**Ministry of Education and Science of the Kyrgyz Republic**

**Osh State University**
**Osh International Medical University**
**Federal State-Funded Educational Institution of Higher Education**
**"Voronezh State Medical University named after N.N. Burdenko"**
**of the Ministry of Health of the Russian Federation**

**Department of Anatomy, Histology and Normal Phyzioligy**
**Department of Natural Sciences**
**Department Histology**

# TRAINING MANNUALS – ALBUM

in Human Histology

for practical classes, independent self work and self-preparation for the specialty "560001-General Medicine"

**Osh-Voronezh, 2023**

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Training mannuals – album in Human Histology for practical classes, independent self work and self-preparation of foreign students of medical university in the specialty "560001-General Medicine"; Osh-Voronezh – 2023. – 176 p.

"Training mannuals – album in Human Histology for practical classes, independent self work and self-preparation of foreign students of medical university ", the manual is compiled in accordance with the requirements of the State Educational Standard (2021) in the specialty "560001-General Medicine", approved by the order of the Ministry of Education and Science of the Kyrgyz Republic, taking into account the recommendations of the approximate work program for the specialty

***"Training manuals album .."*** contains recommendations in preparation studying and drawing, situational tasks, current test control questions, test control questions to remaining knowledge, tables and scheme-pictures for student's self work.

**Reviewer:** Pavlov A.V. Head of the Department of Histology, Cytology and Embryology of the Federal State Budgetary Educational Institution of Higher Education "Yaroslavl State Medical University" of the Ministry of Health of the Russian Federation, Doctor of Medical Sciences, Professor, Honored Worker of the Higher School of the Russian Federation.

**Recommended** by the Central problem educational and methodic committee of histology, cytology, embryology to use in education.

**Name**_____

**Course, faculty, No of group**_____

**No of microscope**_____

## RECOMMENDED EDUCATIONAL-METHODICAL LITERATURE

### BASIC


1. Junqueira's Basic Histology/ Text and Atlas/ Anthony L. Mescher – 14th ed. – New York, USA: ISBN 978-1-25-925098-9; MHID 1-25-925098-9. p. 560.

2. Gartner, L. P. Textbook of Histology / L. P. Gartner. – 4-th ed. – Philadelphia, PA : Elsevier, 2017. – ISBN 9780323355636. – URL: http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=1287508. – Text: electronic.

3. Histology/ Color Atlas and textbook/ Leslie P. Gartner, James L. Hiatt (6th ed.)
4. Inderbir Singh's textbook of Human Histology/ Neelam Vasudeva, Sabita Mishra/ Color Atlas and practical guide (7th ed)


### Additional


5. Histology : a Text and Atlas With Cell and Molecular Biology / M.H. Ross, G.I. Kaye, P. Wojciech. – 4 edition. – Philadelhia : LIPPINCOTT WILLIAMS & WILKINS, 2003. – 864p. + 1CD-Rom. – ISBN 0-683-30242-6.
6. Singh I. Textbook of Human Histology : With Colour Atlas / I. Singh, J. Brothers. – 5 ed. – New Delhi : Medical Publishers (P) LTD, 2006. – 365 c. – ISBN 81-8061-809-9.
7. Yushkantseva, S. A brief atlas of histology, cytology and embryology with 279 color illustrations = Гистология,цитология и эмбриология / S. Yushkantseva, B. Bykov. – SPb : П-2, 2007. – 120 p. – ISBN 978-5-93893-403-0.
8. Histology/ textbook. Eduardo G. Gonzales, M.D. (5th ed.)
9. Human histology/ Alan Stevens, James Lowe. (3rd ed.)

## The Instructions of the Anatomy, Histology and Normal physiology department for the students to follow

1. Students have to handle the Department property, microscopes and other equipment with care and caution
2. Students have to follow a dress-code: students wear medical gowns and cap
3. Students are to come to the lectures and the practical class on time
4. Students are to have TRAINING MANNUALS – ALBUM and colored pencils for drawing slides at every practical class
5. to get the permission for current control, milestone control and exam control, students are to attend all lectures and practical classes and perform correctly all tasks in the workbook
6. If students are missing at practical classes, they will have to take a permission and work off a missed class within a few time.

I will read the Instruction of the Department_____

*(signature)*

# SECTION I. Histological equipment

## Rules for working with microscopes

**The purpose of the lesson**

Is able and willing to define the role of histology, cytology and embryology in practice, knows the methods of microscopy of histological preparation and stages, principles of preparation of histological preparations and educational literature. Apply the study material in his/her future profession

1. It is necessary to dust microscope optical parts with the napkin before you start working.
2. Mount the microscope on the desk edge and have it ready for work:
    a) Place the low magnifying objective at the distance of 1 – 1,5 cm from the desk;
    b) Set the light by the concave mirror side from the artificial light source;
    c) Looking into the ocular with one eye (more convenient with the left one) without shutting another, illuminate equally and intensively a vision site by the mirror.
3. Place a micropreparation on the objective table with the covering glass being up (pay a special attention to it). The micropreparation should be shifted holding thumb and index finger on the edges. Fix the position on the table with the third finger.
4. Observe the preparation and concentrate the object studied in the site vision center.
5. While turning from low to high magnification it is necessary:
    a) to raise the microscopic cone, rotating microscrew towards yourself (~0,5 cm from the objective table),controlling it visually;
    b) to change the objective turning revolver till the crack;
    c) to lower the cone so that the objective almost contacts with the micropreparation by slow screw forward rotation;
    d) to look into the ocular and rotate the screw slowly towards yourself until an image of the object appears in the vision site;
    e) in the presence of the condenser it is possible to supply a better illumination of preparation at high magnification.
6. While microscoping the left hand should be constantly placed on the screw in order to correct the depth of image rotating the screw backward and forward.
7. Having studied the structures in the site vision at high magnification it's necessary to choose and draw a proper fragment.

8. When you complete the work don't remove the preparation from under the high magnifying objective without raising the cone upwards (no more than 0,5 cm). The preparation is to be removed at low magnification.
9. It is prohibited to unscrew any parts of microscope. In case of microscope disrepair address the tutor.

## BASIS OF HISTOLOGICAL EQUIPMENT

Essential principles of specimen preparation for light microscopy

The significance of tissue, organ and cell thin structure and function is essential for doctor of any specialization. It is to realize the vitality processes taking place on different structural levels. Apart from this the principle diagnostic method sometimes consists of vital cell, tissue and organ research. It (biopsy) is widely used in clinics.

The basic histological method is the light microscopy, i.e. the preparation study in light microscope. Hence students should know basic principles of microscopic specimen preparation.

A histological preparation production process includes the following stages:

1. Material teasing. 2. Fixation. 3. Dehydration and induration. 4. Material embedding (paraffin, celloidin and others). 5. Sectioning. 6. Staining. 7. Brightening and embedding, supplying the preparation safety.

### 1. Material teasing

A piece of organ (10x10x5 mm) is cut by thin sharp instruments for further research. The structure of an organ or a tissue should be taken into consideration. Thus the organ piece is to be cut in such a way that it could reflect the peculiarities of the organ structure. After the material has been teased it should be embedded into fixative.

### 2. Material fixation

Fixation provides tissue structure strengthening and induration. The mechanism is based on protein coagulation and lipid stabilization. A fixative choice depends on further research aim. There is a number of fixation facilities. They are subdivided into simple (one substance) and compound (two and more substances) facilities. An example of the simple one is: 10% formalin, 70% spirit. The compound one is: 60 ml of absolute spirit, 30 ml of chloroform and 10 ml of icy vinegar acid (a Karnua liquid). The fixative liquid volume should 10 – 20 times excel the fixated material volume. Second fixative application is impossible. Fixation time is determined by fixative and fixated material (a pattern size) properties.

Further fixated material processing depends on the fixative chosen:

- Washing in water with the following dehydration or
- Freezing or
- Dehydration

Tissue or organ pattern fixation may result in two ways: either they are sectioned on freezing microtome, or washed in water and dehydrated later, it depending on the fixative. The washing purpose is to remove extra fixative liquid amount. Washing time is determined by the pattern size.

### 3. Material dehydration and induration

The chief purpose of the processing consists of water removal from tissues and pattern induration to produce thin sections. Dehydration is carried out with the use of spirit that also contributes to induration. The pattern is successively carried through spirits with increasing concentration: 70%, 80%, 90%, 96% – I, 96% – II, 100% (absolute) – I, 100% – II. The exposure is from 6 to 24 hours in each spirit depending on the pattern size.

### 4. Material embedding

This processing is done by embedding the pattern into the substance, which soaks it and makes it dense and homogeneous. The principle of the processing is to carry the pattern successively through the number of liquids each of those should be able to dissolve with the following one.

PARAFFIN EMBEDDING SCHEME: material is transferred from 100 % spirit to equal mixture of absolute spirit and xylene (or chloroform) – 15-30 min. (6-12 hours), first and second xylene

(chloroform) – 15-30 min. (6-12h.) Paraffin solution is saturated in xylene and chloroform at $37^0$ from 30 min to 24 hours.

