithelium.
4. Understand the organization of the taste buds on the microscopic and ultramicroscopic level.
5. Understand the structure and function of the taste buds at different regions of the tongue.
6. Recognize different specialized peripheral receptors their functions.

• **Key words and phrases:** basal cells, Bowman's gland, ciliated cells, dorsal surface of the tongue, endoneurium, epineurium, ergastoplasm, filiform papillae, foliate papillae, goblet cells, intrinsic striated muscles of tongue, Meissner's corpuscle, mucous secreting cells (if present), nerves, olfactory cells, olfactory epithelium, Pacinian corpuscle, perineurium, respiratory epithelium, secretory vesicles, serous secreting cells, supporting cells, taste buds, von Ebner's glands and ducts

References:

4. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 488-496.
5. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 333-345.
6. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 330-341
Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 346-349

II. For self-training students should fill in these tables:

Table 1.

Characteristic of the receptor zones of the olfaction, taste and touch analyzers .

Receptor zone	Location	Morphological characteristic	Functional significance

Table 2.

Cells of the olfactory epithelium and taste buds

Special sense	Types of cells	Functional significance

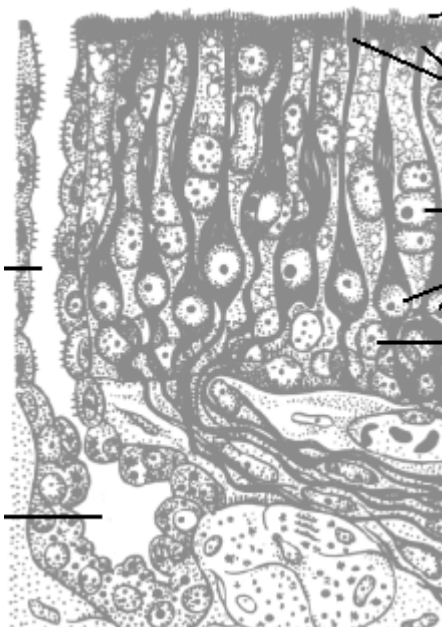
III. Visual Aids and Material Tools:

1. Olfactory epithelium
2. Taste buds in the papillae of the tongue
3. Receptors in skin.

IV. Students' practical activities:

Students must know and illustrate such histologic specimens:

SLIDE 1 Olfactory epithelium (H&E)

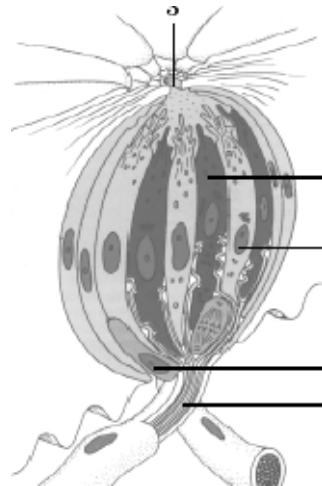
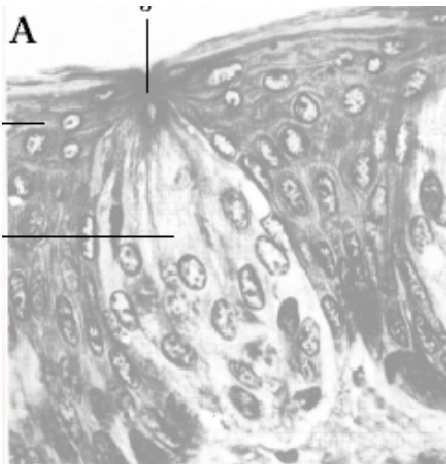


This is a frontal section through the nasal cavity. Orient yourself on this slide, identify nasal conchae and nasal septum. Observe the lining of the nasal cavity which is represented by a typical pseudostratified columnar ciliated epithelium (respiratory mucosa) with few scattered goblet cells. In the upper portion of the nasal cavity find an area of thicker epithelium which has many layers of nuclei. This is the olfactory epithelium. The majority of the nuclei in the olfactory epithelium belong to olfactory cells, which are receptor bipolar neurons.

The outer layer of the cells represents supporting cells. The basal cells can be found adjacent to the basement membrane. This thick pseudostratified epithelium has tubulo-alveolar (Bowman's) glands located in the lamina propria beneath the epithelium. In addition, there is an abundance of blood vessels and occasional nerves beneath the olfactory epithelium.

Identify and designate: olfactory epithelium, respiratory epithelium, ciliated cells, basal cells, olfactory cells, supporting cells, goblet cells, Bowman's gland, nerves.

SLIDE 2 Taste buds in the papillae of the tongue, rabbit (H&E)



The tongue consists of a specialized mucosa and muscle. The mucosal projections at the dorsal surface of the tongue are filiform and foliate papillae. On the low magnification identify two types of papillae: foliate which occupy the majority of the surface, and filiform on the edge of your section. Observe the well preserved foliate papillae and the sulci between them. Within the epithelium of the sulcus are several taste buds. Directly beneath the epithelium is connective tissue. Examine the bundles of intrinsic muscles in perpendicular orientations. Classify the muscle type. Examine the histological differences between dense connective tissue and muscle. Serous (von Ebner's) glands can be found between muscle fibers and in the connective tissue of the mucosa. These glands secrete into ducts that deposit the secretions at the sulcus. The glands on this slide are predominantly serous, but some mucous glands may be present. Serous secreting cells are basophilic (blue ergastoplasm and blue secretory vesicles) with round nuclei. The cytoplasm of a mucus secreting cell is pale blue with its flattened nucleus

positioned at the basal surface of the cell. Be careful not to confuse a mucous gland with a duct. Classify the epithelium lining the ducts. Be able to distinguish the ducts from the secretory portions of the glands.

Identify and designate: stratified squamous epithelium, basal cells, taste cells, supporting cells, nerves.

V. Real – life situations to be solved

1. In the electron microscopy you can see the taste bud. Which papillae of tongue have this structure?

- A. Filliform, foliate, fungiform and circumvallate.
- B. Filliform, foliate, fungiform.
- C. Filliform, foliate and circumvallate.
- D. Filliform, fungiform and circumvallate.
- *E. Foliate, fungiform and circumvallate.

2. In the electron microscopy you can see the taste bud. Which cells does this structure include?

- A. Photoreceptor and bipolar neurons.
- B. Hair cells without kinocilium and supporting cells.
- *C. Basal, taste and supporting.
- D. Taste and supporting.
- E. Hair cells with kinocilium and supporting cells.

3. In the specimen you can see the olfactory epithelium. Which cells does it have?

- A. Photoreceptor and bipolar neurons.
- B. Hair cells without kinocilium and supporting cells.
- *C. Basal, olfactory and supporting.
- D. Olfactory and supporting.
- E. Hair cells with kinocilium and supporting cells.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 33 FOR STUDENTS

THEME: SUMMARY LESSON ON THE TOPICS 26 – 32

AIM: To generalise and fasten the acquired knowledge in histophysiology of nerve system and sense organs by means of a test control using specimens diagnosis and electron micrographs

Programm questions to the test

1. Nerve system general morphofunctional characteristic, sources of origin, classification (structural and functional).
2. Central nerve system, grey and white matter, nerve centres, brain meninges. Blood-brain barrier.
3. Large hemispheres cortex. Morphofunctional characteristic, cyto- and myeloarchitectony. Cortex gliocytes.
4. Cerebellum general structure and functions Cerebellar cortex layers, neurons. Interneuronal communications. Cerebellum gliocytes.
5. Brainstem. Grey matter neuronal compounds. Medulla oblongata. Reticular formation.
6. Diencephalon. Thalamus and hypothalamus principle nuclei. Diencephalon functions.
7. Spinal cord general morphofunctional characteristic. Grey matter nuclei and their cell compounds. Gliocytes.
8. Morphological and functional peculiarities of spinal node sensory neurons and neuroglial compounds.
9. Peripheral nerve system. Nerve trunks structure. Nerve regeneration after the damage. Simple and complex somatic reflex arc principal compounds.
10. Autonomic (vegetative) nerve system structure peculiarities. Ganglia nerve cells and disposition. Reflex arc special features.
11. The term analisator and their principle portions. Sense organs classification due to the origin and structure of the receptor cells.
12. Visual organ. Eyeball general structure, tunics, their portions and derivatives.
13. Fibrous and vascular tunics of eyeball, their portions thin structure and functions. Cornea microscopic and histochemical characteristic.
14. Inner eye tunic. Retina nerve cells compounds. Ultrastructural and cytochemical characteristic of the photoceptor cells.
15. Eye dioptric and accommodative apparatus.
16. Audiovestibular organ. Cochlear membranous labyrinth structure and functions. Corti's organ histophysiology.
17. Vestibular organ. Membranous labyrinth vestibular portion structure. Disposition, structure and functions of the utricle and saccule macules and ampullary crests.

The list of specimens

1. Brain cortex. Silver impregnation.
2. Cerebellum. Silver impregnation.
3. Spinal cord. Silver impregnation.
4. Spinal node. Stained with haematoxylin and eosin.
5. Nerve (transverse section in human skin). Stained with haematoxylin and eosin.
6. Intramural nerve plexus. Silver impregnation.
7. Cornea. Stained with haematoxylin and eosin.
8. Wall of the eye. Stained with haematoxylin and eosin.
9. Cochlear axial section. Stained with haematoxylin and eosin
10. Organ of Corti. Stained with haematoxylin and eosin

The list of electron micrographs

1. Brain cortex nerve cells. Fig. 5
2. Cerebral cortex protoplasmic astrocyte. Fig. 7.
3. Brain cortex oligodendrocyte. Fig. 8.
4. Spinal cord grey matter. Fig. 3
5. Spinal canal ependyma. Fig. 4

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 163-193, 467-496.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 135-168.
3. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 95-118, 316-342.
4. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 87-107, 337-349.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control tests	15	Tests	Computers	Computer class
2.	Discussion of the main points	55 min	Slides, Tables	Projector	Class room
3.	Summary and results of activity	10 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 34 FOR STUDENTS

THEME: CIRCULATORY SYSTEM. ARTERIES AND VEINS.

PROFESSIONAL MOTIVATION

Microcirculatory bed is an important link of small-sized vessels. It begins with arterioles and lasts to the venules. This morphofunctional complex of vessels proves the regulation of organs blood supplying, transcapillary metabolism and homeostasis in tissues. Each organ and tissue has its own peculiarities of the blood supplying at the microcirculatory level, whose principle compounds are capillaries. The other compounds of the microcirculatory bed are arteriolo-venule anastomoses, which promote direct passage of the arterial blood to the venules, pass round the capillaries. Lymphatic system is responsible for the normalization of the interstitial tissue and blood plasma volume.

GENERAL AIM: Know the microscopic and ultrastructure of arteries and veins, to be able to identify arteries and veins in a specimen.

Final aims: Students should be able to:

1. Identify the organs of the circulatory system.
2. Indicate the general features of the artery.
3. Classify the arteries and veins.
4. Identify the veins in the specimens.
5. Explain the functional properties of different vessels.

BASIC LEVEL

1. Circulatory system – human anatomy department.
2. Knowledge of tissues – general histology.

TESTS TO CONTROL THE BASIC LEVEL OF KNOWLEDGE

1. Doctor examine the state of the circulatory system in patient. Which organs belong to this system?
 - A. Brain and vessels.
 - B. Heart, blood and lymphatic vessels.
 - C. Blood and lymphatic vessels.
 - D. Heart and lymphatic vessels.
 - E. Spleen, lymph node and brain..
2. In the specimen you can see the tissue which consists of muscle fibres. Fibre is the cell with

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. Circulatory system components.
2. The general features of vessels wall structure.
3. Dependence of vessel's wall on the haemodynamic conditions.
4. Arteries classification and functional meaning.
5. Elastic, mixed and muscular arteries structure.
6. Veins, their differences compare to arteries.
7. Veins classification and functions.

Key words and phrases: circulatory system; haemodinamic conditions; intima; endothelium; subendothelial layer; elastic lamina; tunica media; adventitia; «vessels of vessels»; arteries; elastic, mixed and muscular arteries; aorta; veins; valve; muscular vein; nonmuscular vein.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 216-232.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 168-172.
3. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 121, 127-128.
4. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 113-115.

II. For self-control students should fill in these tables

Morphological characteristic of arteries

Type of artery	Structure	Fuctions

Morphological characteristic of veins

Type of artery	Structure	Fuctions

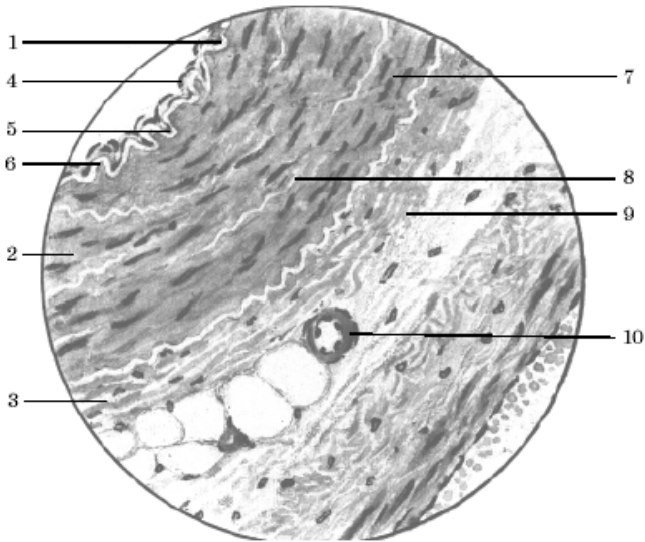
III. Visual aids and material tools:

Charts No:

- 34-1. General structure of vessels.
- 34-2. Elastic artery.
- 34-3. Muscular artery.
- 34-4. Muscular vein.

IV. Students' practical activities

Students must know and illustrate such histologic specimens:



Specimen 1. Muscular artery.

Stained with haematoxylin and eosin.

At a low magnification artery is round or oval-shaped. Its wall consists of three tunics: outer, middle and inner. At a high magnification it is seen that inner tunic luminal surface is covered by the endothelial cells, then subendothelial layer and inner elastic membrane are disposed. The widest middle tunic predominantly consists of smooth myocytes, which are disposed circularly. There are a few elastic fibers between them. Thin outer elastic membrane separates the middle tunic from the outer one. The last tunic (adventitia) is composed of a loose connective tissue.

Illustrate and indicate: 1. Tunica intima: a) endothelial layer; b) subendothelial layer; c) internal elastic lamina. 2. Tunica media: a) smooth muscle cells. 3. Adventitia.

Specimen 2. Muscular vein. Stained with haematoxylin and eosin.

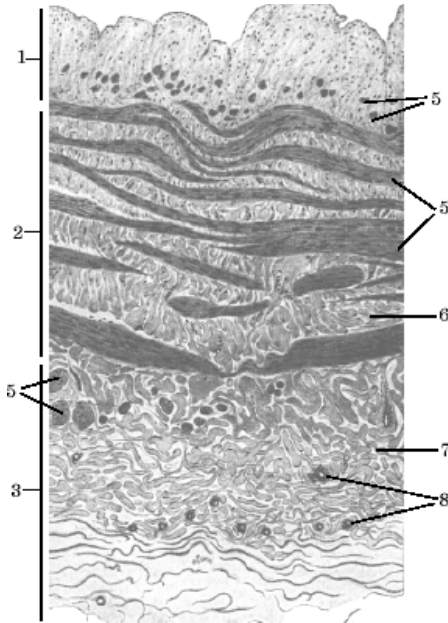
At a low magnification let you recognize the vein and middle sized artery. The lumen of the vein is .the inner tunic of the vein has no elastic membrane, the middle one is much more thinner than in muscular artery. Adventitia of the vein is thick and contains smooth myocytes. Watch the specimen at a high magnification, paint the wall of the vein.

Illustrate and indicate: 1. Tunica intima: a) endothelial layer; b) subendothelial layer. 2. Tunica media. 3. Adventitia.

Compare the size of artery and vein, please.

Does vein have well prominent outer and inner elastic membrane?

What is the most prominent tunic of the vein wall and why it is so?



V. Real - life situations to be solved

1. In the specimen you can see an organ of circulatory system. Its function is to transport the blood with nutrients and oxygen to the tissues. Which organ is in the specimen?

- *A. Artery.
- B. Vein.
- C. Heart.
- D. Capillary.
- E. Bronchus.

2. In the specimen you can see an organ of circulatory system. Its function is to transport the blood with catabolites and CO₂ from tissues to the heart. Which organ is in the specimen?

- A. Artery.
- *B. Vein.
- C. Heart.

- D. Capillary.
 E. Bronchus.
3. In the specimen you can see a vessel. Which cells line this organ?
 A. Cuboidal epithelial.
 *B. Endothelial.
 C. Fibroblasts.
 D. Osteocytes.
 E. Macrophages.
4. In the specimen you can see an organ, which is a hollow tube. Its wall includes tree tunics and is lined by a single layer of endothelial cells. Which system is this organ referred to?
 A. Respiratory.
 B. Digestive
 C. Male reproductive.
 D. Endocrine.
 *E. Circulatory.
5. In the specimen you can see an artery. Which tunic is the thickest in this vessel?
 A Intima.
 *B. Media.
 C. Mucosa.
 D. Submucosa.
 E. Adventitia.
6. In the specimen you can see a vein. Which tunic is the thickest in this vessel?
 A. Intima.
 B. Media.
 C. Mucosa.
 D. Submucosa.
 *E. Adventitia.

Technological card to practical classes

Nº	Types of activity	Duratio n	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 35 FOR STUDENTS

THEME: MICROCIRCULATORY BED. LYMPHATIC VESSELS.

PROFESSIONAL MOTIVATION

Microcirculatory bed is an important link of small-sized vessels. It begins with arterioles and lasts to the venules. This morphofunctional complex of vessels proves the regulation of organs blood supplying, transcapillary metabolism and homeostasis in tissues. Each organ and tissue has its own peculiarities of the blood supplying at the microcirculatory level, whose principle compounds are capillaries. The other compounds of the microcirculatory bed are arteriolo-venule anastomoses, which promote direct passage of the arterial blood to the venules, pass round the capillaries. Lymphatic system is responsible for the normalization of the interstitial tissue and blood plasma volume.

AIM: Know the thin structure and functional meaning of the microcirculatory bed vessels. To know the structure and functions of lymphatic vessels. To be able to identify the blood and lymphatic capillaries in specimen and different types of capillaries in electron micrographs.

Final aims: Students should be able to:

1. Describe morphofunctional characteristic and significance of the microcirculatory bed.
2. Identify blood capillary wall structure. Ultrastructural peculiarities and regeneration of the endothelium.
3. Interpret capillaries types due to its endothelium and basement membrane structure.
4. Explain the microscopic structure of the arterioles and venules.
5. Analyse the anastomoses classification, structure and functions.
6. Recognise lymphatic system components and significance. Lymphatic capillaries.

BASIC LEVEL

1. Angiology – human anatomy department.
2. Tissues – general histology.
3. Arteries and veins – special histology.

TESTS TO CONTROL THE BASIC LEVEL OF KNOWLEDGE

In the specimen you can see a vessel. Which cells line this organ?

- A. Cuboidal epithelial.
- *B. Endothelial.
- C. Fibroblasts.
- D. Osteocytes.
- E. Macrophages.

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

7. Morphofunctional characteristic and significance of the microcirculatory bed.
8. Blood capillary wall structure. Ultrastructural peculiarities and regeneration of the endothelium.
9. Capillaries types due to its endothelium and basement membrane structure.
10. Microscopic structure of the arterioles and venules.
11. Anastomoses classification, structure and functions.
12. Lymphatic system components and significance. Lymphatic capillaries.

Key words and phrases: microcirculatory bed; blood capillary; somatic capillary; visceral capillary; sinusoides; lymphatic capillary; arteriole; venule; endothelium; basement membrane; fenestra, basal surface; luminal surface.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 218-226.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 171-174.
3. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 123-127.
4. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 111-112.

II. For self-training students should fill in these tables:

Morphological characteristic of the microvessels:

Type of vessel	Morphological features	Function

Morphological characteristic of different types of capillaries

Type of capillaries	Structure	Functional properties

III. Visual aids and material tools:

Students should be able to indicate elements in the electron micrographs:

1. Somatic capillary (cross section in the brain cortex). 1st type.
2. Visceral (fenestrated) capillary of the kidney glomerulus. 2nd type.
3. Sinusoidal capillary of the liver. 3rd type.

Charts No:

35-1. Microcirculatory bed of the pia mater.

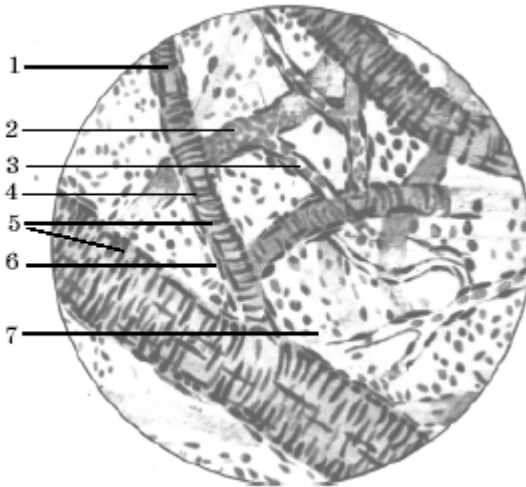
35-2. Scheme of the capillaries structure.

IV. Students' practical activities:

Students must know and illustrate such histologic specimens:

Specimen 1. Arterioles, venules, capillaries (total specimen of the pia mater).

Stained with haematoxylin and eosin



At a low magnification special attention should be paid on the dense network of hemocapillaries. At a high magnification let you identify the arteriole, capillary and venule due to the wall structure peculiarities. In the wall of arteriole the cross striations may be observed because of circular disposition of the smooth myocytes. Venules have larger diameter, smooth myocytes almost are absent in the wall, there are a lot of blood cells in the lumen. Capillaries in the specimen have a small size and thin wall (which consists of one layer of the endotheliocytes).

Illustrate and indicate: 1. Arteriole: a) endothelium nuclei; b) smooth muscle cells nuclei. 2. Venule: a) endothelium nuclei; b) adventitial cells nuclei; c) blood cells. 3. Capillaries: a) endothelium; b) blood cells.

What are the specific features of the arterioles in the specimen?

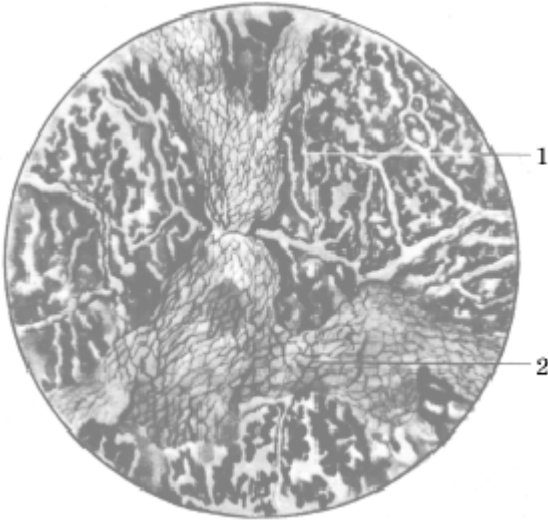
What kind of microcirculatory bed blood vessels has the largest lumen?

What type of vessels has the thinnest wall?

Specimen 2. Lymphatic capillaries.

Stained with methylen blue

At a low magnification lymphatic capillary diameter is much larger than the hemocapillary. At a high magnification it is seen, that lymphatic capillary wall has only endothelial cells.



Illustrate and indicate: 1. Endothelium nuclei. 2. Capillary lumen.

What kind of capillaries has the larger clear space (lumen): blood or lymphatic?

What kind of capillaries has no basement membrane: blood or lymphatic?

V. Real - life situations to be solved

1. In the specimen you can see an organ of circulatory system. Its function is interchange between blood and tissues. Which organ is in the specimen?

- A. Artery.
- B. Vein.
- C. Heart.
- *D. Capillary.
- E. Spleen.

2. In the specimen you can see an organ of circulatory system. Its function is to return the fluid of the tissue space to the blood. Which organ is in the specimen?

- A. Artery.
- B. Vein.
- C. Heart.
- D. Capillary.
- *E. Lymphatic vessel.

3. In the specimen you can see blood capillaries. Which is the function of these vessels?

- *A. To make exchange between blood and tissues.
- B. To return the fluid of the tissue space to the blood
- C. To carry the blood with nutrients and oxygen to the tissues
- D. To pump the blood.
- E. To transport the blood with catabolites and CO₂ from tissues to the heart

4. In the electron microphotograph you can see a capillary. Its wall is characterised by the absence of fenestrae in endothelial cells and presence of continuous basal lamina. Which type of capillaries is described?

- *A Somatic (continuous).
- B. Fenestrated (visceral)
- C. Sinusoidal (discontinuous)
- D. Bile.
- E. Lymphatic.

5. In the electron microphotograph you can see a capillary. Its wall is characterised by the presence of fenestrae in endothelial cells and continuous basal lamina.

Which type of capillaries is described?

- A. Somatic (continuous).
- *B. Fenestrated (visceral).
- C. Sinusoidal (discontinuous).
- D. Bile.
- E. Lymphatic.

Technological card to practical classes

No	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 36 FOR STUDENTS

THEME: HEART. AORTA.

PROFESSIONAL MOTIVATION

During the last years in most highly developed countries cardiac and vascular diseases prevail over other diseases as for their occurrence, severity and lethality. This is due to peculiarities of modern man's living, a remarkable physical activity decrease, psychoemotional overstrain, alcohol usage. These unfavorable factors results in changing structural and metabolic processes in the heart and vascular walls and promote developing some prerequisites for their impairment. The knowledge of histophysiology of the heart and vessels can help to understand the pathogenesis of many diseases of these organs.

AIM: Know the layers of tissue (tunics) those make up the wall of the heart and be able to identify the endocardium, myocardium, and epicardium in the specimens and electron micrographs.

Final aims: Students should be able to:

1. Identify the layers of tissues (tunics) that make up the wall of the heart.
2. Analyse the structure of the endocardium.
3. Compare heart wall with the structure of the blood vessels wall.
4. Recognise myocardium: structure of cardiac muscle cells compare to the cells of conductive system.
5. Compare the structure of the valves in the heart with that of those found in veins.
6. Identify the components of the impulse generating and conducting system.

BASIC LEVEL

1. Structure of the heart (department of anatomy)
2. General and special tissues (general histology)
3. Blood vessels (special histology)

STUDENTS'S INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. Layers of tissues (tunics) that make up the wall of the heart.
2. Structure of the endocardium. Comparison with the structure of the blood vessels wall.
3. Myocardium: structure of cardiac muscle cells compare to the cells of conductive system.

4. Comparison of the structure of the valves in the heart with that of those found in veins.
5. List, in order, the components of the impulse generating and conducting system of the heart through which an electrical stimulus must pass to cause contraction of the ventricular myocardium, include the cardiac muscle cells themselves.
6. Nerve regulation of the heart activity.
7. Regeneration of the heart.

Key words and phrases: heart, atria, ventricles, endocardium, myocardium, epicardium, pericardium, cardiac valves, tricuspid valve, bicuspid valve (mitral valve), semilunar valves, aortic valve, pulmonary valve, conducting system, sinoatrial node (pacemaker node), atrioventricular node, bundle of His, Purkinje fibers, cardiac muscle cells, intercalated disks.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 227-229.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 176-178.
3. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 118-121.
4. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 117-121.