Paraffin I, II, III – 30-45 min. (depending on pattern size) at $54\text{-}56^0$ in thermostat.

Pattern embedding in pure paraffin wax is done in shape or Petri dish, cooling is produced in flowing water.

Cut patterns are stuck on wooden blocks.

**5. Sectioning**

It is compulsory to get acquainted with microtome mechanism, block cutting knifes, objective glass preparation, instruments and liquids for cutting (protein, water, etc.). Sections from paraffin blocks must be ready.

**6. Staining**

The purpose of staining is to make specimen structures more contrast, i.e. to change structure refraction index. Chief stains are hematoxilin (structures stained with it are called basophil structures) and acidic stain (eosin), these are oxyphilic structures.

STAGES OF PARAFFIN SECTION STAINING

1. Deparaffinization
   - ✓ Toluol I (or xylene) – 5-7 min.
   - ✓ Toluol II – 5-7 min.
2. Degreasing
   - ✓ Spirit 96% I – 5 min.
   - ✓ Spirit 96 % II – 5 min.
   - ✓ Spirit 70% – 5 min.
3. Sections should be washed in distil water for two times (each time the new one) 5 min in each.
4. Staining should be performed with hematoxilin and eosin in the following order:
5. Hematoxilin staining – 1-4 min; (depending on maturity and hematoxilin preparation method)
6. Washing in distil water (quickly!)
7. Washing in flowing water from 1 to several hours
8. Rinsing in distil water (quickly!)
9. Eosin staining – 30 sec
10. Dehydrate the stained sections:
    - Spirit 96% I –5 min;
    - Spirit 96% II – 5 min;
    - Spirit 100% – 5 min
11. Brightening and embedding

Sections are brightened:

- Carbol-xylene – 2 min;
- Xylene I – 5 min;
- Xylene II – 5 min.

**7. Mounting.**

Sections are embedded in Canadian (fur) balsam. A drop of balsam is applied on the stained and brightened section, and then the section is covered with pure fatless covering glass.

**Blood smear preparation and staining according to Romanovsky-Gimsa**

Thoroughly washed and fatless objective glass is usually used for blood smear preparation. A drop of blood is placed on the right end of the objective glass. It is then taken with thumb, index and third fingers of left hand in such a way that drop of blood is on the glass. The smear will be taken with a polished glass, it being placed at $30^0\text{-}45^0$ angle and 1-2 mm distance in front of the drop. Hold it with your thumb and index finger of right hand. The polished glass is shifted backwards so that it touches blood drop. The drop should flow in the corner between polished and objective glass. The smear is made with the quick hand movement. During smear preparation thumb and index finger should slide along the objective glass edges, thus producing necessary basis for equal blood layer distribution.

The prepared smear must dry up till the wet shine disappears. Dried smear is fixed in 96% spirit for 10-12 min. Then it is pulled out with pincers and placed on filtered paper vertically until spirit vaporizes. It is later stained according to Romanovsky-Gimsa method.

Washing is produced in distil water. Blotting is done with filtered paper. The preparation is researched with immersion system, basophil lymphocyte protoplasm is bluish.

## COMMON HISTOLOGICAC STAINS AND REACTIONS

| Reagent | Results |
|---|---|
| **Hematoxylin** | **Blue: nucleus, acidic regions of cytoplasm, cartilage matrix** |
| **Eosin** | **Pink: basic region of the cytoplasm, collagen fibers** |
| **Masson's trichrome** | **Dark blue: nuclei red: muscle, keratin, cytoplasm**<br>**Light blue:mucinogen, collagen** |
| **Orcein** | **Brown: elastic fibers** |
| **Weigert's elastic stain** | **Blue: elastic fibers** |
| **Silver stain** | **Black: reticular fibers** |
| **Iron hemotoxylin** | **Black: striations of muscle, nuclei, erythrocytes** |
| **Alcian blue – Van Gison** | **Blue: mucocytes; red: collagen** |
| **Periodic acid-Schiff** | **Magenta: glycogen and carbohydrate rich molecules** |
| **Wright and Giemsa stains** | **Used for differential staining of blood cells**<br>**Pink: erythrocytes, eosinophil granules;**<br>**Purple: leukocyte nuclei, basophil granules;**<br>**Blue: cytoplasm of monocytes and lymphocytes** |

## TEST CONTROL QUESTIONS.

*1. In preparing tissue for routine light microscopic study, which procedure immediately precedes clearing the specimen with an organic solvent?*

a. Dehydration; b. Fixation; c. Staining; d. Clearing; e. Embedding.

*2. Which of the following staining procedures relies on the cationic and anionic properties of the material to be stained?*

a. Enzyme histochemistry; b. Periodic acid-Schiff reaction; c. Hematoxylin & eosin staining; d. Metal impregnation techniques.

*3. In a light microscope used for histology, resolution and magnification of cells are largely dependent on which component?*

a. Condenser; b. Objective lens; c. Eyepieces or ocular lenses; d. Specimen slide; e. The control for illumination intensity.

*4. Cellular storage deposits of glycogen, a free polysaccharide, could best be detected histologically using what procedure?*

a. Autoradiography; b. Electron microscopy; c. Enzyme histochemistry; d. Hematoxylin & eosin staining; e. Periodic acid-Schiff reaction

*5. Adding heavy metal compounds to the fixative and ultrathin sectioning of the embedded tissue with a glass knife are techniques used for which histological procedure?* a. Scanning electron microscopy; b. Fluorescent microscopy; c. Enzyme histochemistry; d. Confocal microscopy; e. Transmission electron microscopy

*6. Resolution in electron microscopy greatly exceeds that of light microscopy due to which of the following?*

a. The wavelength of the electrons in the microscope beam is shorter than that of the beam of light.
b. The lenses of an electron microscope are greatly improved quality.
c. For electron microscopy the tissue specimen does not require staining.
d. An electron microscope can be much more finely controlled than a light microscope.

*7. Microscopic autoradiography uses radioactivity and can be employed to study what features in a tissue section?*
a. The types of enzymes found in various cell location; b. Cellular sites where various macromolecules are synthesized;
c. The sequences of mRNA made in the cells; d. The dimensions of structures within cells;
e. The locations of genes transcribed for specific mRNA.
*8. To identify and localize a specific protein within cells of the extracellular matrix one would best use what approach?*
a. Autoradiography; b. Enzyme histochemistry; c. Immunochemistry; d. Transmission electron microscopy; e. Polarizing microscopy.
*9. In situ hybridization is a histological technique used to visualize what type of macromolecule?*
a. Proteins; b. Carbohydrates; c. Certain enzymes; d. Nucleic acids; e. Lipids
*10. Hospital laboratories frequently use unfixed, frozen tissue specimens sectioned with a cryostat for rapid staining, microscopic examination, and diagnosis of pathological conditions. Besides saving much time by avoiding fixation and procedures required for paraffin embedding, frozen sections retain and allow study of what macromolecules normally lost in the paraffin procedure?*
a. Carbohydrates; b. Small mRNA; c. Basic proteins; d. Acidic proteins; e. Lipids.
*11. What is the resolution of a modern electron microscope?*
a. 0,002 nm; b. 2 – 5,0 nm; c. 10,0 nm; d. 0,02 nm.
*12. Which microscopy increases the contrast of structures and studies living, unpainted cells?*
a. luminescence; b. polarization; c. phase-contrast; d. light microscopy.
*13. When and by whom was the microscope improved, which made it possible to study the structure of tissues?*
a. M.Malpigi, 1674y; b. R. Huck, 1665; c. N. Grew, 1772; d. A. Levenguk, 1668.
*14. Basophilia of the cytoplasm is characteristic of cells:*
a. actively secreting mucus; b. accumulating lipids; c. having cilia; d. having microvilli; e. actively synthesizing proteins
15. *At what stage of preparation of histological preparations the intravital structure of a tissue is preserved by rapid coagulation of its proteins:*
a. dehydration; b. pouring into special media; c. fixation; d. manufacture of sections;
*16. Indicate the correct alternation of the main steps in the preparation of histological preparations:*
a. fixation, dehydration, sectioning, embedding, staining, and incision of slices;
b. dehydration, fixation, embedding, sectioning, staining slices and concluding slices;
c. fixation, dehydration, embedding, staining of slices and conclusion of slices;
d. fixation, dehydration, embedding, sectioning, staining of slices and conclusion of slices;
e. fixation, dehydration, sectioning, staining of slices, embedding and conclusion of slices.
*17. Which step of the preparation of histological preparations the lifetime structure of tissue is preserved by rapid coagulation of it's proteins:*
a. dehydration; b. embedding; c. fixation; d. sectioning; e. staining and incision of slices.
*18. In which step of the preparation of histological preparations is contrast given to tissue structures:*
a. fixation; b. dehydration; c. embedding; d. sectioning; e. staining and imaging of slices.
*19. In which step of the preparation of histological preparations is given density and homogeneity of the taken material:*
a. fixation; b. dehydration; c. embedding; d. sectioning; e. staining and imaging of slices.
*20. At which stage of preparation of histological preparations a certain thickness of the taken material is achieved:*
a. fixation; b. dehydration; c. embedding; d. sectioning; e. staining and imaging of slices.