II. For self-training students should fill in this table:

Characteristic of the heart wall layers

Layer	Tissues	Functional significance

III. Visual aids and material tools:

Students should be able to indicate elements in the electron micrographs:

1. Fragment of the cardiac muscle cell (longitudinal section)
2. Fragment of the cardiac muscle cell (cross section)
3. Cardiac muscle cells junction
4. Intercalated disc

Charts No:

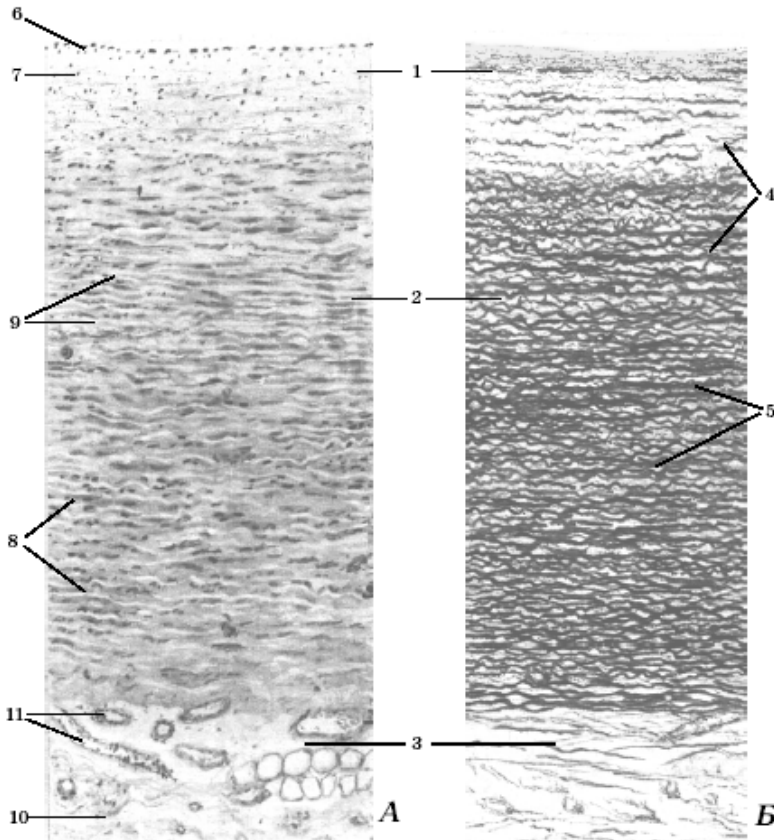
- 36-1. Intercalated disc
- 36-2. Cross section of the heart wall
- 36-3. Conductive system (schematic diagram)
- 36-4. Myocardium

IV. Students' practical activities

Students must know and illustrate such histologic specimens:

Specimen 1. Elastic artery: aorta.

Stained with rein-haematoxylin



At a low magnification the wall of aorta is easily identified compare to the muscular artery ones by the structure of the middle tunic, which has a lot of elastic membranes. Watch the specimen at a high magnification; paint the wall of the aorta.

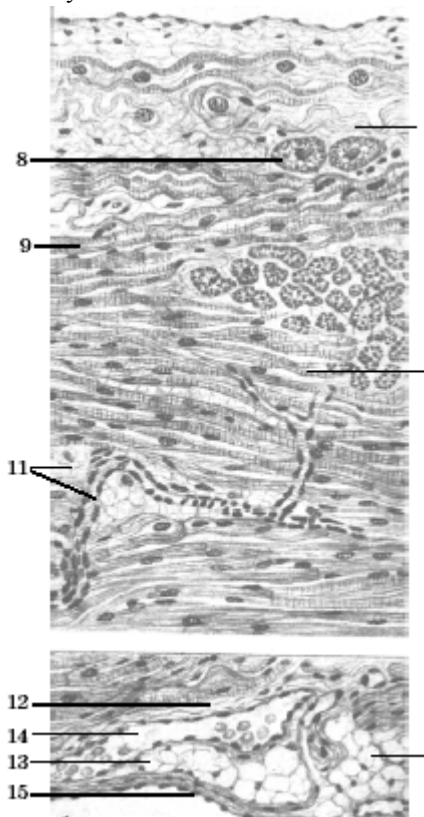
Illustrate and indicate: 1. Tunica intima: a) endothelium nuclei. 2. Tunica media: a) elastic membranes. 3. Adventitia: a) «vessels of vessels».

What is the principal difference between elastic and muscular arteries?

What is the name of the elastic structures in the middle tunic?

Why does aorta belong to the elastic vessel?

Specimen 1. Endocardium and myocardium.
Haematoxylin and Eosin.



The endocardium, the innermost layer of the heart, consists of an endothelial lining and its supporting connective tissue. The endothelium is a single layer of flattened epithelial cells, which is continuous with the endothelium of the vessels entering and leaving the heart. The endothelium is supported by a delicate layer of the connective tissue which accommodates gross movements of the myocardium without damage to the endocardium. The subendothelial connective tissue becomes continuous with the perimysium of the cardiac muscle. The endocardium contains blood vessels, nerves and branches of the conducting system of the heart (modified cardiac muscle fibers).

Modified cardiac muscle fibers (Purkinje fibers) cross in the subendocardial connective tissue before penetrating the ventricular myocardium. The conducting cells are large, sometimes binucleate, with extensive pale

cytoplasm containing relatively few myofibrils which are arranged in an irregular manner immediately beneath the plasma membrane of the cell. The cytoplasm is rich in glycogen and mitochondria but in contrast to cardiac muscle cells, there is no T tubule system. Connections between the Purkinje cells are via desmosomes and gap junctions rather than by intercalated discs as in the myocardium.

Illustrate and indicate: 1.Endocardium. 1.Endothelium; 2.Subendothelial layer; 3.Muscular-elastic layer; 4.External layer of the loose connective tissue. 5.Purkinje fibers (modified cardiac muscle fibers).

V. Real – life situations to be solved:

1. In the specimen you can see a vessel. The best-developed tunic in its wall is media, which includes perforated elastic laminae (40-70), elastic fibres and smooth muscle cells layers. Which vessel is described?

- A. Vein.
- B. Muscle artery.
- *C. Large elastic artery.
- D. Capillary.
- E. Arteriole.

2. In the specimen you can see the heart wall. Which tunics does its wall include?

- A Mucosa, submucosa, muscularis externa, adventitia.
- B. Mucosa and adventitia.
- *C. Endocardium, myocardium, epicardium.
- D. Endometrium, myometrium and perimetrium.
- E. Mucosa, submucosa, cartilaginous, adventitia.

3. In the specimen of the heart you can see the myocardium. Which tissue forms this tunic?

- A. Smooth muscle.
- B. Skeletal muscle.
- C. Loose connective tissue.
- D. Myoepithelial.
- *E. Cardiac muscle.

4. In the specimen of the heart you can see large cells in subendocardial region. These cells have round nuclei on the periphery and pale stained cytoplasm. It include few myofibrils, and a lot of glycogen granules and vesicles with calcium. Which is the function of these cells?

- A. Regeneration.
- B. Contraction.
- C. Secretion of atrial natriuretic factor.
- *D. Generation and conduction of a rhythmic stimulus
- E. Transport of nutrients.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 37 FOR STUDENTS

THEME: ORGANS OF HAEMOPOIESIS AND IMMUNE SYSTEM: BONE MARROW, THYMUS.

PROFESSIONAL MOTIVATION

Man's ability to mount an immune response is a two – edged sword. While immunologic competence is vital for survival in the sometimes hostile microbiologic environment, immune reactions may cause fatal disease as in the case of an overwhelming hypersensitivity reaction to the sting of a bee. Indeed, a host of disorders known collectively as the autoimmune diseases are thought to result from the abnormal emergence of immunity against one's own tissues and cells. Students must know fundamentals of the immune system followed by a consideration of its role in the normal conditions and in the production of the diseases.

GENERAL AIM: be able to recognize the various precursors of mature erythrocytes and granulocytes in electron photographs or specimens of bone marrow. For each cell type, be able to name the cell type and the stages preceding and following the blood formation.

Final aims: Students should be able:

1. Explain the functions of the lymphoid system.
2. Identify the distinguishing features of the lymphoid organs.
3. Recognise the difference between central and peripheral lymphoid organs.
4. Recognise the thymus
5. Identify the red bone marrow in the specimens.

BASIC LEVEL

1. Basic anatomical structures of the blood-forming organs (department of anatomy).

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. Functions of the lymphoid system.
2. Distinguishing features of the lymphoid organs.
3. Difference between central and peripheral lymphoid organs.
4. Description of the thymus in terms of its general functions, its location in the body and the type of reticular cells it contains and their embryonic germ layer of origin.

5. Comparison of the cortex and medulla of the thymus in terms of the packing density of lymphocytes and presence of Hassall's corpuscles.
6. Location of the blood-thymus barrier, the layers through which a substance in the blood would have to pass to cross the blood-thymus barrier.
7. The probable function of the blood-thymus barrier.

Key words and phrases: lymphoid tissue, peripheral lymphoid organs, central lymphoid organs, thymus, antigen-independence, Hassall's corpuscles, dark-staining cortex, central light-staining medulla, epithelial reticular cells, blood-thymus barrier, thymic hormones, T-lymphocytes (thymocytes), macrophages, thymus-dependent regions, thymopoietin, thymosin, adrenocorticosteroids, thymocyte proliferation, growth hormone, androgens and estrogens, thymectomy, bone marrow, red marrow, yellow marrow, reticular connective tissue, stroma, hematopoietic cords, blood islands, medullary tissue, lymphatic tissue, bone marrow smear.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 251-252, 265-268.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 186-189.
3. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 151-152, 161-166.
4. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 68-72, 131-133.

II. For self-training students should fill in these tables:

Characteristic of the organ of immunity

Organ	Morphological features	Function

Characteristic of the different zones of the thymus.

<i>Zone</i>	<i>Process which takes place in this zone</i>	<i>Cellular content</i>	<i>Functional significance</i>

III. Visual aids and material tools:

Students should be able to indicate elements in the electron micrographs:

1. Hematopoietic compartment of erythrocytes

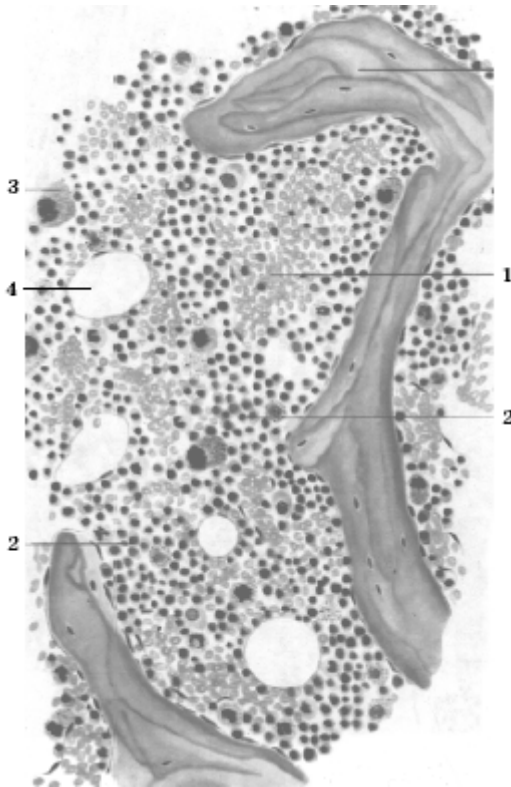
2. Hematopoietic compartment of granulocytes
3. Megakaryocytes
4. Vascular sinuses. Red bone marrow
5. Thymic cortex

IV. Students' practical activities

Students must know and illustrate such histological specimens:

Specimen 1. Bone marrow smear.

Giemsa.



In intertrabecular spaces of all bones are filled with bone marrow containing the primitive stem cells from which all the cellular elements of blood are derived. In section, bone marrow is seen to consist of a mass of nucleated blood cell precursors pervaded by broad blood sinuses. This bone marrow smear illustrates several stages in erythropoiesis and granulopoiesis. The proerythroblast

is the first recognisable erythrocyte precursor; the cell has a large, intensely stained, granular nucleus containing one or more paler nucleoli. The sparse cytoplasm is strongly basophilic due to its high content of RNA and lack of haemoglobin. A narrow, pale zone of cytoplasm close to the nucleus represents the Golgi apparatus. Three increasingly differentiated normoblast forms can also be distinguished. An early normoblast (basophilic erythroblast) is recognised by its basophilic cytoplasm and smaller nucleus with increasingly condensed chromatin. More advanced in the maturation sequence is an intermediate normoblast (polychromatic erythroblast), the cytoplasm of which exhibits both basophilia and eosinophilia, the latter due to increasing haemoglobin content. The nucleus is also condensed. With further haemoglobin synthesis and degeneration of cytoplasmic ribosomes, the late normoblast stage is reached and by this time the nucleus is extremely condensed prior to being extruded from the cell. Reticulocytes are usually slightly larger than the surrounding mature erythrocytes, and their cytoplasm contains granular structures – remains of nuclei and organelles. Erythrocytes are stained pink due to their high content of haemoglobin. The pale staining of the central region of the erythrocyte is a result of its unusual biconcave disc shape.

In this specimen you also see three phases of neutrophil granulocyte development. A neutrophil myelocyte is recognized by a large, eccentrically located nucleus, a prominent Golgi apparatus and cytoplasm containing many azurophilic (primary) granules. The next stage towards maturity, the metamyelocyte is a smaller cell characterized by indentation of the nucleus and loss of prominence of the azurophilic granules. The final stage before maturity, the stab cell, has a more highly segmented nucleus approaching that of the mature neutrophil.

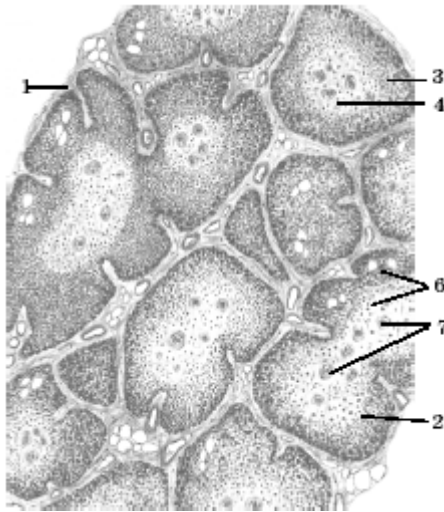
Megakaryocytes – are the cells of bone marrow where they are responsible for production of platelets. Megakaryocytes are huge cells with a single, highly irregular polyploid nucleus. The extensive cytoplasm appears finely granular due to a profusion of organelles. Platelets are formed by budding from the megakaryocyte cytoplasm.

Illustrate and indicate: 1.Proerythroblast. 2.Polichromatic erythroblast. 3.Neutrophil metamyelocyte. 4.Megakaryocyte. 5.Sinusoidal capillaries: a)erythrocytes; b)leucocytes.

Specimen 2. Thymus.

Haematoxylin and Eosin.

The thymus is a highly lobulated organ invested by a loose connective tissue capsule from which short septa containing blood vessels radiate into the substance of the organ. Thymic tissue is divided into two distinct zones, a dense outer cortex and an inner, pale-stained medulla.



The thymic cortex is predominantly populated by lymphocytes and, as seen in this specimen, those of the outer cortex are larger than those deeper in the cortex. The large lymphocytes of the outer cortex represent lymphoblasts which divide by mitosis to produce large numbers of smaller lymphocytes which are pushed into the deeper layers. The thymic cortex also contains numerous pale-stained, vacuolated macrophages responsible for engulfing dead lymphocytes but which also may be involved in 'processing' antigens before presentation to the lymphocytes. Note also a small capillary, lined by flattened endothelial cells, entering the cortex from the capsule. Around the capillary can be seen a distinct basement membrane constituting the blood-thymus barrier.

In the thymic medulla, cells of the epithelial framework can be more readily identified by their relatively large, pale-stained nuclei, eosinophilic cytoplasm and prominent basement membranes. A feature of the thymic medulla are the concentrically lamellated eosinophilic structures known as Hassal's corpuscles which first appear in fetal life and increase in number throughout life. Initially, the corpuscles begin as a single medullary epithelial cell which enlarges and then degenerates to form a vacuolated eosinophilic mass. Further epithelial cells become similarly involved to form a lamellated hyaline mass surrounded by flattened degenerating epithelial cells as seen in this specimen. Nearby is a small mass of large atypical degenerate epithelial cells which may represent an early Hassal's corpuscle.

Illustrate and indicate: I. Lobule of the gland: 1. Thymic cortex: a) T – lymphocytes. 2. Thymic medulla: a) epithelioreticulocytes; b) Hassal's corpuscles. II. Connective tissue between lobules: 3. Blood vessels.

V. Real – life situations to be solved:

1. In the specimen you can see on organ of immune system. Which tissues can form the parenchyma of this organ?

- A. Epithelial.
- B. Epithelial and/or nervous.
- *C. Myeloid or lymphoid.
- D. Loose connective.
- E. Bone or/and cartilage.

2. In the specimen you can see the red bone marrow. Which tissue forms this organ?

- *A. Myeloid.
- B. Epithelial.
- C. Lymphoid.
- D. Loose connective.
- E. Adipose.

3. In the specimen you can see the thymus. Which tissue forms the parenchyma of this organ?

- A. Myeloid.
- B. Epithelial.
- *C. Lymphoid.
- D. Loose connective.
- E. Adipose.

4. In the specimen you can see the parenchymatous lobulated organ. Each lobule has a peripheral dark cortex and a central light medulla. Which organ is in the specimen?

- A. Spleen.
- B. Lymph node.
- C. Red bone marrow.
- D. Yellow bone marrow.
- *E. Thymus.

5. In the specimen you can see the thymus. Which cells does this organ produce?

- A. Erythrocytes.
- *B. T-lymphocytes.
- C. T- and B-lymphocytes.
- D. B-lymphocytes.
- E. Granulocytes.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 38 FOR STUDENTS

THEME: LYMPH AND HEMOLYMPH NODES.

PROFESSIONAL MOTIVATION

In the organism blood – forming organs and the organs of immune protection are of particular importance as they support the morphological state of the blood and immunologic homeostasis. Although rarely the site of primary disease, lymph nodes act as defensive barriers and are secondarily involved in virtually all systemic infections and in many neoplastic disorders arising elsewhere. In this complex and very important system all the morphological elements are closely connected histologically and functionally. A future doctor will need deep knowledge of structural and functional components of the blood – forming organs for making blood analyses and evaluating the patient’s blood picture, in ascertaining his life – time myeloid blood formation, cellular and humoral immunity.

GENERAL AIM: Know the disposition and functions of lymph and hemolymph nodes; their cells and tissues and to be able to identify them as well as the named structural elements of the organs in specimens or in electron micrographs.

Final aims: Students should be able to:

1. Describe the lymph nodes in terms of their general functions, their location in the body and their embryonic germ layer of origin.
2. Identify the afferent lymphatic vessels and ending with the efferent lymphatic vessels, trace the path of lymph through a lymph node. What percentage of the lymph actually penetrates the nodules?
3. Recognise cells and structures commonly found in the lumens of a lymph node’s sinuses.
4. Identify the type of cells of lymph node contain in paracortical zone.
5. Demonstrate the main features in structure of cortex and medulla.

BASIC LEVEL

1. Structural peculiarities of lymphatic organs (department of anatomy)

STUDENTS’ INDEPENDENT STUDY PROGRAM

I. Objectives for Students’ Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. Description of lymph nodes in terms of their general functions, their location in the body and their embryonic germ layer of origin.

2. Beginning with the afferent lymphatic vessels and ending with the efferent lymphatic vessels, trace the path of lymph through a lymph node. What percentage of the lymph actually penetrates the nodules?
3. Cells and structures commonly found in the lumens of a lymph node's sinuses.
4. The type of cells of lymph node contain in paracortical zone.
5. Main features in structure of cortex and medulla.
6. Basic function of each cell type: B-lymphocyte, T-lymphocyte, memory cell, plasma cell, follicular dendrites cell, macrophage, reticular cell.

Key words and phrases: lymph node, parenchyma, peripheral cortex, convex surface, central medulla, depression (hilum), tightly packed lymphocytes, secondary lymphoid nodules, B-lymphocytes, germinal centers, reticular cells, antigen-presenting follicular dendrites cells, macrophages, plasma cells, helper T-cells, medullary cords, medullary sinuses, paracortical zone, T-dependent region, high-endothelial postcapillary venules, subcapsular sinus, peritrabecular sinuses, medullary sinuses, lymph, immunoglobulins, lymphoid nodules, primary nodules, secondary nodules, encapsulated lymphoid aggregates, unencapsulated lymphoid aggregates.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 269-272.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 180-184.
3. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 166-172.
4. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 125-129.

II. For self-training students should fill in this table.

Characteristic of the lymph node

Part of organ	Morphological characteristic	Functional significance

III. Visual aids and material tools:

Students should be able to indicate elements in the electron micrographs:

1. Lymphoid follicle of the cortex
2. Reticular cells in sinuses of lymph node
3. Lymph node medulla

Charts No:

38-1. Structural features of lymph nodes

38-2. Medullary cords and medullary sinuses

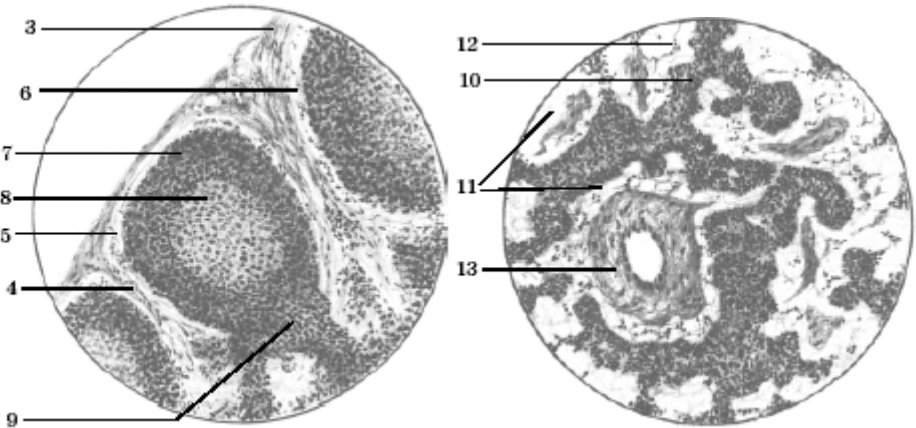
- 38-3. Lymphoid follicle and germinal center
- 38-4. Lymphatic circulation in lymph nodes

IV. Students' practical activities:

Students must know and illustrate such histological specimens:

Specimen 1. Lymph node.

Haematoxylin and Eosin.



The lymph node is encapsulated by dense connective tissue from which trabeculae extend for variable distances into the substance of the node. Afferent lymphatic vessels divide into several branches outside the lymph node, then pierce the capsule to drain into a narrow space called the subcapsular sinus. Lymph from the subcapsular sinus drains via a series of interconnected channels, the trabecular sinuses, the medullary sinuses, into the hilum of the node from which arises one or more efferent lymphatic vessels.

The body of the lymph node consists of an open meshwork of fine reticular fibers which provides a loose support for the ever changing populations of lymphocytes. The cortex consists of densely-packed lymphocytes and forms extensions called medullary cords which project into the medulla between the medullary sinuses.

The lymphocytes of the outer cortex are mainly arranged in spheroidal lymphoid follicles and these are the major sites in which lymphocytes localize and proliferate. Traditionally, lymphoid follicles have been classified as 'primary follicles' if a central pale area is absent and 'secondary follicles' if such an area is present. The pale central areas are termed germinal centers and the 'primary' follicles probably merely represent quiescent 'secondary' follicles. Cells of a

germinal centre are a mixed population of lymphocytes and the plasma cell precursors, plasmablasts and proplasmacytes.

The deep cortical zone, or paracortex, consists mainly of T-lymphocytes which are never arranged as follicles. The medullary cords mainly contain lymphocytes and their derivatives.

Illustrate and indicate: 1. Dense connective capsule. 2. Trabeculae. 3. Cortex: a) lymphoid follicle. 4. Medulla: a) medullary cords 5. Subcapsular sinus. 6. Trabecular sinus. 7. Medullary sinuses. 8. Hilum of the node. 9. Reticular tissue.

V. Real-life situations to be solved:

1. In the specimen you can see an organ, which is distributed (situated) along the course of the lymphatic vessels. Which organ is in the specimen?

- A. Spleen.
- B. Red bone marrow.
- C. Thymus.
- *D. Lymph node.
- E. Adrenal gland.

2. In the specimen you can see the lymph node. Which zones are defined in this organ?

- A. Cords and follicles.
- *B. Outer cortex, inner cortex (paracortical zone) and medulla.
- C. Glomerulosa, fasciculata and reticularis.
- D. Lobules with cortex and medulla.
- E. Anterior part and posterior part.

3. In the specimen of the lymph node you can see its part that consists of cord (formed by lymphoid tissue) and sinuses. Which part of organ is in the specimen?

- *A. Medulla.
- B. Paracortical zone.
- C. Zona reticularis.
- D. Outer cortex.
- E. White pulp..

4. In the specimen of the lymph node you can see the medulla. Which parts (structures) does it include?

- A. Red and white pulp.
- B. Lobules with cortex and medulla.
- C. Lymphoid nodules, subcapsular and intermediate sinuses.
- D. Epithelial cords and sinuses.
- *E. Medullary cords and medullary sinus.

5. In biopate of the lymph node of patient with immunodeficiency you can see a cortex, where inner cortex is absent. Alteration of which type immunity is occur in this patient?

- A. Humoral immunity.

- *B. Cellular immunity.
- C. Opsonization.
- D. Antigen presentation.
- E. Phagocytosis.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 39 FOR STUDENTS

THEME: SPLEEN.

PROFESSIONAL MOTIVATION

The spleen is one of the so-called secondary lymphoid organs in contrast to the thymus. It is active in blood formation during the initial part of fetal life. The spleen is involved in all systemic inflammations, generalized hematopoietic disorders and many metabolic disturbances such as lipoidoses. It is rarely the primary site of disease and, therefore, for correlation with clinical disease one must understand bases of splenic derangement, which lead to damage structures of this organ. The spleen is one of the so-called secondary organs in contrast to the thymus. It is active in blood formation during the initial part of fetal life.

GENERAL AIM: Know the spleen micro- and ultrastructure, can to identify red splenic pulp in specimen, distinguish it from a white splenic pulp and able to indicate main components in electron micrographs, to be able to differentiate it from other organs of the haemopoietic system.

Final aims: students should be able to:

1. Classification of lymphoid tissues and organs.
2. Characteristic of the lymphoid system main cells.
3. Major components of the white pulp, the predominant type of lymphocytes which they contains.
4. Description of the sequence of events in the life cycle of B lymphocyte following its encounter with an appropriate antigen in the marginal zone of the white pulp.
5. Major components of red pulp.
6. Comparison of the white and red pulp of the spleen in term of the predominant cell type present.
7. Comparison of the red pulp sinusoids with common capillaries.

BASIC LEVEL

1. Basic anatomical structures of the spleen (department of anatomy)

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. Classification of lymphoid tissues and organs.
2. Characteristic of the lymphoid system main cells.

3. Major components of the white pulp, the predominant type of lymphocytes which they contains.
4. Description of the sequence of events in the life cycle of B lymphocyte following its encounter with an appropriate antigen in the marginal zone of the white pulp.
5. Major components of red pulp.
6. Comparison of the white and red pulp of the spleen in term of the predominant cell type present.
7. Comparison of the red pulp sinusoids with common capillaries.
8. Peculiarities of the splenic circulation, open and closed theory.
9. Macrophage system of haemopoietic organs.

Key words and phrases: spleen, dense irregular connective tissue capsule, trabeculae, red splenic pulp, white splenic pulp, periarterial lymphatic sheaths, tortuous vascular channels, central arteria, secondary nodules with germinal centers, marginal zone, lymphoid nodule of the white pulp, splenic reticulum, splenic sinuses, splenic cords, immune surveillance function, splenic arteries, trabecular arteries, follicular arteries, open splenic circulation, veins of the pulp, trabecular veins, splenic veins, B-lymphocytes, T- lymphocytes, hilum of the spleen, closed circulation theory, open circulation theory.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7 th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 272-279.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4 th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 184-186.
3. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 173-178.
4. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9 th ed. Lippincott Williams and Wilkins, 2000. – pp. 133-134, 135-139.