# SECTION II. Cytology.

The basis of the structure and functioning of organs is the cell. The study of the microscopic structure of cells on histological material taken during life (biopsy) or from a dead organism (autopsy) is the basis for the diagnosis of conditions. Cytomorphology of buccal epithelium of the cheek mucosa has great informativeness and accessibility in the lifetime diagnosis of various diseases, determining the importance of histological discipline in clinical research.

Cytological examinations of blood, punctures of red bone marrow, liver and other organs are widespread in the clinic. In this regard, the future doctor needs to have an idea of the ultramicroscopic structure of cellular formations equivalent to cytochemical criteria of optical characteristics in the diagnosis.

**The purpose of the lesson**

Able and willing to parse the general outline of cell structure. Give an idea of the structure of the plasmolemma. Explain microscopic and ultramicroscopic structure of organelles and inclusions, note their localization and degree of development in different cells. Draw attention to the connection between the degree of development of organelles and inclusions and the level of cellular metabolism.

**Tasks**

- To know the general organization of cells, taking into account the peculiarities of organelle compartmentalization to characterize the functional state of cells.
- To be able to identify electron microscopic cellular components is equivalent to a light-optical characteristic with the justification of the functional state.
- To master the solution of situational problems that allow revealing knowledge of the studied theoretical foundations of the topic.

# Topic: Organels and inclusions.

**Date:**

***Class self work.***

**Table 1.** Morphofunctional cell cytoplasm organelles characteristics.

| **Organelle name** | **Light microscopy data** (or chemical equivalent) | **Electronmicroscopy data** | **Functions** | **Renewal** |
|---|---|---|---|---|
| **<u>Membranous organelles (to draw)</u>** | | | | |
| 1. Endoplasmic reticulum<br>a) smooth | | | | |
| b) granular | | | | |
| 2. Golgi complex | | | | |
| 3. Mitochondria | | | | |
| 4. Lysosomes | | | | |
| 5. Peroxysomes | | | | |

| | | | | |
|---|---|---|---|---|
| **Nonmembranous organelles (to draw)** | | | | |
| 1. Ribosomes | | | | |
| 2. Centrioles | | | | |
| 3. The cytoskeleton:<br>- Microtubules<br>- Microfilaments<br>- Intermediate filaments | | | | |
| **Organelles of special assignment (to draw)** | | | | |
| 1. Cilia | | | | |
| 2. Flagella | | | | |
| 3. Microvilli | | | | |
| 4. Basal labyrinth | | | | |
| 5. Tonofilaments | | | | |
| 4. Myofibrils | | | | |

***Extracurricular self work.***

**Table 2.** Inclusion classification.

| Inclusion name | | Chemical composition | Significance |
|---|---|---|---|
| Trophic | | lipid<br>carbohydrate (glycogen) | they are used in the cell as an energy source, determining active processes |
| Secretory | | protein<br>mucous<br>lipid | specific products of glandular epithelial cells for accumulation and release when in demand (salivary, sebaceous glands, etc.) the final products of the cell's vital activity are subject to removal |
| Excretory | | waste products (sweat, urine) | the final products of the cell's vital activity are subject to removal |
| Pigment | Endogenous | • hematogenic<br>hemoglobin<br>hemosiderin is a product of hemoglobin breakdown<br>• non-hematogenic<br>melanin<br>bilirubin<br>lipofuscin<br>carotenoids | transfer of gases (O2; CO2)<br>iron stock<br><br>UV protection<br>bile pigment, a product of hemoglobin breakdown<br>aging pigment<br>pigment coloring vegetables and fruits – antioxidants |
| | Exogenous | dyes, carotene, coal dust, chemotherapeutic substances | coloring |

**Date:**

*Directions for work with micropreparation:*

Find the mostly stained section part of liver on low magnification.
Draw one cell in which cytoplasm pinkly stained glycogen projections could be observed on high magnification.

**Draw glycogen in hepatic cells** (SHIC-reaction-hematoxilin)

1. Glycogen projections in the cytoplasm. 2. Nucleus

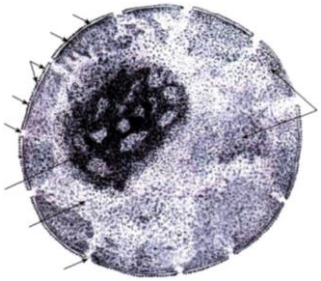
Correct task_____

Date "___" _____

***Class self work.***

**Nucleus. Cell division.**

**Table 3.** Morphofunctional interphase cell nucleus characteristics (*draw and fill in).*

| Nucleus structures in Electron microscope | Functions: storage, realization, reproduction and transmission of genetic information, protein synthesis | | | |
|---|---|---|---|---|
| 1 – perinuclear space;<br>2 – internal nuclear membrane;<br>3 – ribosomes;<br>4 – outer nuclear membrane;<br>5 – nuclear pores;<br>6 – the nucleus;<br>7 – euchromatin;<br>8 – nuclear pores;<br>9 – heterochromatin  | Nucleolemma | Chromatin | Nucleolus | Nucleoplasm |
| | | | | |

***Extracurricular self work.***

**Table 4.** Mitotic cycle phases morphology.

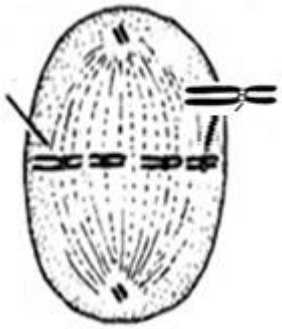
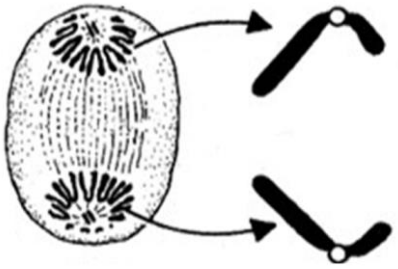
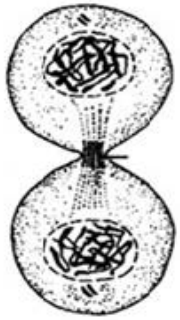
| **Mitosis phases** | | | |
|---|---|---|---|
| Prophase | Metaphase | Anaphase | Telophase |
|  |  |  |  |

**Table 5.** Comparative characteristics of mitosis and meiosis (*draw and describe).*

| Characteristics of interphase and phase separation | Mitosis | Meiosis | |
|---|---|---|---|
| | | division | division |
| Interphase | | | |
| Prophase | | | |
| Metaphase | | | |
| Anaphase | | | |
| Telophase | | | |

**Date:**

*Directions for work with micropreparation:*
Examine spinal ganglion at low magnification. Find oval-formed cell with well-distinguished nucleus at section periphery. Study the nucleus structure at high magnification: nuclear coating, nucleolus, chromatin projections (condensated chromosome spaces), and nuclear juice. Draw one cell.

**Pseudonipolar neuron of the spinal sensitive ganglion**
(staining by hematoxilin-eosin)**.**
1. Nuclear envelope. 2. Nucleolus. 3. Chromatin projections. 4. Nucleoplasm.

Correct task_____

Date "___" _____

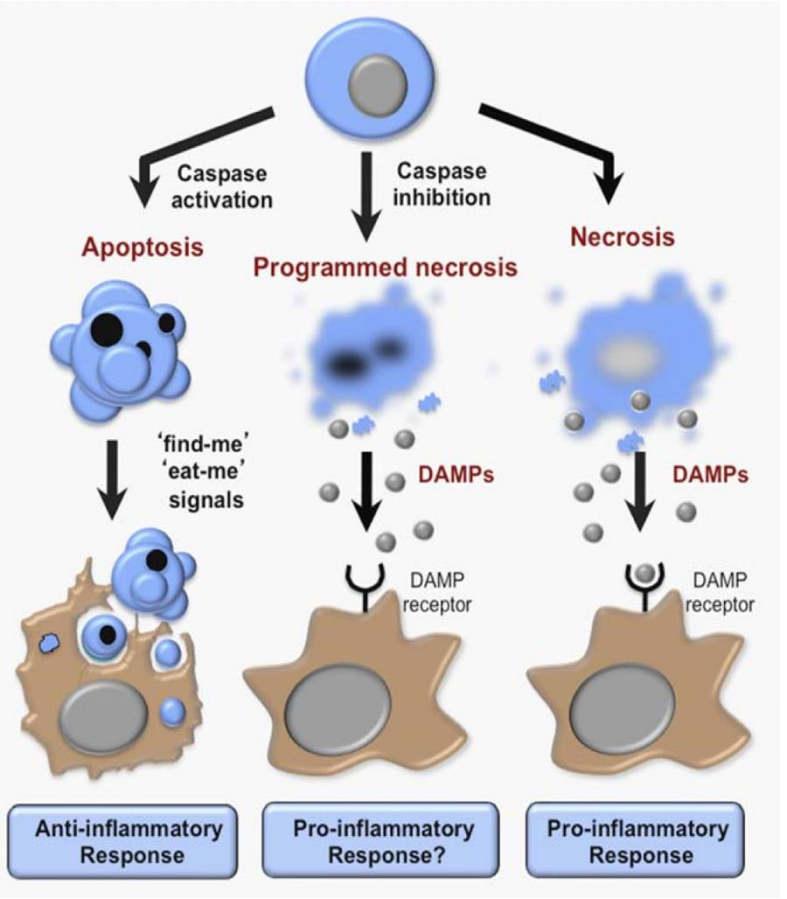
# The main morphological criteria of cell death.