III. Visual aids and material tools:

Students should be able to indicate elements in the electron micrographs:

1. Lymphocytes in white pulp
2. Reticular cells in the parenchyma of the spleen
3. Structure of red pulp

Charts No:

39-1. Illustration of the splenic circulation and the arrangement of sinusoidal cells

39-2. White pulp: secondary nodules with germinal centers

39-3. Paracortical zone

39-4. Splenic sinuses and cords

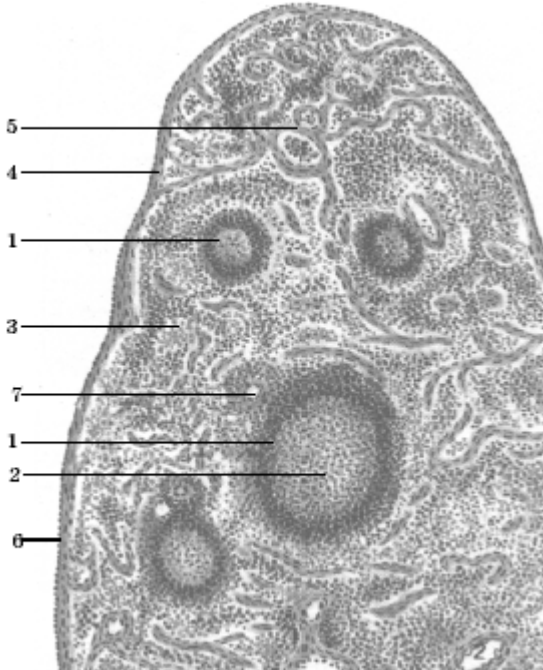
39-5. Structure of red pulp

IV. Students' practical activities:

Students must know and illustrate such histologic specimens:

Specimen 1. Spleen.

Heamatoxylin and Eosin.



On macroscopic examination of the cut surface, the spleen appears to consist of discrete white nodules, the so-called white pulp, embedded in a red matrix called the red pulp. Microscopically, the white pulp is seen to consist of lymphoid aggregations and the red pulp making up the bulk of the organ, to be a highly vascular tissue.

Like lymph nodes, the spleen has a dense, fibro-elastic outer capsule which is thickened at the hilum and gives rise to supporting connective tissue trabeculae which conduct larger blood vessels throughout the spleen. In some mammals, the capsule and trabeculae contain smooth muscle which exerts a rhythmic pumping action, clearing the spleen of blood and allowing the spleen to act as a reservoir. In humans only a few smooth muscle cells persist.

The capsule and the trabeculae provide a robust framework, which supports a fine reticulin meshwork ramifying throughout the organ in the red pulp.

The reticular skeleton is almost absent in the centre of the white pulp but is well developed at the white pulp margins and around the central arteriole.

The white pulp or periarteriolar lymphoid sheaths contain populations of both T and B lymphocytes, the central region containing predominantly B lymphocytes, which may form germinal centers if a humoral response is stimulated in the spleen by blood-borne antigen. The outer marginal zone consists mainly of closely packed T lymphocytes.

The red pulp consists of irregular anastomosing plates, separated by broad interconnected venous sinuses.

The pulp cords are supported by a delicate reticulin skeleton which supports a large population of highly phagocytic macrophages and the fibroblasts responsible for reticulin formation. The spaces between this meshwork in the pulp cords contain variable numbers of both erythrocytes and leucocytes, mainly lymphocytes.

The venous sinuses are lined by unusual, highly elongated, spindle-shaped endothelial cells, which lie parallel to the long axes of the sinuses. Externally, the sinuses are encircled by reticulin fibers lying in the endothelial basement membrane in a manner reminiscent of the steel bands holding together a wooden barrel. The venous sinuses drain into progressively larger vessels, the trabecular veins, which converge to form the splenic vein which passes out of the spleen at the hilum.

Illustrate and indicate: 1. Spleen capsule. 2. Connective tissue trabeculae. 3. White pulp (lymphatic follicles): a) central artery. 4. Red pulp: a) reticular tissue; b) blood cells. 5. Venous sinuses.

V. Real – life situations to be solved:

1. In the specimen you can see the spleen. Which component does its parenchyma include?

- *A. Red and white pulp.
- B. Lobules with cortex and medulla.
- C. Lymphoid nodules, subcapsular and intermediate sinuses.
- D. Epithelial cords and sinuses.
- E. Medullary cords and medullary sinus.

2. In the specimen of the spleen you can see the red pulp. Which structural components does it include?

- *A. Splenic cords and sinusoids.
- B. Cortex and medulla.
- C. Lymphoid nodules and lymphoid sheaths.
- D. Epithelial cords and sinuses.
- E. Medullary cords and medullary sinus.

3. In the specimen of the spleen you can see the white pulp. Which structural components does it include?

- A. Splenic cords and sinusoids.
- B. Cortex and medulla.
- *C. Lymphoid nodules and lymphoid sheaths.
- D. Epithelial cords and sinuses.
- E. Medullary cords and medullary sinuses.

4. In the specimen of the spleen you can see the white pulp. Which tissue forms this part of the organ?

- A. Myeloid.
- B. Epithelial.
- *C. Lymphoid.
- D. Loose connective.
- E. Adipose.

5. In the specimen of the spleen you can see the white pulp. Which is the function of this part of the organ.

- A. Blood accumulation and elimination of aged erythrocytes.
- *B. Realisation of immune response.
- C. Hormone production.
- D. Lymph filtration and cleaning.
- E. Antigen independent maturation of T-lymphocytes.

6. In the specimen of the spleen you can see the red pulp. Which is the function of this part of the organ.

- *A. Blood accumulation and elimination of aged erythrocytes.
- B. Realisation of immune response.
- C. Hormone production.
- D. Lymph filtration and cleaning.
- E. Antigen independent maturation of T-lymphocytes.

7. In the specimen of the spleen you can see the white pulp. With which vessel is this part of the organ associated?

- A. Sinusoids.
- B. Trabecular artery.
- C. Trabecular vein.
- *D. Central artery.
- E. Pulpar vein.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 40 FOR STUDENTS

THEME: ENDOCRINE SYSTEM. HYPOTHALAMUS. PITUITARY GLAND

PROFESSIONAL MOTIVATION

All vital activity processes in a human and an animal's organism are regulated by the nervous and endocrine systems. In performing their functions they are so closely connected that, as a matter of fact, present the united whole neuroendocrine regulating system. Endocrine glands are the sites of synthesis and secretion of substances known as hormones, which are disseminated throughout the body by the bloodstream where they act on specific target organs. In conjunction with the nervous system, hormones co-ordinate and integrate the functions of all the physiological systems.

GENERAL AIM: To be able to distinguish the neurohypophysis, the adenohypophysis and identify the cell types present in a specimen of the pituitary. Also locate and identify the pars anterior, pars tuberalis, pars intermedia, pars nervosa, infundibulum, Rathke's cysts, and the sinusoidal capillaries in specimens and electron micrographs.

Final aims: Students should be able to:

1. Interpret the general morphofunctional characteristic of the endocrine system. Endocrine glands classification.
2. Describe the location of the pituitary, its embryonic origins.
3. Identify the major divisions of the pituitary and their descriptions.
4. Recognise cell types found in each division of the pituitary and indications of characteristic staining properties.
5. Explain hormones produced by the pituitary, indicating for each one the division and cell type responsible for its production as well as its target site.
6. Recognise hypothalamus nuclei. Peculiarities of the neurosecretory cells.
7. Explain the role of the hypothalamus in controlling pituitary function.

BASIC LEVEL

1. Anatomical peculiarities of hypothalamus and pituitary gland (department of anatomy)

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. The general morphofunctional characteristic of the endocrine system. Endocrine glands classification.

2. Description of the location of the pituitary, its embryonic origins.
3. major divisions of the pituitary and their descriptions.
4. Cell types found in each division of the pituitary and indications of characteristic staining properties.
5. Hormones produced by the pituitary, indicating for each one the division and cell type responsible for its production as well as its target site.
6. Hypothalamus nuclei. Peculiarities of the neurosecretory cells.
7. Description of role of the hypothalamus in controlling pituitary function.
8. Description of blood supply to the pituitary and its role in pituitary function.

Key words and phrases: pituitary gland (hypophysis cerebri), adenohipophysis, neurohypophysis, prolactin, follicle – stimulating hormone (FSH), luteinizing hormone (LH), thyrotropin (thyroid – stimulating hormone, TSH), growth hormone (GH), adrenocorticotropin (ACTH), lipotropin (lipotropic hormone, LPH), melanocyte – stimulating hormone (MSH), endorphins, acidophils, lactotropes (mammotropes), somatotropes, basophils, corticotropes, thyrotropes, gonadotropes, chromophobes, pituitary dwarfs, acromegaly, hypothalamohypophysial portal system, supraoptic and paraventricular nuclei, antidiuretic hormone (ADH), oxytocin, releasing hormones, unmyelinated nerve fibers, hypothalamohypophysial tract, neurosecretory neurons, pituicytes.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 394-403.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 299-304.
3. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 258-263.
4. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 267-273.

II. For self-training students should fill in these tables:

General characteristic of the organs of the endocrine system

Parts of the endocrine system	Organs which belong to it

Characteristic of the pituitary gland

Lobes	Tissues	Functions

III. Visual Aids and Material Tools:

Students should be able to indicate elements in the electron micrographs:

1. Hypothalamic neuron cell bodies in the supraoptic nucleus
2. Hypothalamic neuron cell bodies in the paraventricular nucleus
3. Cells of the adenohypophysis
4. Adenohypophysis: somatotrope
5. Adenohypophysis: thyrotrope
6. Adenohypophysis: corticotrope
7. Posterior pituitary (neurohypophysis)

Charts No:

40-1. Hypothalamohypophysial tract

40-2. Neurosecretory neurons

40-3. Adenohypophysial cell types

40-4. Schematic diagram of major interrelationships of some endocrine

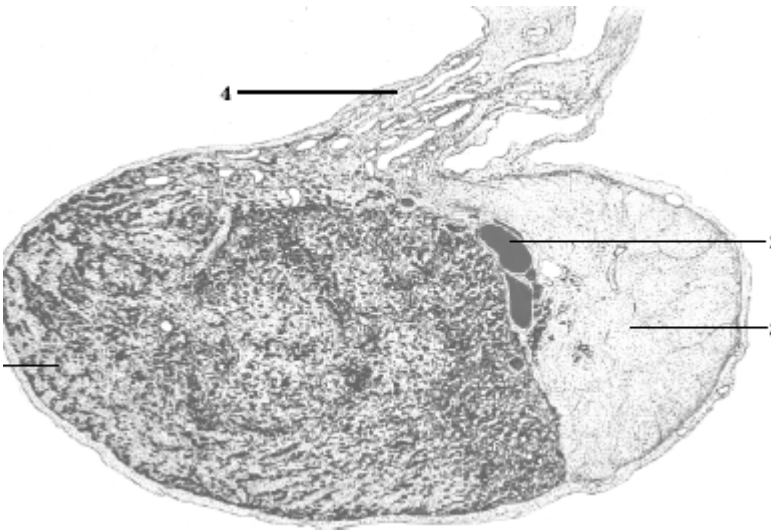
and neurons regulatory organs

Students' practical activities

Students must know and illustrate such histological specimens:

Specimen 1. Pituitary gland.

Haematoxylin and Eosin.



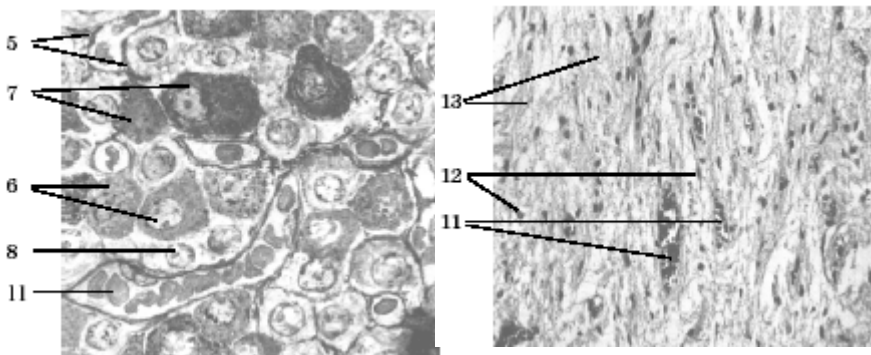
This specimen from a mid-line section through the brain and cranial floor illustrates the pituitary gland in situ. The pituitary is almost completely enclosed in a bony depression in the sphenoid bone, called the sella turcica. The three major

components of the gland, the anterior pituitary, pars intermedia and the posterior pituitary, are easily seen at this magnification. The posterior pituitary is connected to the hypothalamus by a short stalk, the pituitary stalk.

Illustrate and indicate: 1. Anterior pituitary (adenohypophysis). 2. Pars intermedia. 3. Posterior pituitary (neurohypophysis).

Specimen 2. Pituitary gland.

Paraldegid and fuxin.



Cells of the anterior pituitary, chromophils and chromophobes, form cords of secretory cells, which are surrounded by a rich network of sinusoidal capillaries. The chromophils are subdivided into two groups, acidophils and basophils because of their staining properties with a variety of histological methods. For example in specimen, acidophils are stained orange and basophils are stained blue. The somatotrophs and mammotrophs represent the acidophils of traditional light microscopy, the basophils being the thyrotrophs, gonadotrophs and probably the corticotrophs (which were formerly thought to be chromophobic). The chromophobes are the smallest cell in the anterior pituitary and contain few cytoplasmic granules; they have little affinity for either acidic or basic dyes and probably represent resting forms of chromophil cells. The cells of pars intermedia are basophilic, form irregular clumps lying between the pars anterior and pars posterior but tending to spill out into the neural tissue of the pars posterior.

The posterior pituitary contains the non-myelinated axons of neurosecretory cells, the cell bodies of which are located in the hypothalamus. Cells called pituicytes similar in structure and function to the neuroglial cells of the central nervous system support the neurosecretory cells axons. Most of the nuclei seen in this micrograph are those of pituicytes. A rich network of fine, fenestrated capillaries pervades the posterior pituitary.

Illustrate and indicate: 1. Adenohypophysis: a) acidophils; b) basophils; c) sinusoidal capillaries. 2. Cells of the pars intermedia. 3. Neurohypophysis: a) pituicytes; b) capillaries.

V. Real-life situations to be solved:

1. In the specimen you can see an organ that produces hormones. Which system of the human organism is this organ referred?

- A. Digestive.
- *B. Endocrine.
- C. Circulatory.
- D. Respiratory.
- E. Skin.

2. In the specimen of hypophysis (pituitary gland) you can see adenohypophysis. Which tissue forms the parenchyma of this organ?

- A. Nervous.
- B. Elements of nervous tissue.
- *C. Glandular epithelium.
- D. Lymphoid.
- E. Muscle.

3. In the specimen you can see an organ of endocrine system. It consists of two lobes. Parenchyma of one of them is glandular epithelium, which forms the cords of epithelial cells surrounded by large-bore capillaries. Another lobe composed by neural fibres and glial cells. Which organ is in the specimen?

- A. Hypothalamus.
- B. Thyroid gland.
- C. Adrenal gland.
- *D. Hypophysis.
- E. Parathyroid gland.

4. In the specimen of hypophysis you can see the anterior part of adenohypophysis. Its parenchyma composed by the cord of epithelial cells of three types. Which are they?

- *A. Chromophobes, basophilic chromophils and acidophilic chromophils.
- B. Chromophobes, nervous and glial cells.
- C. Nervous, glial and endothelial cells.
- D. Thyrocytes, C-cells and A-cells.
- E. Basophilic chromophils, acidophilic chromophils and mixed chromophils.

5. In the specimen of hypophysis you can see the anterior part of adenohypophysis. Its parenchyma composed by the cord of epithelial cells. Which hormones do they produce?

- A. Antidiuretic hormone (vasopressin) and oxytocin.
- B. Steroids and catecholamines.
- C. Thyroxine, triiodothyronine and calcitonin.
- *D. Growth hormone (somatotropin), prolactin, thyrotropin, gonadotropins and adrenocorticotropin.
- E. Prolactin, thyrotropin, gonadotropins, adrenocorticotropin and antidiuretic hormone.

6. In the specimen of hypophysis you can see the intermediate part of adenohypophysis. Which structures does its parenchyma form?

- *A. Pseudofollicles.
- B. Cords.
- C. Follicles.
- D. Islets.
- E. Acini.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 41 FOR STUDENTS

THEME: PINEAL GLAND. DIFFUSE ENDOCRINE SYSTEM.

PROFESSIONAL MOTIVATION

All the processes of human and animal activity are regulated by the nervous and endocrine systems. In performing their functions they are so closely connected that, as a matter of fact, present the united whole neuroendocrine regulating system.

Endocrine glands are the sites of synthesis and secretion of substances known as hormones, which are disseminated throughout the body by the bloodstream where they act on specific target organs. Commonly with the nervous system, hormones coordinate and integrate the functions of all the physiological systems.

GENERAL AIM: Know the origin, development and functions of the pineal gland and diffuse endocrine system in regulation of human body functions.

Final aims: Students should be able to:

1. Recognise gland general structure and functions.
2. Identify pinealocytes and neuroglial cells.
3. Explain pineal gland interconnections with the other endocrine glands and nervous system.
4. Describe age changes of the pineal gland.
5. Interpret the APUD system. Paracrine (local) and distant regulation of human organs and systems.

BASIC LEVEL

1. General structure of the pineal body – human anatomy department.
2. Nerve tissue structure and functions – general histology.
3. Hemocapillaries micro- and ultrastructure – general histology.

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. Pineal gland general structure and functions.
2. Pinealocytes and neuroglial cells.
3. Pineal gland interconnections with the other endocrine glands and nervous system.
4. Age changes of the pineal gland.
5. Alone endocrinocytes origin and disposition.
6. Apud system. Paracrine (local) and distant regulation of human organs and systems.

Key words and phrases: endocrine, paracrine, autocrine, hormone, target organ, distant regulation, diffuse endocrine system, APUD system, pineal gland, pinealocytes, light pinealocytes, dark pinealocytes, glial cells, melatonin, serotonin, brain send.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 422-423.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 304-306, 313-315.
3. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 273-275.

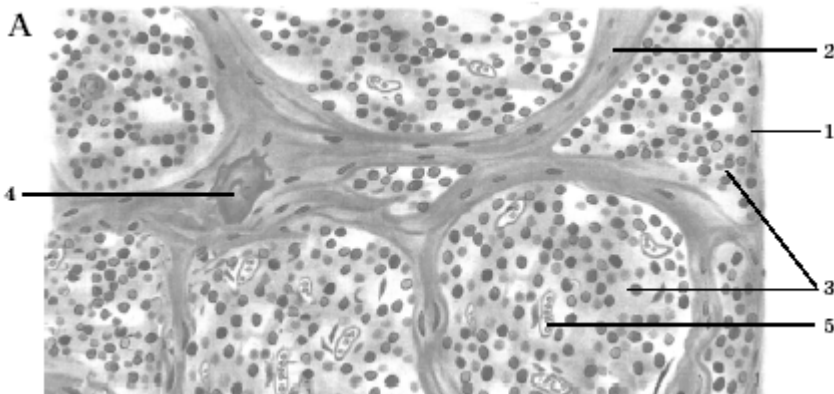
III. Visual aids and material tools:

Charts No:
41-1. Epiphysis

IV. Students' practical activities

Students must know and illustrate such histological specimens:

Specimen 1. Pineal gland.
Haematoxylin and Eosin.



At a low magnification it is seen that pineal body is covered by the connective tissue capsule, from which the septas appear and divide the parenchyma onto the lobules. At a high magnification let you find irregular shaped light cells with round shaped nuclei – pinealocytes. They occupy the middle part of lobules. Glial cells are smaller and have dark nuclei.

Illustrate and indicate: 1. Capsule. 2. Connective tissue septum. 3. Lobules. 4. Pinealocytes. 5. Neuroglial cells. 6. Pineal send.

There are a lot of dark pinealocytes in the pineal gland specimen. What is the functional condition of these cells?

There are two specimens of pineal gland: the first one is the specimen of 5 years old child, the second – of adult (40 years). Is it possible to recognize them? What are the differences?

In the pineal gland specimen you can see a lot of small cells with dark nuclei and processes. What are these cells? What are their functions?

V. Real-life situations to be solved:

1. In the specimen of hypophysis you can see the neurohypophysis. Which structures compose the parenchyma of this lobe?

- A. Chromophobes, basophilic chromophils and acidophilic chromophils.
- *B. Nervous fibres and glial cells.
- C. Nervous, epithelial and glial cells.
- D. Thyrocytes, C-cells and A-cells.
- E. Neurones and glial cells.

2. In the specimen of hypophysis you can see the neurohypophysis. Its parenchyma is composed by the glial cells and nervous fibres which endings contact with capillaries wall. Which hormones are secreted here?

- *A. Antidiuretic hormone (vasopressin) and oxytocin.
- B. Steroids and catecholamines.
- C. Thyroxine, triiodothyronine and calcitonin.
- D. Growth hormone (somatotropin), prolactin, thyrotropin, gonadotropins and adrenocorticotropin.
- E. Prolactin, thyrotropin, gonadotropins, adrenocorticotropin and antidiuretic hormone.

3. In the specimen of hypophysis you can see the neurohypophysis. Its parenchyma is composed by the glial cells and nervous fibres which endings contact with capillaries wall, where antidiuretic hormone and oxytocin are secreted in blood. Where are these hormones produced?

- A. Neurohypophysis.
- B. Adenohypophysis.
- C. Posterior hypothalamus nuclei.
- *D. Anterior hypothalamus nuclei.
- E. Infundibulum.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 42 FOR STUDENTS

THEME: THYROID AND PARATHYROID GLANDS.

PROFESSIONAL MOTIVATION

All vital activity processes in a human and an animal's organism are regulated by the nervous and endocrine systems. In performing their functions they are so closely connected that, as a matter of fact, present the united whole neuroendocrine regulating system. Endocrine glands are the sites of synthesis and secretion of substances known as hormones which are disseminated throughout the body by the bloodstream where they act on specific target organs. In conjunction with the nervous system, hormones co-ordinate and integrate the functions of all the physiological systems.

GENERAL AIM: To study the histophysiology of the thyroid and parathyroid glands. Can to identify the thyroid follicles, follicular cells, colloid in a specimen of thyroid gland. Be able to identify different states of follicular cells in electron micrographs. To identify the capsule, chief cells, and oxyphil cells in electron micrographs of a parathyroid gland.

Final aims: Students should be able to:

1. Interpret the role of the pituitary gland and hypothalamus in the regulation of thyroid follicular activity.
2. Explain effects of thyroid hormones on their target tissues.
3. Recognise structure, function, location, and embryonic origin of the C or parafollicular cells.
4. Describe the thyroid follicles, follicular cells, basement membrane, colloid, capillaries of the thyroid gland.
5. Compare the parenchymal cell types of the parathyroids (chief cells and oxyphil cells) in light and electron microscopes.
6. Explain the role of the parathyroid hormone in controlling blood calcium and phosphate levels and the specific effects of this hormone on its target tissues.
7. Interpret the factors that controls the secretory activity of the parathyroid glands.

BASIC LEVEL

1. General properties of endocrine glands (department of anatomy).

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. The general morphofunctional characteristic of the endocrine system. Endocrine glands classification.
2. Location, shape, and embryonic origin of the thyroid gland.
3. Role of the pituitary gland and hypothalamus in the regulation of thyroid follicular activity.
4. Effects of thyroid hormones on their target tissues.
5. Structure, function, location, and embryonic origin of the C or parafollicular cells.
6. Description of the thyroid follicles, follicular cells, basement membrane, colloid, capillaries of the thyroid gland.
7. Distinguish between an active and inactive thyroid gland on the basis of follicular morphologic characteristics.
8. Comparison of parenchymal cell types of the parathyroids (chief cells and oxyphil cells) in light and electron microscopes.
9. Role of the parathyroid hormone in controlling blood calcium and phosphate levels and the specific effects of this hormone on its target tissues.
10. Factors that controls the secretory activity of the parathyroid glands.
11. Comparison of the parathyroid hormone and calcitonin in terms of their source and function.

Key words and phrases: thyroid gland, thyroid follicles, simple cuboidal epithelium of follicular cells, colloid, thyroid follicular cells, peptide hormone – secreting cell, thyroglobulin, triiodothyronine (T3), tetraiodothyronine (thyroxine; T4), interfollicular spaces, parafollicular cells (C cells), calcitonin, parathyroid glands, chief cells, parathyroid hormone (PTH, parathormone), oxyphil cells, hyperthyroidism, hypothyroidism, cretinism and myxedema, hypoparathyroidism, blood calcium level, iodine-containing hormones.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 413-422.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 306-309.
3. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 263-267.
4. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 273-277, 281.

II. For self-training students should fill in these tables:

Characteristic of the thyroid gland cells

Type of cells	Morphological features	Function/hormones

III. Visual aids and material tools:

Students should be able to indicate elements in the electron micrographs:

1. Thyroid follicle (normal function)
2. Thyroid follicle (hyperfunction)
3. Thyroid follicle (hypofunction)
4. Parafollicular cells (C cells)

Charts No:

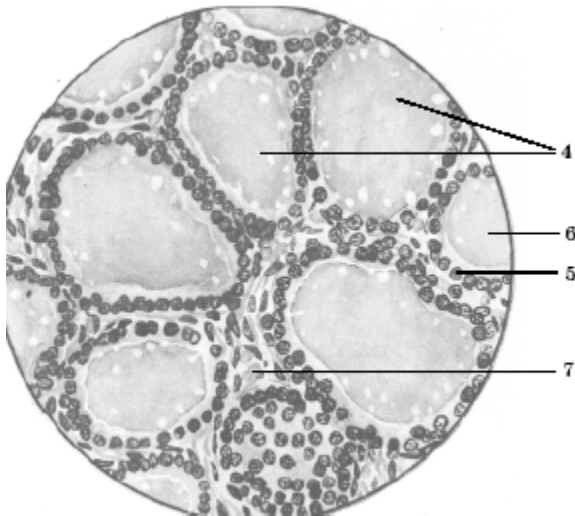
- 42-1. Structure of thyroid follicles
- 42-2. Thyroid follicular epithelial cells
- 42-3. Interfollicular spaces: C cells
- 42-4. General features of the parathyroid gland

IV. Students' practical activities:

Students must know and illustrate such histologic specimens:

Specimen 1. Thyroid gland.

Hematoxylin and Eosin.



The thyroid gland consists of two lobes, connected by the isthmus and is lying in the neck in front of the upper part of the trachea. The functional units of the thyroid gland are the thyroid follicles, irregular, spheroidal structures. The follicles are variable in size and contain a homogeneous, colloid material which is stained pink in this preparation. The thyroid gland is enveloped in an outer capsule

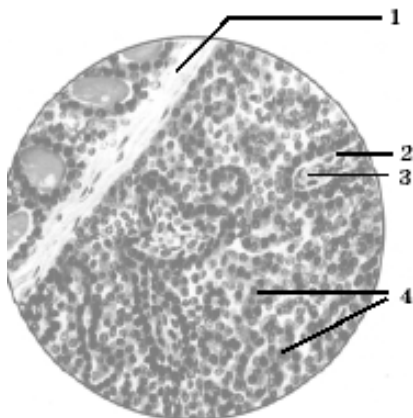
of loose connective tissue. From the capsule, connective tissue septa extend into the gland dividing the gland into lobules, and conveying a rich blood supply, together with lymphatics and nerves.

Thyroid follicles are lined by a simple cuboidal epithelium which is responsible for the synthesis and secretion of the iodine-containing hormones T3 and T4. Thyroid follicles are filled with a glycoprotein complex called thyroglobulin or thyroid colloid, which stores the thyroid hormones prior to secretion. In actively secreting thyroid glands, as in these spacement, the follicles tend to be small and the amount of colloid diminished; the cuboidal lining cells are relatively tall reflecting active hormone synthesis and secretion. Conversely, the follicles of the less active thyroid are distended by stored colloid and the lining cells appear flattened against the follicular basement membrane.