## Necrosis vs apoptosis

| | Necrosis *(uncontrolled cell death)* | Apoptosis *(programmed cell suicide)* |
|---|---|---|
| **Size** | Cellular swelling | Cellular shrinkage |
| | Many cells affected | One cell affected |
| **Uptake** | Cell contents ingested by macrophages | Cell contents ingested by neighbouring cells |
| | Significant inflammation | No inflammatory response |
| **Membrane** | Loss of membrane integrity | Membrane blebbing, but integrity maintained |
| | Cell lysis occurs | Apoptotic bodies form |
| **Organelles** | Organelle swelling and lysosomal leakage | Mitochondria release pro-apoptotic proteins |
| | Random degradation of DNA | Chromatin condensation and non-random DNA degradation |

**APOPTOSIS is** a physiologically programmed cell death.

**NECROSIS is** a pathological death of a group of cells that occurs when exposed to adverse factors




Davidovich, Pavel, Kearney, Conor J. and Martin, Seamus J.. "Inflammatory outcomes of apoptosis, necrosis and necroptosis" *Biological Chemistry*, vol. 395, no. 10, 2014, pp. 1163-1171. https://doi.org/10.1515/hsz-2014-0164

## TEST CONTROL QUESTIONS. Cytology.

***Directions: each of the following statements contains five suggested completions. Choose the one that is best in each case.***

1. The spesifity of biological membranes functions is possible due to:
a) the presence of pors; b) the surface charge; c) receptirs; d) the pH of the medium; e) oxygen saturation of the medium.
2. The glycoliprotein complex which is the external part of the cell membrans is called: a) a villus; b) a desmosome; c) a flagellum; d) the glycocalyx; e) an ion channel.
3. The intercellular junction where ionic channels pierce the adjacent membranes is called:
a) desmosome; b) nexus; c) tight junction; d) synapse; e) lateral interdigitations.
4. The disk-shaped intercellular junction where a dense plaque with filaments is present on the cytoplasmic surface of each opposing plasma membrane is called: a) desmosorne: b) nexus; c) tight junction; d) synapse; e) lateral interdigitations.
5. The intercellular junction that blocks the substance access to the intercellular space is called: a) desmosorne: b) nexus; c) tight junction; d) synapse; e) lateral interdigitations.
6. Cytoplasm basophilia is inherent in the cells that:
a) have cilia; b) accumulate lipids; c) actively synthesize proteins; d) accumulate glycogen; e) synthesize mucus.
7. Basophilia of the cytoplasm is characteristic of the following kind of cells: a) shrinking cells; b) cell which contain a lot of RNA in the cytoplasm; c) cell which contain Hgb; d) cell which accumulate lipids; e) aging cell.
8. The proteins of intracellular membranes are syntehesised in:
a) the smoth ER; `b) the rougt ER; c) mitochondria; d) lysosomes; e) peroxisomes
9. New mitochondria of a cell are formed:
a) in the Golgi apparatus; b) in the rougt ER; c) in the smooth ER; d) as a result of mitochondria division by procariotic binary fission; e) in the nucleus.
10. Microfilaments are composed of the following proteins:
a) actin; b) desmin; c) keratin; d) vimentin; e) integrin.
11. Ribosomal subunits are formed in:
a) the smoth ER; b) the rougt ER; c) the Golgi apparatus; d) nucleoli; e) mitochondria.
12. The function of peroxisomes is:
a) protein sinthesis; b) ATP sinthesis; c) deactivation of hydrogen peroxide; d) digestion of absorbed substances; e) RNA sinthesis.
13. As a result of ionising radiation some cell organelles are destroyed in some cells. How will their residues be utilised by the cell?
a) an autophagy; b) phagocytosis; c) endocytosis; d) exocytosis
14. The following is synthesised in the nucleous:
a) mRNA; b) rRNA; c) DNA; d) ATP; e) Proteins
15. The following structures are correspond to the zones of primary strangulations (centromeres) of mitotic chromosomes:
a) telomeres; b) nucleolar organisers; c) kinetochores; d) nucleosomes; e) pores.
16. Heterochromatin is: a) an actively working part of chromosomes; b) an inactive part of chromosomes
c) a nucleolar organizer; d) an artifact; e) a carbohydrate.
17. If the cell, have a villa, performs the following function*:*
a) provides passive diffusion of water; b) promotes the movement of substances near its surface; c) transmits a nerve impulse; d) participates in phagocytosis; e) absorbs substances.
18. Protein involved in the formation of bordered endocytotic vesicles:
a) calmodulin; b) myosin; c) tubulin; d) dynein; e) clathrin.
19. Violation of cytotomy in mitosis leads to: a) the appearance of polyploid nuclei; b) cell death; c) the appearance of abnormal cells d) the formation of giant single-nucleated cells;
e) the appearance of binary and multinuclear cells
20. Tell us, cilia can perform the following function:
a) transfer substances through the plasmolemma;
b) participates in the reabsorption of water;
c) transmit nerve impulses;
d) absorbs organic substances;
e) promotes the movement of substances on the cell surface.

21. Tell us, what is endocytosis?
a) the transport of substances within the cell;
b) synthesis of substances inside the cell;
c) changing the shape of the cell
d) transport of substances from the cell**;**
e) transport of substances inside the cell
22. Which organelle takes part in the processes of intracellular digestion: a) the Golgi complex; b) cilia; c) mitochondria; d) ribosomes; e) lysosomes
23. What is the programmed cell death? a) paranecrosis;
b) endomitosis; c) cytokinesis; d) necrosis; e) apoptosis.
24. One cell has a well-defined Golgi apparatus. The rough endoplasmic reticulum is abundant, there are mitochondria and a centrosome. The other cell contains many mitochondria, a large number of lysosomes and a few membranes of the rough and smooth endoplasmic reticulum. What are the functions of these cells? Does protein synthesis take place in them?
a) $1^{st}$ – formation of secretion, active synthesis of intracellular digestion; $2^{nd}$ – the process of protein is going on.
b) $1^{st}$ – formation of lipids, active synthesis of fat is going on; $2^{nd}$ – the process of intracellular supply.
c) $1^{st}$ – formation of secretion, active synthesis of protein is going on; $2^{nd}$ – the process of intracellular digestion.
d) $1^{st}$ – formation of secretion, active synthesis of protein is going on; $2^{nd}$ – the process of extracellular digestion
25. At the lesson a student is examining a microscopic slide under the microscope with the magnification of the lens 40 times and of the eyepiece – 15 times. How many times is the visible image of the structures bigger than the real one?
a) 200 times; b) 400 times; c) 600 times; d) 300 times; e) 55 times
26. On the free surface of the cells there are structures where 9 peripheral pairs and 2 central pairs of microtubules are visible under the electron microscope. What are the names of these structures?
a) cilia; b) villi; c) invagination; d) cell center; e) dendrite.
27. In a histological specimen we can see neurons with large light-colored nuclei and nucleoli. Evaluate the activity of protein synthesis in these sells.
a) active synthesis of lipids is going on
b) active cell division is going on
c) active synthesis of myelin is going on
d) active synthesis of protein is going on
28. Forensic examination of a blood smear determined that the blood belongs to a woman. How could they come to such a conclusion?
a) by the presence of Hb in red blood cells
b) by the presence of Barr bodies in white blood cells
c) by the presence of eosinophil granules in white blood cells
d) by the presence of basophil granules in white blood cells
29. Which cytoplasmic components are the main constituents of the dark precipitate that forms in reticulocytes upon staining with the dye cresyl blue? a) Golgi complexes; b) Hemoglobin;
c) Nucleoli; d) Nuclear fragments ; e) Polyribosomes
30. Which process occurs during granulopoiesis but not during erythropoiesis?
a) Cells lose their capacity for mitosis
b) Euchromatin content increases
c) Nucleus becomes increasingly lobulated
d) Overall cell diameter decreases
e) Overall nuclear diameter decreases

# SECTION III. General Histology. Tissues. Embryonic histogenesis

## Epithelial tissues

Epithelial tissues are widely represented in the body. They cover the body, line the surfaces of hollow organs, and are part of many internal organs. The borderline position of the epithelial tissue determines the protective nature of the underlying tissue formations from the effects of factors of various nature. In some lesions, the epithelium serves as a diagnostic criterion for diseases. Knowledge of the characteristic morphological features of epithelial tissues normally helps to understand the essence of many pathological processes, correctly diagnose using markers and predict the outcome of the disease.

**Purpose of classes**

Is able and ready to determine features of morphofunctional structure of different kinds of epithelium, to understand specific features of organization of each of them. Determine the connection between their structure and the function performed. Can identify abnormalities in the normal structure and functions of epithelial tissues. Apply the learning material in their future profession as a physician.

**Tasks**

- Knows and understands the different types of epithelial tissues, classification, peculiarities of structure and function of each type of epithelium for the most common abnormalities and malformations of their development.
- Can identify epithelial tissues and their components at microscopic level, assess histophysiological state of various epithelia.
- Knows how to microcopy and analyze histological preparations;

**Date:**

# General histology (tissues).

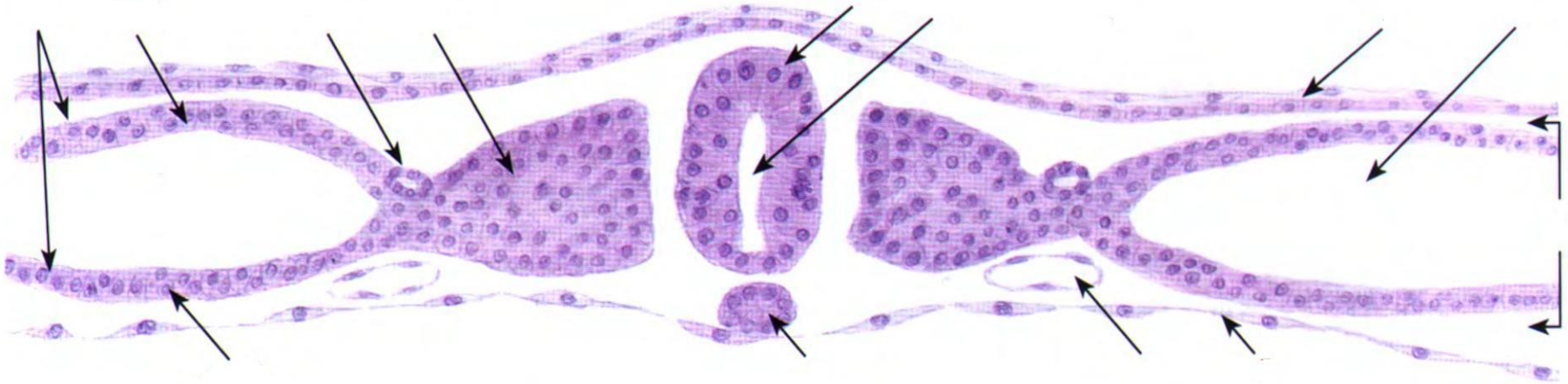
***Extracurricular self work.***

**Table 6.** Germinal layers and their derivatives. Tissue development sources.

| Layer name | | Derivative |
|---|---|---|
| ***Ectoderm*** | Nervous tube | |
| | Ganglioznic plate | |
| | Placods | |
| | Skin ectoderm | |
| | Prekhordal plate | |
| | Extraembrionic ectoderm | |
| ***Mesoderm*** | Somites: - myotome | |
| | - sclerotome | |
| | - dermatome | |
| | Nefrogonotome | |
| | Paramezonefral channel | |
| | Splanchnotome | |
| | Splanchnotome mesenchyme | |
| | Extraembrionic mesoderme | |
| ***Endoderm*** | Intestinal endoderm | |
| | Yoik endoderm | |

*Directions for work with micropreparation:*

Study germ section at early development stage at low magnification. A neural tube is observed under the external layer (ectoderm), there is a chorda under it. On the both sides of neural tube and chorda there is a mesoderm, where you can distinguish somites, intermediate mesoderm (nephrotome), parietal and visceral splanchotome layers. There is a secondary cavity between the layers – coelom. There is an inner layer under the chorda – endoderm (intestinal). Examine the structure details at high magnification and mark the picture. One by one observe structures in demonstration slide.



**Transverse section of chicken embryo in the axial bud stage (initial organogenesis)**

1. Ectoderm
2. Neural tube
3. Chorda
4. Somites
5. Nephrogonotome
6. Parietal splanchotome layer
7. Visceral splanchotome layer
8. Coelom
9. Endoderm

Correct task_____

Date "___" _____

***Extracurricular self work.***

## Topic: Epithelial tissues

**Table 7.** Epithelia topography (*draw and describe*)

| **Name** | | **Structure of epithelium and organ localization** |
|---|---|---|
| 1.Simple | Squamous | |
| | Cuboidal | |
| | Columnar | |
| | Pseudostratified columnar ciliated | |
| 2. Stratified | Squamous nonkeratinized | |
| | Squamous keratinized | |
| | Transitional | |

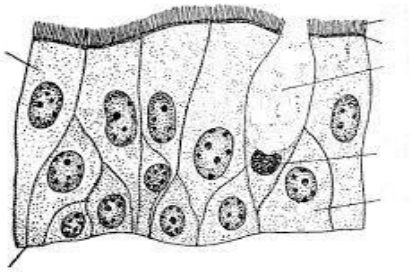
**Date:**

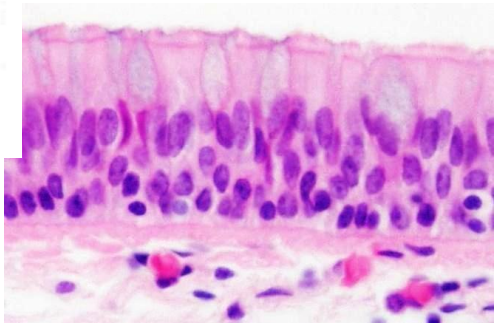
# Simple epithelia

*Directions for work with micropreparations:*

1. At low magnification examine transversal sections of epithelial tubules whose walls are formed by columnar or cylindrical cells. At high magnification draw 3-4 adjoining cells of epithelial tubule. Pay attention to the round-formed nuclei located near the basal membrane, oxyphilic cytoplasm and thin narrow line-like basal membrane where epithelial cells are located on.

2. In trachea section at low magnification find frontier epithelium location presenting a cell stratum with great number of nuclei lying on different levels. At high magnification study and draw small stratum area, which consists of columnar cells (ciliated), goblet and intermediate (short and long) cells. Cell boundaries are poorly seen. Upper nuclei layer belongs to ciliary epitheliocytes, lower one – to basal, medium – to intermediate.





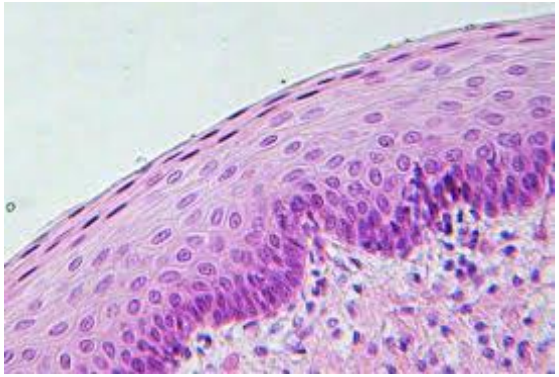
**Columnar kidney epithelium**
(staining by hematoxilin-eosin)
1. Basal membrane. 2. Columnar cells.
3. Apical part. 4. Basal part.

**Simple pseudostratified columnar ciliated epithelia**
(staining by hematoxilin-eosin)
1. Basal membrane. 2. Basal epitheliocytes nuclei.
3. Intermediate epitheliocytes nuclei. 4. Ciliated epitheliocytes nuclei. 5. Twinkling cilia 6. Goblet cell

# Stratified epithelia.

*Directions for work with micropreparations:*

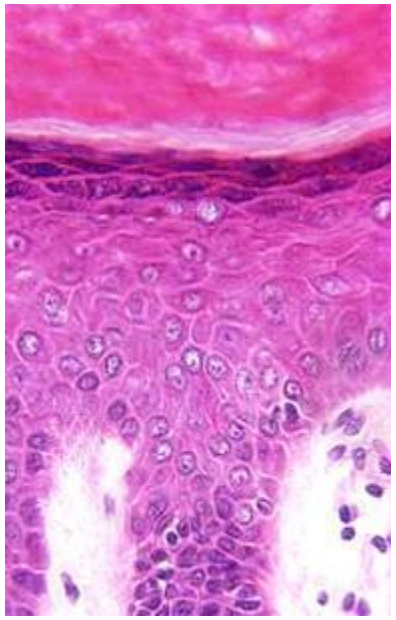
1. Stratified squamous nonkeratinized epithelium. At low magnification find an epithelium stratum. At high magnification draw epithelium layers: basal, spiny and flat (superficial). Epithelium is situated on basal membrane, under which there is a connective tissue



**Stratified squamous non-keratinized epithelium of the esophagus**
(staining by hematoxilin-eosin)

1. Basal membrane
2. Basal layer
3. Intermediate layer
4. Superficial (flat) layer

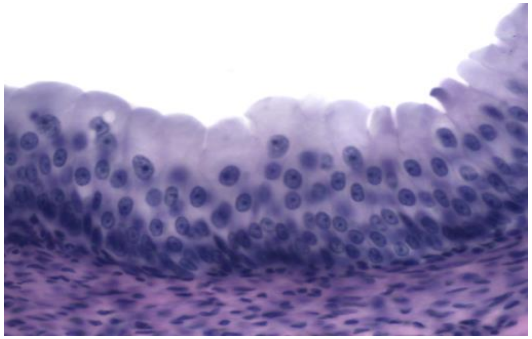
2. Stratified squamous keratinized epithelium of finger skin. At low magnification find epithelium and mark on the image it's layers in finger skin.