A second secretory cell type is found in the thyroid gland either as single cells among the follicular cells or as small clumps in the interfollicular spaces. These are so-called parafollicular cells. Parafollicular cells synthesise and secrete the hormone calcitonin in direct response to raised blood calcium levels.

Illustrate and indicate: 1.Capsule. 2.Connective tissue septa. 3.Thyroid follicles: a) simple cuboidal epithelium (thyrocytes); b) thyroid colloid. 4.Parafollicular cells. 5.Capillaries.

Specimen 2. Parathyroid gland.
Haematoxylin and Eosin.



This micrograph shows a parathyroid gland characteristically embedded in capsule of a thyroid gland. The thin capsule of the parathyroid gland gives rise to delicate connective tissue septa, which divide the parenchyma into dense, cord-like masses of secretory cells. The septa carry blood vessels, lymphatics and nerves.

The parathyroid gland contains secretory cells with two types of morphological characteristics:

1). Chief or principal cells: these are the most abundant cells and are responsible for the secretion of parathyroid hormone. Chief cells have a prominent nucleus and relatively little cytoplasm which varies in staining intensity according to the degree of secretory activity of the cell. Actively secreting cells contain much rough endoplasmic reticulum and stain strongly; in contrast, inactive cells contain little rough endoplasmic reticulum and stain poorly.

2). Oxyphil cells: these are larger and much less numerous than chief cells and tend to occur in clumps. They have smaller, densely stained nuclei and strongly eosinophilic (oxyphilic) cytoplasm containing fine granules. Few oxyphil cells are found in the human parathyroid gland until puberty, after which they increase in number with age. Oxyphil cells do not secrete hormones except in certain pathological conditions and their function is poorly understood.

Illustrate and indicate: 1.Connective tissue septa. 2.Parathyrocytes. 4.Blood vessels.

V. Real-life situations to be solved:

1. In the specimen of the adrenal gland you can see the cortex. Which layers (zones) can you define (can be defined) in this part of the organ?

- A. Anterior, intermediate and infundibular.
- B. Outer and inner.
- C. Glomerulosa and fasciculata.
- D. Anterior and posterior.
- *E. Glomerulosa, fasciculata and reticularis.

2. In the specimen of the adrenal gland you can see the cortex. Which hormones are produced in this part of the organ?

- A. Gonadotropines, somatotropim
- *B. Steroids.
- C. Oxytocin and antidiuretic hormone.
- D. Norepinephrine and epinephrine.
- E. Thyroxine and thriiodothyronine.

3. In the specimen of the adrenal gland you can see the medulla. Which hormones are produced in this part of the organ?

- A. Gonadotropines, somatotropim
- B. Steroids.
- C. Oxytocin and antidiuretic hormone.
- *D. Norepinephrine and epinephrine.
- E. Thyroxine and thriiodothyronine.

4. In the specimen you can see the thyroid gland. Which tissue forms the parenchyma of this organ?
- A. Loose connective.
 - B. Nervous.
 - *C. Glandular epithelium.
 - D. Lymphoid.
 - E. Muscle.
5. In the specimen you can see the thyroid gland. Which hormones does this gland produce?
- A. Antidiuretic hormone (vasopressin) and oxytocin.
 - B. Steroids and catecholamines.
 - *C. Thyroxine, triiodothyronine and calcitonin.
 - D. Growth hormone (somatotropin), prolactin, thyrotropin, gonadotropins and adrenocorticotropin.
 - E. Prolactin, thyrotropin, gonadotropins, adrenocorticotropin and antidiuretic hormone.
6. In the specimen you can see the thyroid gland. Which arrangement does its parenchyma have?
- A. Straight cords.
 - B. Network of cords.
 - *C. Follicles and interfollicular islets.
 - D. Islets and cords.
 - E. Pseudofollicles.
7. In the specimen you can see the thyroid gland. Which is the structural unit of this organ?
- A. Acinus.
 - B. Nephron.
 - *C. Follicle.
 - D. Islet.
 - E. Pseudofollicle.
8. In the specimen of the thyroid gland you can see a follicle. Which components does this structure include?
- A. Stratified epithelium and colloid.
 - B. Simple columnar epithelium, zona pellucida and oocyte.
 - C. Simple squamous epithelium and oocyte.
 - *D. Simple cuboidal epithelium and colloid.
 - E. Epithelium and loose connective tissue.

9. In the specimen of the thyroid gland you can see a follicle. Which epithelium lines this structure normally?

- A. Stratified squamous.
- B. Simple columnar.
- C. Simple squamous.
- *D. Simple cuboidal.
- E. Transitional.

Technological card to practical classes

Nº	Types of activity	Duratio n	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 43 FOR STUDENTS

THEME: ADRENAL GLAND.

PROFESSIONAL MOTIVATION

The pathology of the adrenal cortex is of particular clinical significance by virtue of the capacity of diseases to affect the types and amounts of hormones secreted by this organ. Inflammatory and regressive processes and, rarely, some tumors may destroy sufficient functioning cortical tissue to lead to hypocorticalism (Addison's disease). On the other hand, hyperplastic or neoplastic processes, by the production of increased amount of steroids, lead to hypercorticalism. To understand these processes, the biosynthesis of the steroids and the enzyme systems that play role in this synthetic process must be known. In this area of pathology, as in so many others, function cannot be separated from structure.

GENERAL AIM: Can to identify the capsule, cortex, zona glomerulosa, zona fasciculata, zona reticularis, medulla, chromaffin cells in a specimen of the adrenal gland, and to identify the ultrastructural features in electron micrographs.

Final aims. Students should be able to:

1. Recognise the differences between the cortex and medulla of the adrenals in terms of their histologic structure, function, location, and embryonic origin.
2. Identify the layers of the adrenal cortex in terms of each layer's histologic structure, the hormones secreted, and the layer's location.
3. Explain the roles of the pituitary, hypothalamus, and kidney in regulating adrenocortical hormone secretion.
4. Interpret functional relationship between the adrenal medulla and the nervous system.
5. Analyse the role of adrenocortical hormones in regulating adrenomedullary function.

BASIC LEVEL

1. Anatomy of the suprarenal glands (department of anatomy).

STUDENTS' INDEPENDENT STUDY PROGRAM

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to the following:

1. Distinguish between the cortex and medulla of the adrenals in terms of their histologic structure, function, location, and embryonic origin.
2. Layers of the adrenal cortex in terms of each layer's histologic structure, the hormones secreted, and the layer's location.

3. Roles of the pituitary, hypothalamus, and kidney in regulating adrenocortical hormone secretion.
4. Functional relationship between the adrenal medulla and the nervous system.
5. Role of adrenocortical hormones in regulating adrenomedullary function.

Key words and phrases: adrenal gland, adrenal cortex, zona glomerulosa, arched clusters (glomeruli), mineralocorticoids, zona fasciculate, straight cords (fascicles), glucocorticoids, zona reticularis, anastomotic network reticulum, lipid droplets, mineralocorticoids, aldosterone, glucocorticoids (cortisol, corticosterone), adrenal androgens, adrenal medulla, chromaffin cells, electron – dense secretory granules, catecholamines, epinephrine, norepinephrine, ganglion cells.

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 403-410.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 309-312.
3. Wheater P.R., Burkitt H.G., Daniels V.G. Functional Histology: a text and colour atlas. - 2nd ed. Longman Group UK Limited, 1987. - pp. 267-272.
4. Victor P. Eroschenko. Atlas of Histology with functional correlations. - 9th ed. Lippincott Williams and Wilkins, 2000. – pp. 277-279, 281-285.

II. For self-control students should fill in this table:

Characteristic of the adrenal gland

Parts of organ	Tissues	Hormones

III. Visual aids and material tools:

Students should be able to indicate elements in the electron micrographs:

1. Adrenal cortex: zona fasciculata.
2. Chromaffin cells of the adrenal medulla.

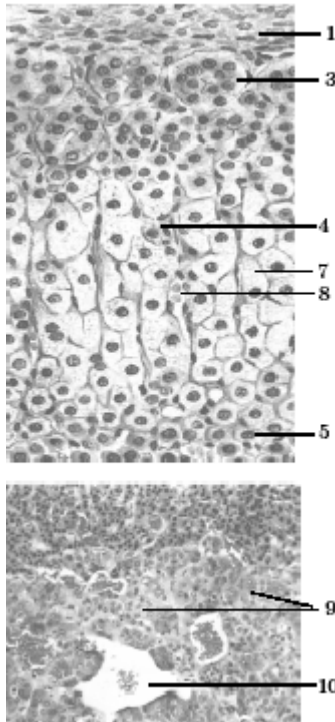
Charts No:

- 43-1. Blood supply of the adrenal gland
- 43-2. Morphologic and functional zonation of adrenal gland
- 43-3. Adrenal cortex: zona glomerulosa
- 43-4. Lipid droplets in adrenal zona fasciculate
- 43-5. Adrenal cortex: zona reticularis
- 43-6. Adrenal medulla

IV. Students’ practical activities:

Students must know and illustrate such histological specimens:

Specimen 1. Adrenal gland.
Haematoxylin and Eosin.



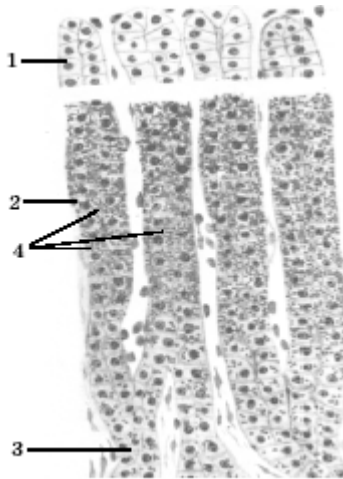
The adrenal gland is seen to be divided into an outer cortex and a pale-stained inner medulla. Capsule, invests the gland and provides external support for a delicate collagenous framework supporting the secretory cells.

The adrenal cortex can be seen to consist of three histological zones which are named according to the arrangement of the secretory cells: zona glomerulosa, zona fasciculata, zona reticularis. The zona glomerulosa lying beneath the capsule consists of short columnar cells closely packed in ovoid groups or in columns which may form arcs. The zona fasciculata consists of polyhedral cells considerably larger than those of the zona glomerulosa. They are arranged as anastomosing «cords» of cells with a marked radial orientation, extending between the zona glomerulosa and the reticularis. The zona reticularis consists of an irregular network of branching cords and clumps of glandular cells separated by numerous wide capillary sinusoids. The glandular cells are much smaller than those of the adjacent zona fasciculata.

The adrenal medulla is composed of closely packed clumps of secretory cells supported by a fine reticular network containing numerous wide capillaries. The secretory cells of the adrenal medulla have large, granular nuclei and extensive strongly basophilic cytoplasm.

Illustrate and indicate: 1. Capsule; 2. Adrenal cortex: a) zona glomerulosa; b) zona fasciculata; c) zona reticularis; 3. Adrenal medulla: a) chromaffin cells; b) sinusoidal capillaries.

Specimen 2. Adrenal cortex.
Sudan.



Note that the cytoplasm of cells zona fasciculata is even richer in smooth endoplasmic reticulum and lipid droplets than the zona glomerulosa and this may confer a foamy appearance of the cells. In this specimen you see lipid droplets in cells of zone fasciculata look like black drops of different sizes. Lipid droplets of secretory cells of zona glomerulosa, when present, are scarce and small. Cells of zona reticularis contain few lipid droplets, so cytoplasm stains more strongly.

Illustrate and indicate: 1. Lipid droplets in the cytoplasm of secretory cells of zona fasciculata.

V. Real-life situations to be solved:

1. In the specimen you can see the adrenal gland. Which tissues form the parenchyma of this organ?
 - A. Epithelial and loose connective.
 - B. Lymphoid and myeloid.
 - C. Smooth muscle and epithelial.

- D. Nervous and loose connective.
- *E. Nervous and epithelial.

2. In the specimen of the adrenal gland you can see the cortex. Which tissue forms the parenchyma of this part?

- *A. Epithelial.
- B. Lymphoid.
- C. Smooth muscle.
- D. Loose connective.
- E. Nervous.

3. In the specimen of the adrenal gland you can see the medulla. Which tissue forms the parenchyma of this part?

- A. Epithelial.
- B. Lymphoid.
- C. Smooth muscle.
- D. Loose connective.
- *E. Nervous.

4. In the specimen of the adrenal gland you can see the cortex. Which layers (zones) can you define (can be defined) in this part of the organ?

- A. Anterior, intermediate and infundibular.
- B. Outer and inner.
- C. Glomerulosa and fasciculata.
- D. Anterior and posterior.
- *E. Glomerulosa, fasciculata and reticularis.

5. In the specimen of the adrenal gland you can see the cortex. Which hormones are produced in this part of the organ?

- A. Gonadotropines, somatotropim
- *B. Steroids.
- C. Oxytocin and antidiuretic hormone.
- D. Norepinephrine and epinephrine.
- E. Thyroxine and thriiodothyronine.

6. In the specimen of the adrenal gland you can see the medulla. Which hormones are produced in this part of the organ?

- A. Gonadotropines, somatotropim
- B. Steroids.
- C. Oxytocin and antidiuretic hormone.
- *D. Norepinephrine and epinephrine.
- E. Thyroxine and thriiodothyronine.

Technological card to practical classes

№	Types of activity	Duration	Methods	Technique	Site
1.	Control and correction of knowledge	10 min	Tests	Computers	Computer class
2.	Discussion of the main points	20 min	Slides, Tables	Projector	Class room
3.	Independent students activity	45 min	Specimens	Microscopes	Class room
4.	Summary and results of activity	5 min	-	-	Class room

METHODOLOGICAL INSTRUCTIONS TO LESSON 44 FOR STUDENTS

THEME: SUMMARY LESSON ON THE TOPICS 34 – 43

AIM: To substantiate and to fix knowledge and skills as for according to such topics as: sense organs; organ of haemopoiesis and immune system; endocrine system applying differential diagnosis of histological specimens and electron micrographs using Multiple Choice Questions.

I. Objectives for Students' Independent Studies

You should prepare for the practical class using the existing textbooks and lectures. Special attention should be paid to all the questions which you can find in the previous methodological instructions.