**Stratified squamous keratinized epithelium of the finger skin**
(staining by hematoxilin-eosin)

1. Basal membrane
2. Basal layer
3. Spinous layer
4. Granular layer
5. Lucid layer
6. Keratinized (horny) layer
7. Loose connective tissue

3. Transitional epithelium of urinary bladder. At low magnification find urinary bladder mucous membrane fold. Draw epithelium fragment at high magnification.



**Transitional epithelium of urinary bladder**
(staining by hematoxilin-eosin)

1. Basal layer
2. Intermediate layer
3. Superficial layer

Correct task_____

Date “___” _____

***Extracurricular self work.***

## Glandular epithelium.

**Table 8.** Glands classification

| | |
|---|---|
| According to amount of gland forming cells | |
| | |
| According to epithelial stratum location | |
| | |
| According to organization level | |
| | |
| According to secreting locus | |
| | |
| According to the structure | |
| | |
| According to the secretion chemical composition | |
| | |
| | |
| | |
| According to secretion mechanism | |
| | |
| | |

**Table 9.** Morphologic features of exocrine and endocrine gland secretion

| | Exocrine | Endocrine |
|---|---|---|
| Direction of secretion | | |
| Types of parenchyma secretory formations | | |
| | | |
| | | |
| Secreting paths | | |

*Directions for work with micropreparation:*

1. Parotid gland. At low magnification find serous gland end sections stained basophlicaly. At high magnification draw one oval-shaped apical section with slight lumen. Cells are conical-shaped, nuclei at the medium and lower third boundary are oval, there are secretory granules in apical part.

**Serous secretory portion**
(staining by hematoxilin-eosin)

1. Serous cells (serocytes).
2. Serous secretory granules

*Directions for work with micropreparation:*

2. Sublingual gland. At low magnification find mucous end section. At high magnification draw one oval-formed end section (bigger than the serous one), trapeze-shaped cells. Nuclei are flattened and adjoin basal section; secret is vacuolated; cytoplasm is bright.

**Mucous secretory portion**
(staining by hematoxilin-eosin)

1. Mucous cells (mucocytes).
2. Vacuolated secrete.

*Directions for work with micropreparation:*

3. At low magnification examine mixed (muco-serous), alveolar-tubular salivary gland. At high magnification find, study and draw one muco-serous apical section consisting of big mucocytes surrounded by serocytes in semilunar form.

**Mixed secretory portion**
(staining by hematoxilin-eosin)

1. Mucocyte.
2. Serocytes (serous demilune)

Correct task_____

Date "___" _____

# TEST CONYROL QUESTIONS. Epithelial tissue.

1. The epithelia are simple if:
a) their cells are polarized; b) their cells form sheets; c) all their cells rest on the basement membrane; d) not all their cells reach the apical surface; e) their cells are continuously sloughed.
2. The epithelia are stratified if:
a) their cells are continuously sloughed; b) their cells form sheets; c) their cells are polarized; d) all their cells can divide; e) not all their cells are in contact with the basement membrane.
3. The main difference between stratified epithelium and simple epithelium is: a) the presence of the basement membrane
b) borderline location; c) the contact of all the cells in the epithelial layer with the basement membrane; d) the contact of only one layer of cells (the basal layer) with the basement membrane
e) considerable thickness of the epithelial layer;
4. In an epithelium all cells of a cylindrical form and all lie on a basal membrane. What is a type of an epithelium?
a) pseudostratified columnar epithelium b) the simple columnar epithelium; c) stratified squamous transitional; d) stratified squamous cylindrical;
5. A histological specimen presents an artery. One of the membranes of its wall has flat cells lying on the basal membrane. What type of cells is it? a) mesothelium; b) fibroblasts; c) macrophages; d) endothelium; e) smooth myocytes
6. The epithelial layer is formed by cells which nuclei are located at different height in relation to the basement membrane. At the same time all the cells in contact with the basement membrane. What type of epithelium is this? a) simple squamous; b) simple cuboidal;
c) pseudostratified; d) stratified**;** e) transitional
7. In the specimen of a gland we can see that its acinus consists of several layers of cells in which the following processes occur with distance from the basement membrane: accumulation of secretion, shrinkage of the nuclei and destruction of cells. What type of secretion is characteristic of this gland?
a) holocrine type of secretion, a sebaceous gland; b) merocrine type of secretion, a salivary gland; c) apocrine type of secretion, a sweat gland; d) exocrine type of secretion, a mammary gland**;** e) holocrine type of secretion, a salivary gland
8. The electronogram shows a secretory cell with a good developed Golgi apparatus, a large number of vacuoles and small vesicles in the apical pole. The plasmalemma is not broken. Determine what type of cell is secreted? a) merocrine; b) apocrine;
c) holocrine; d) endocrine; e) diffusion
9. A histological preparation is presented, on which the gland with round end sections and branched excretory ducts is determined. What type of gland is it? a) simple unbranched alveolar;
b) simple branched alveolar; c) complex branched alveolar;
d) complex branched tubular; e) simple unbranched tubular;
10. Certain antibiotic therapies slow the replacement of the cells lining the small intestine. This may cause the loss of what tissue type?
a) ciliated pseudostratified columnar epithelium
b) simple cuboidal epithelium
c) simple columnar epithelium
d) pseudostratified columnar epithelium with stereocilia
e) stratified squamous, nonkeratinized tract wall
11. Functions of the basement membrane include which of the following? a) contractility; b) molecular filtering;
c) active ion transport; d) excitability; e) modification of secreted proteins;
12. Using immunohistochemistry a population of cells is shown to be positive for the protein connexin. From this we can infer that the cells are connected by what type of junction?
a) tight (occluding) junctions; b) zonula adherens; c) gap junctions; d) Hemidesmosomes; e) Desmosomes (macula adherens)
13. An individual genetically unable to synthesize normal occludin is likely to have epithelia with defective regulation in which of the following?
a. material crossing the epithelium between the cells (paracellular movement)

b. communication between the cells
c. attachment to the basement membrane
d. strong attachment to neighboring cells
e. movement of membrane proteins in the apical domains of cells

14. An intermediate filament protein found in cytoplasm of most epithelial cells in which of the following?
a) actin; b) vimentin; c) laminin; d) myosin; e) keratin

15. Which of the following cellular features is used is naming types of epithelia? a) shape of cells in the basal layer
b) number of cell layers; c) presence of a basal lamina
d) size of the nuclei; e) nature of the cell junctions that are present

16. The release of lipid droplets from cells is which type of secretion?
a) merocrine; b) serous; c) apocrine; d) mucous; e) holocrine;

17. Exocrine glands in which the acini all produce a secretion of heavily glycosylated, hydrophilic proteins are an example of which type of gland? a) serous gland; b) mixed gland;
c) mucous gland; d) tubuloacinar gland;e) simple gland;

18. With a 5-year history of chronic respiratory infections, a 23-year-old, non-smoking man is referred to an otolaryngologist. A bronchial biopsy indicates altered structures in the epithelial cells. Which of the following, if altered to reduce function, is most likely involved in this patient's condition? a) hemidesmosomes; b) cilia;c) basolateral cell membrane folds; d) icrovilli; e) tight junctions;

19. An 11-month girl is referred to a pediatric gastroenterology clinic due to a history of generalized weakness, slow growth, and refractory diarrhea. For the past month she has been hospitalized regularly to receive parenteral nutrition. Examination of the epithelium lining her small intestine confirms that the failure to absorb nutrients is most likely due to a significant decrease in which of the following?
a) microvilli; b) gap junctions; c) cilia;
d) cell layers; e) basement membrane thickness;

20. A 42-year-old woman of Mediterranean descent presents with multiple oral blisters and a few cutaneous blisters on her back and buttocks. The superficial bullae are fragile, some have unroofed to form ulcerated lesions, and there is a positive Nikolsky sign. Blood tests reveal antibodies to a subfamily of cadherins and immunohictochemical staining of a biopsy from the oral mucosa shows distribution of the antigen throughout the epithelium. In what structures is the defect that is causing this patient's condition?
a) desmosomes; b) tight junctions; c) hemidesmosomes
d) gap junctions; e) reticular lamina

21. In the histopreparation of the small intestine, villi are identified, covered with a tissue consisting only of cells forming a layer that is located on the basement membrane. The tissue does not contain blood vessels. What kind of fabric covers the surface of the villi?
a) loose connective tissue; b) smooth muscle tissue;
c) reticular tissue; d) epithelial tissue;

22. Morphological analysis of the biopsy material of the esophagus mucosa taken from the patient revealed the process of keratinization of the epithelium. Which of the following types of epithelium covers the mucosa of this organ in normal?
a) stratified squamous keratinized epithelium;
b) stratified squamous nonkeratinized epithelium;
c) pseudostratified columnar epithelium;
d) simple columnar epithelium;

23. When the child falls, they squeeze the skin of the palm. What epithelium was damaged in this? a) simple cuboidal epithelium;
b) stratified squamous nonkeratinized epithelium; c) stratified squamous keratinized epithelium; d) simple squamous epithelium;

24. During the intubation, the tracheal wall was damaged. Integrity of what kind of epithelium was broken in this case?
a) stratified squamous keratinized epithelium; b) simple squamous epithelium; c) simple cuboidal epithelium; d) stratified nonkeratinized epithelium; e) Pseudostratified columnar epithelium;

25. A male 48 years old had a benign epithelial tumor of the visceral pleura of the upper lobe of the right lung. What epithelium is the source of tumor development? a) simple squamous epithelium;
b) pseudostratified columnar epithelium; c) stratified squamous keratinized epithelium; d) transitional epithelium; e) stratified nonkeratinized epithelium;

**Questions for preparation for practical training and stage control**

1. Sources of epithelial tissue development.
2. General signs of epithelial tissues.
3. Variants of classifications of epithelial tissues.
4. Functional types of epithelial tissues.
5. Functions of epithelial tissues.
6. Cellular composition and localization of simple squamous epithelium.
7. Cellular composition and localization of a simple cuboidal epithelium.
8. Cellular composition and localization of simple pseudostratified epithelium.
9. Cellular composition and localization of transitional epithelium.
10. Cellular composition and localization of multilayered flat non-corneating epithelium.
11. Cellular composition and localization of multilayer flat keratinizing epithelium.
12. The main components of the basement membrane and its functions.
13. Classification of glands: by the place of excretion of secretions; by the number of cells; in relation to the epithelial layer; by the method of secretion.
14. Localization of exocrine unicellular glands.
15. Phases of the secretory cycle.
16. Histogenetic classification of epithelium.

## Internal medium tissues: Blood
## proper connective tissues
## skeletal (supporting) connective tissues

## Blood

Knowledge of blood components as tissues and quantitative indicators of shaped blood elements is necessary for a doctor of any profile to diagnose conditions. Blood as a tissue is part of the functional blood system, which in addition to blood includes organs of hematopoiesis and blood destruction, collectively determining homeostasis at the body level.

The purpose of the lesson:
Able and willing to determine the histophysiology of blood and lymph, understand their structure, the relationship between the structure of the form elements and the functions they perform, learn how to apply the study material in their future profession of medicine.

Tasks

- Knows and understands the general laws of blood structure, the structure of blood plasma, concepts of the hemogram and leukocyte formula, and the structure and function of the blood elements (erythrocytes, leukocytes, thrombocytes).
- Can identify blood forming elements and use hemogram and leukocyte formula data in the examination of patients;
- Knows the basic methods and skills of microscopy and "reading" of histological preparations, microphotographs, solving situational problems, revealing knowledge of the studied theoretical foundations of the topic.

***Extracurricular self work.*** **Topic: Internal medium tissues. Blood.**

**Table 10.** Blood formula. Morphofunctional formal blood elements characteristics.

| Blood index | Amount (in 1 mcl, % or ‰) | Size (in mcm) | Basic morphological signs (describe) | Functions (significance) | Life duration | |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Erythrocytes** | | | | | | |
| *Hemoglobin* | | | | | | |
| *Staining index* | | | | | | |
| *ESR* | | | | | | |
| *Reticulocytes* | | | | | | |
| **Leukocytes** | | | | | | |
| Neutrophils young | | | | | | |
| Neutrophils rod-nuclear | | | | | | |
| Neutrophils segment-nuclear | | | | | | |
| Eosinophils | | | | | | |
| Basophils | | | | | | |
| Lymphocytes | | | | | | |
| Monocytes | | | | | | |
| **Blood platelets** | | | | | | |

**Date:**

*Directions for work with micropreparation:*

## Blood smear in adult.

At low magnification find the most thin smear parts whose cells don't adjoin each other and are not deformed. At high magnification study and draw all formal blood elements. On identifying take into consideration presence or absence of nucleus and granular staining in cytoplasm. Erythrocytes are stained in pale-pink color with centered impression. Segmented nucleus (2-5 segments) and profuse dusty-like pink-violet granularity serve to distinguish segment-nuclear neutrophils. Rod-nuclear neutrophils have curved rod-shaped nucleus. Young neutrophils have bean-shaped nuclei. Eosinophilic granulocytosis has bigger size, and nucleus is segmented (more often 2, rarely 3 segments). There is large oxyphilic (bright-red) granularity in cytoplasm. There is a small lymphocyte with dense oval dark nucleus and extremely narrow basophil cytoplasm rim (of blue color). Medium leucocyte is larger in sizes and possesses the same signs, but its nucleus has slight impression. Monocyte is the largest blood cell with big oval or bean-shaped nucleus and slight basophilic cytoplasm (bluish-gray color). Blood platelets are located in groups and could be observed as small basophil platelets.

I. 1. Erythrocyte
   2. Reticulocyte
II. Leukocytes
   3. Granulocytes
      A. Neutrophils:
         a. young
         b. band form (rod-nuclear)
         c. segment-nuclear
      B. Eosinophils
      C. Basophils
   4. Agranulocytes
      A. Lymphocytes
      B. Monocytes
III. Platelets

Correct task_____

Date “___” _____

**Leukocyte formula determination.** Determine leucocyte formula in blood smear yourself. In order to perform it, i.e. to count percent ratio of all leucocyte forms, it is necessary to fill in the table with leucocyte forms met, marking them with initial letters. It is essential to remember that larger leucocytes are situated at smear periphery, and small ones are observed in the smear center. Therefore calculation must be performed by preparation shifting along zigzag line. In each zigzag count cells of 2-3 site visions. Count the amount of each leucocyte type, which will compose their percent ratio. Compare the obtained results with normal leucocyte formula.

| | | | | | | | | | |
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**Leukocyte ratio in %.**

- Neutrophils: young –
  band –
  segment-nuclear –
- Eosinophils –
- Basophils –
- Lymphocytes –
- Monocytes –

## TEST CONTROL QUESTIONS. Blood.

1. In the punctate of the myeloid tissue of a 6-year-old child, cells are found in which pycnosis and nucleus removal occurs during differentiation. Name the type of hemopoiesis for which these morphological changes are characteristic.
a) granulocytopoiesis; b) thrombocytopoiesis;
c) erythrocytopoiesis; d) lymphocytopoiesis;
e) monocytopoiesis;
2. Live vaccine is injected into the human body. Increasing activity of what cells of connective tissue can be expected?
a) macrophages and fibroblasts; b) adipocytes and adventitious; cells c) fibroblasts and labrocytes; d) plasmocytes and lymphocytes e) pigmentocytes and pericytes.
3. Neutrophils are present in the blood flow for:
a) a year; b) 8-12 hours; c) a month; d) 120 days; e) 1 hour
4. Granular and reticular structures in reticulocytes are:
a) residues of ribonucleoproteins and organelles; b) residues of DNA;
c) haemoglobin granules; d) microtubules; e) microfilaments;
5. Heparin and histamine are contained in the granules of:
a) neutrophils; b) basophils; c) eosinophils;
d) monocytes; e) platelets;
6. Which of the following properties is not characteristic of all the leukocytes: a) motility; b) participation in protective reactions; c) ability to function in tissues; d) capacity for phagocytosis; e) the presence of the nucleus;
7. Blood serum differs from blood plasma by the absense of:
a) erythrocytes; b) platelets; c) antibodies;
d) albumins; e) fibrinogen;
8. In course of an experiment a big number of stem cells of red bone marrow was in some way destructed. Regeneration of which cell populations in the loose connective tissue will be inhibited?
a) of pigment cells; b) of fibroblasts; c) of microphages;
d) of lipocytes; e) of pericytes.
9. In the study of histology slide connective tissue neutrophils are determined. What is the function of these cells, penetrates from the blood into the tissue? a) dilates blood vessels; b) phagocytosis of microorganisms; c) supporting; d) trophic; e) regulate the contraction of smooth myocytes;
10. In the blood of a 26-year-old man it was revealed 18% of erythrocytes of the spherical, ball-shaped, flat and thorn-like shape. Other eritrocytes were in the form of the concavo-concave disks. How is such phenomenon called? a) pathological poikilocytosis;
b) Pathological anisocytosis; c) Erytrocytosis;
d) Physiological poikilocytosis; e) Physiological anisocytosis;
11. In the analysis of blood found reduced levels of hemoglobin. What is the function of the blood in this case?
a) transport of hormones; b) clotting; c) transport of nutrients;
d) transport of gases; e) provision of immunity
12. In the patient with pneumonia, a general analysis of the blood showed an increase in the total number of leukocytes. What is the name of this phenomenon? a) leukocytosis; b) leukopenia;
c) poikilocytosis; d) anisocytosis; e) anemia;
12. In the blood of a man of 26 years 18% of erythrocytes were found spherical, flattened, spherical and spiny. Other erythrocytes were in the form of biconcave disks. What is the name of this phenomenon?
a) pathological poikilocytosis; b) pathological anisocytosis;
c) erythrocytosis; d) physiological poikilocytosis;
e) physiological anisocytosis;
13. In the patient's blood, 12.5% of erythrocytes with a diameter greater than 8 μm, 12.5% of erythrocytes less than 6 μm were detected, the remaining erythrocytes had a diameter of 7.1-7.9 μm. What is the name of this phenomenon? a) pathological poikilocytosis;
b) pathological anisocytosis; c) erythrocytosis; d) physiological poikilocytosis; e) physiological anisocytosis;
14. When analyzing the blood in a patient with parasitic disease (helminthic invasion), a rise in blood was detected:
a) the basophilus; b) lymphocytes; c) monocytes; d) eosinophils;