II. Multiple Choice Questions

1. For question 1.1 through 1.9 select the single best answer.

1.1. The structure that serves as the border between the anterior and posterior chambers of the eye is the:

- Iris
- Lens
- Zonule
- Ora serrata
- Vitreous body

1.2. The fovea of the eye:

1. Is also known as the blind spot
2. Is the region where the axons of the ganglion cells converge and leave the eye as the optic nerve
3. Is the region where retinal veins converge to leave the eye
4. Is the thinnest part of the neural retina
5. Contains no photoreceptive cells

1.3. The thickest layer in the walls of veins is the:

1. Tunica media
2. Tunica adventitia
3. Subendothelial connective tissue
4. Tunica intima
5. Internal elastic lamina

1.4. Each of the following statements concerning muscular arteries is true EXCEPT

- A They contain more elastic fibers than smooth muscle cells
- B The media contains smooth muscle cells
- C They have an endothelium at the lumen
- D They have an elastica externa
- E The media contains elastic fibers

1.5. Each of the following statements concerning large veins is true EXCEPT

- A They have valves
- B They have well-defined elastica interna and externa
- C The adventitia may contain smooth muscle
- D The media contains elastic fiber
- E The media contains smooth muscle

1.6. Many blood vessels have elastic fibers in their tunica media. Which of the following blood vessels contains the most elastic fibers?

- A The radial artery
- B The renal artery
- C The aorta
- D The inferior vena cava
- E The superior vena cava

1.7. Characteristics of sinusoidal capillaries include all of the following except:

- A They have unusually wide lumens
- B They have abundant fenestrations
- C They usually follow a tortuous (twisting) course
- D They usually have a continuous basal lamina
- E They often have phagocyte cells inserted between the endothelial cells

of their lining

1.8. Pericytes:

- 1. Are specialized cardiac muscle cells
- 2. Cling to the outside of capillaries
- 3. Are specialized smooth muscle cells
- 4. Are terminally differentiated
- 5. Are multinucleated

1.9. Each of the following statements concerning cardiac muscle cells is true EXCEPT

- A They have less sarcoplasmic reticulum than skeletal muscle cells
- B They are abundant in the walls of the ventricles and atria
- C They are abundant in the epicardium
- D They contain T-tubules
- E Gap junctions facilitate ionic communication between cardiac muscle

cells

1. Questions 2.1 through 2.79 may have more than one correct answer

- A Bowman's membrane
- B Descemet's membrane
- C Bruch's membrane
- D None of the above

2.1. Innermost layer of the choroid

- 2.2. Posterior epithelium of the cornea
- 2.3. Contains elastin
- 2.4. Basement membrane of the pigmented epithelium
- 2.5. Anterior epithelium of the cornea
- A External ear
- B Middle ear
- C Internal (inner) ear
- D All of the above
- E None of the above
- 2.6. Communicate(s) with the pharynx through the Eustachian tube
- 2.7. Include(s) the auricle
- 2.8. Also known as the labyrinth
- 2.9. Contain(s) the cochlea
- 2.10. Contain(s) the ossicles
- 2.11. Communicate(s) with the mastoid air cells
- 2.12. Include(s) the external auditory meatus
- 2.13. Include(s) the tympanic membrane
- 2.14. Include(s) the ceruminous glands
- 2.15. Contain(s) the vestibular apparatus
- 2.16. Contain(s) endolymph
- 2.17. Contain(s) perilymph
- 2.18. Include(s) the modiolus
- 2.19. Include(s) the semicircular canals
- 2.20. Contain(s) the organ of Corti
- A Lymphocytes
- B Macrophages
- C Reticular cells
- D Plasma cells
- E Dendrite cells
- 2.21. Nonphagocytic cells that bind antigen on their surfaces and present them to lymphocytes for recognition and stimulation
- 2.22. Derived from blood monocytes
- 2.23. Secrete immunoglobulins
- 2.24. Primary cellular component of the stroma of the lymph nodes and spleen
- 2.25. Contain the largest amount of rough endoplasmic reticulum of those listed
- A Thymus
- B Spleen
- C Lymph nodes
- D All of the above
- E A and C only

F B and C only

- 2.26. Exhibit(s) a cortex and a medulla
- 2.27. Contain(s) significant numbers of B lymphocytes
- 2.28. Contain(s) significant numbers of T lymphocytes
- 2.29. Primary immunologic filter of blood
- 2.30. Primary immunologic filter of lymph
- 2.31. Contain(s) lymphoid nodules
- 2.32. Encapsulated organ(s)
- 2.33. Central (primary) lymphoid organ(s)
- 2.34. Peripheral (secondary) lymphoid organ(s)
- 2.35. Capsule contains some smooth muscle
- 2.36. Contain(s) cords and sinuses
- 2.37. Contain(s) a subcapsular sinus
- 2.38. Contain(s) Hassall's corpuscles
- 2.39. Receive(s) afferent lymphatic vessels
- 2.40. Contain(s) periaarterial lymphatic sheaths
 1. T lymphocytes
 2. B lymphocytes
 3. Both
 4. Neither
- 2.41. Respond to antigenetic stimulation by blast transformation and proliferation
 - 2.42. Primarily associated with humoral immunity
 - 2.43. Primarily associated with cell-mediated (cellular) immunity
 - 2.44. Form both memory and effector cells
 - 2.45. Differentiate into plasma cells
 - 2.46. Differentiate into cytotoxic (killer/graft rejection) cells
1. Aldosterone
2. Corticosterone
3. Dehydroepiandrosterone
4. Epinephrine
5. Norepinephrine
6. Glucagon
7. Insulin
8. Somatostatin
9. Pancreatic polypeptide
10. Thyroxin
11. Calcitonin
12. Parathyroid hormone
13. Melatonin
 - 2.47. Glucocorticoid(s)
 - 2.48. Mineralocorticoid(s)

- 2.49. Androgen(s)
 - 2.50. Steroid hormone(s)
 - 2.51. Peptide hormone(s)
 - 2.52. Catecholamine(s)
 - 2.53. Synthesized and secreted by cells in the pancreas
 - 2.54. Synthesized and secreted by cells in the thyroid gland
 - 2.55. Synthesized and secreted by cells in the parathyroids
 - 2.56. Synthesized and secreted by cells in the pineal body
 - 2.57. Synthesized and secreted by cells in the adrenal glands
 - 2.58. Produced in response to stimulation by pituitary hormones
 - 2.59. Produced in response to elevated blood calcium levels
 - 2.60. Produced in response to angiotensin II
 - 2.61. Produced in response to stress
 - 2.62. Produced in response to decreased blood calcium levels
 - 2.63. Produced in response to increased blood sugar levels
 - 2.64. Produced in response to decreased blood sugar levels
 - 2.65. Production influenced by external visual stimuli
 - 2.66. Storage form stored extracellularly
 - 2.67. Storage form complexes with zinc
 - 2.68. Increases basal metabolic rate
 - 2.69. Decreases exocrine secretions of pancreas and liver
 - 2.70. Increases absorption of salt by distal tubules
1. Adrenal cortex
 2. Adrenal medulla
 3. Both
 4. Neither
- 2.71. Produce(s) steroid hormones
 - 2.72. Produce(s) catecholamines
 - 2.73. Derived from neural crest
 - 2.74. Derived from mesoderm
 - 2.75. Contains chromaffin cells
1. Calcitonin
 2. Parathyroid hormone
 3. Both
 4. Neither
- 2.76. Increases bone resorption
 - 2.77. Lowers blood calcium and increases osteogenesis
 - 2.78. Below-normal concentrations in blood cause tetany
 - 2.79. Diminishes absorption of phosphate in renal tubules
1. For questions 3.1 through 3.21, one, more than one, or all of the answers may be correct. Select
- A. if only (1), (2) and (3) are correct

- B. if only (1) and (3) are correct
- C. if only (2) and (4) are correct
- D. if only (4) is correct
- E. if all answers are correct

3.1. Contraction of the ciliary muscles:

1. Is under involuntary control
2. Is required for focusing on near objects
3. Allows accommodation
4. Pulls the ciliary body anteriorly

3.2. The pigmented epithelium of the retina:

1. Rests on Bruch's membrane
2. Continues anteriorly over the ciliary body and iris
3. Is derived from the outer wall of the optic cup
4. Phagocytoses flattened vesicles shed by the cone cells

3.3. The tunica intima:

1. Has a layer of dense connective tissue
2. Is avascular
3. Is separated from the tunica media of arteries by the external elastic lamina
4. Has a layer of simple squamous epithelium

3.4. Fenestrated capillaries:

1. Are found in the kidney
2. Are important in the transport of macromolecules between blood and tissues
3. Have a continuous basal lamina
4. May have thin diaphragms covering their pores

3.5. Physiologic functions in which arteriovenous anastomoses play an important part include:

1. Menstruation
2. Thermoregulation
3. Erection
4. Regulation of blood pressure

3.6. Lymphatic vessels:

1. Have walls resembling those of veins
2. Contain valves
3. Have indistinct borders between their tunics
4. Contain longitudinal smooth muscle fibers in their tunica media

3.7. Purkinje fibers:

1. Are specialized cardiac muscle cells
2. Are densely packed with myofilaments
3. Communicate with typical cardiac muscle cells through gap junctions
4. Are most commonly found directly beneath the ventricular epicardium

3.8. Effector cell types derived from T-lymphocytes include

1. Helper cells

2. Suppressor cells
3. Cytotoxic cells
4. Plasma cells

3.9. B-lymphocytes are the major type of lymphocytes found

1. In Peyer's patches
2. In the palatine tonsils
3. In the peripheral white pulp of the spleen
4. Circulating in the blood

4. For questions 4.1 through 4.12, either, both or neither of the answers may be correct.

Select

A if only A is correct

B if only B is correct

C if both A and B are correct

D if neither A nor B is correct

1. Rod cells
2. Cone cells
3. Both
4. Neither

4.1. Photoreceptors

4.2. Lack(s) an outer segment

4.3. Flattened vesicles are independent of plasma membrane

4.4. Contain(s) iodopsin

4.5. Responsible for night vision

4.6. Greatest visual acuity

4.7. Absent from the fovea

4.8. Contain(s) intracytoplasmic cilia

4.9. Most abundant

4.10. Located in the layer of the retina adjacent to the pigmented epithelium

4.11. Contain(s) rhodopsin

4.12. Responsible for color vision

III. Answer to the Multiple Choice Questions:

1.1.A 1.2.D 1.3.B 1.4.A 1.5.B 1.6.C 1.7.D 1.8.B 1.9.C

2.1.C 2.2.D 2.3.B 2.4.C 2.5.D 2.6.B 2.7.A 2.8.C 2.9.C 2.10.B 2.11.B
 2.12.A 2.13.A 2.14.A 2.15.C 2.16.C 2.17.C 2.18.C 2.19.C 2.20.C 2.21.E 2.22.B
 2.23.D 2.24.C 2.25.D 2.26.E 2.27.F 2.28.D 2.29.B 2.30.C 2.31.F 2.32.D 2.33.A
 2.34.F 2.35.B 2.36.F 2.37.C 2.38.A 2.39.C 2.40.B 2.41.C 2.42.B 2.43.A 2.44.C
 2.45.B 2.46.A 2.47.B 2.48.A 2.49.C 2.50.A,B,C 2.51.F,G,H,I,J,K,L 2.52.D,E
 2.53.F,G,H,I 2.54.J,K 2.55.L 2.56.M 2.57.A,B,C,D,E 2.58.A,B,C,J 2.59.K 2.60. A
 2.61.D,E 2.62. L 2.63.G 2.64.F 2.65.M 2.66.J 2.67.G 2.68.J 2.69.I 2.70.A 2.71.A
 2.72.B 2.73.B 2.74.A 2.75.B 2.76.B 2.77.A 2.78.B 2.79.B

3.1.E 3.2.E 3.3.C 3.4.E 3.5.E 3.6.E 3.7.B 3.8.A 3.9.A

4.1.C 4.2.D 4.3.A 4.4.B 4.5.A 4.6.B 4.7.A 4.8.C 4.9.A 4.10.C 4.11.A

4.12.B

IV. Students should be able to indicate elements in the electron micrographs:

1. Photoreceptor neurons of the neural retina: rods.
2. Photoreceptor neurons of the neural retina: cones.
3. Arteriola.
4. Fenestrated capillary.
5. Continuous capillary.
6. Sinusoidal capillary.
7. Lymphatic vessel.
8. Cardiac muscle cell.
9. Intercalated discs.
10. Hematopoietic compartment of erythrocytes.
11. Hematopoietic compartment of granulocytes.
12. Thymic cortex.
13. Lymphoid follicle of the lymph node's cortex.
14. Cells of the adenohypophysis.
15. Adenohypophysis: somatotrope producing cell.
16. Adenohypophysis: thyrotrope producing cell.
17. Adenohypophysis: corticotrope producing cell.
18. Thyroid follicle (normal function).
19. Thyroid follicle (hyperfunction).
20. Thyroid follicle (hypofunction).
21. Adrenal cortex: zona fasciculata.
22. Chromaffin cells of the adrenal.

V. Students must know and be able to describe such histological specimens as:

1. Wall of the eye: H&E
2. Cornea: H&E
3. Cochlear organ of Corti: H&E
4. Muscular artery: H&E
5. Elastic artery: aorta, orcein
6. Muscular vein: H&E
7. Arterioles, venules, capillaries: H&E
8. Lymphatic vessel. Methylene blue.
9. Heart: myocardium. Iron hematoxylin
10. Heart: endocardium. Purkinje fibers. H&E
11. Bone marrow smear. Giemsa.
12. Thymus. H&E
13. Lymph node. H&E.

14. Spleen. H&E
15. Pituitary gland. Acid fuchsin.
16. Pineal gland. H&E
17. Thyroid gland. H&E
18. Adrenal gland. H&E

References:

1. Carlos Junqueira, Jose Carneiro, Robert O. Kelley. Basic Histology. - 7th ed. Appleton and Lange. Norwalk, Connecticut, 1992, pp. 281-357.
2. Inderbir Singh. Textbook of Human Histology with colour atlas. – 4th ed. Jaypee Brothers Medical Publishers (P) LTD, 2002, pp. 207-254.
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