15. To determine the functional activity of blood cells in a tube containing leukocyte mass, a suspension of microorganisms was introduced. Specify cells in the cytoplasm of which phagocytosed microbes will be detected: a) lymphocytes and basophils;
b) monocytes and lymphocytes; c) lymphocytes and neutrophils;
d) neutrophils and monocytes; e) lymphocytes and eosinophils.
16. In a blood smear stained by Romanovsky-Giemsa, 20% of large (20 μm in diameter), rounded cells with a pale basophilic cytoplasm and a bean-like nucleus are observed. Clinically, this phenomenon is characterized as: a) lymphocytosis; b) neutrophilia;
c) reticulocytosis; d) monocytosis; e) leucopenia;
17. In the red bone marrow, the blood cells that develop are located by the islets. Some of the islets are associated with macrophages. What uniform elements of blood develop in these islets?
a) basophilic granulocytes; b) erythrocytes; c) monocytes;
d) precursors of T-and B-leukocytes; e) platelets;
18. What blood cells contain the granules having affinity to sour dyes?
a) platelets b) eosinophils c) basophiles d) erythrocytes e) lymphocytes
19. What blood cells provide humoral immunity?
a) erythrocytes b) monocytes c) B-lymphocytes
d) T-lymphocytes e) neutrophils
20. Form of a nucleus of young granulocytes.
a) round; b) bean-shaped; c) the segmented; d) rhabdoid; e) the flat;
168. In what nucleus of blood cells of women is defined sexual chromatin? a) neutrophils; b) monocytes; c) lymphocytes;
d) basophiles; e) eosinophils;
21. Which cell provide cellular immunity?
a) erythrocytes; b) eosinophils; c) B-lymphocytes;
d) T-lymphocytes; e) monocytes;
22. Mature erythrocytes contains
a) nucleus; b) an endoplasmic network; c) mitochondria
d) hemoglobin; e) lamellar complex;
23. Form of nucleus of mature granulocytes?
a) round; b) bean-shaped; c) the segmented;
d) rhabdoid; e) the flat;
24. Specify indicators with aberrations in the provided analysis of blood of the adult patient
a) neutrophil of 75%; b) an eosinophil – 12%;
c) basophils – 1%; d) lymphocytes – 35-40%;
25. During embryogenesis blood develops from?
a) from a mesoderm; b) from ectoderm; c) from endoderm;
d) from a mesenchyme; e) from leaves splanchnotoma;

**Questions for preparation for practical training and stage control**

1. The number of erythrocytes, leukocytes and blood plates within the normal reaction range.
2. The main morphological features of erythrocytes and their functions.
3. The main morphological features of reticulocytes, their number and value.
4. The main signs of granulocytes.
5. Morphofunctional characteristics of neutrophils.
6. Morphofunctional characteristics of eosinophils.
7. Morphofunctional characteristics of basophils.
8. The main signs of agranulocytes.
9. Morphofunctional characteristics of lymphocytes.
10. Morphofunctional characteristics of monocytes.
11. What is the shift of the leukocyte formula to the left and its diagnostic value?
12. Morphofunctional characteristics of platelets.

**Connective tissue proper.**

Knowledge of histogenesis and morphofunctional features of various types of connective tissue is necessary to understand the processes of vital activity of the body. They take part in maintaining homeostasis, perform plastic, shaping, protective, take part in regeneration processes.

**Purpose of classes**

Is able and willing to classify, describe the structure and localization of connective tissue, and identify abnormalities in the normal structure and function of connective tissue and have an understanding of the consequences of abnormalities of individual functions of this tissue. Can apply learning material to his/her future profession as a physician.

**Tasks**

- Knows and understands the features of the structure of loose fibrous connective tissue, the structure of collagen, elastic and reticular fibers, the fine structure of connective tissue cells (fibroblasts, macrophages, plasma, mast, adipocytes), the varieties, structure and functions of dense fibrous connective tissue
- Be able to identify morphological and cytological signs that determine the functional purpose of components of various types of connective tissues at the light-optical level and electronic microphotographs.
- Master the solution of situational problems that determine the knowledge of the studied theoretical foundations of the topic.

## Topic: Connective tissue proper.

**Table 11.** Classification of connective tissue proper.

| № | Tissue name | Topography | Functions |
|---|---|---|---|
| 1. | Loose fibrous connective tissue | | |
| 2. | Dense irregular connective tissue | | |
| 3. | Dense regular connective tissue | | |
| Specialized Connective tissue | | | |
| 4. | Reticular tissue | | |
| 5. | Pigment tissue | | |
| 6. | Adipose tissue | | |
| 7. | Mucous tissue | | |

*Directions for work with micropreparations:*

1. **Loose connective tissue.** At low magnification find the lightest section of the membranous preparation where fibers are observed. They are located in various directions. There is a lot of cell amorphous primary substance among them. At high magnification draw collagenous fiber bundles stained in blue. Elastic fibers are very fine. They look like branchy brilliant fibers due to higher refraction index. Find and draw two types of cells: fiberblasts and macrophages. Fibroblast doesn't have clear contours, its form is dendritic and cytoplasm is poorly basophilic. A light oval nucleus with well-distinguished nucleoluses is localized in the cell center. Histiocyte (macrophage) may be distinguished by clear contour, on its basophilic background vacuoles, sometimes granules are seen. The nucleus is oval, rounded and bean-shaped with condensated chromatin (stained intensively).

   Tissue basophil (mast cell). Staining – basic color is brown and toluidine blue. At low magnification find small intensively stained oval cells. Cell nuclei are located in the center, in some preparations they are stained with hematoxilin, in some are not stained at all. At high magnification draw one cell having large number of granules in cytoplasm stained in brown or purple-red. In the same preparation find one plasmocyte of small size. Its form is oval; a nucleus is situated eccentrically. Chromatin projections in the nucleus remind spokes of a wheel. The cytoplasm is sharply basophilic and there is a clear unstained section (sphere) near the nucleus.

2. **Loose and dense irregular connective tissues.** Study the preparation made from finger skin. At high magnification under the multi-layered keratinized epithelium find and draw a fine layer of loose connective tissue in which there are a lot of cells, amorphous substance, fatless adipocytes and thin fiber bundles. Under this layer a dense connective tissue with thick closely disposed bundles of rectified fibers and small number of cells is found.

***Extracurricular self work.***

**Table 12.** Cellular composition of loose connective tissue (*draw and describe*)

| **Cells** | **Morphologic signs** | **Functions** |
|---|---|---|
| Fibroblast | | |
| Fibrocyte | | |
| Myofibroblast | | |
| Macrophage | | |
| Mast cell | | |
| Plasma cell | | |
| Adipocyte | | |

**Date:**

**Loose connective tissue**

1. Collagen fibers.
2. Elastic fibers.
3. Basic amorphous substance.
4. Fibroblast.
5. Macrophage (histiocyte).
6. Tissue basophil (mast cell).
7. Plasmocyte.

**Loose and dense irregular connective t*issues*** (staining by hematoxilin-eosin)

1. Bundles of collagen fibers. 2. Desmocytes nuclei
3. Fatless adipocytes. 4. Loose connective tissue.

Correct task_____

Date "___" _____

## TEST CONTROL QUESTIONS. Connective tissue.

1. In embryogenesis, the all types of connective tissue originate from:
a) neural tube; b) mesenchyme; c)ectoderm; d) endoderm; e) notochord.
2. The derivatives of neural crest are:
a) mast cells; b) melanocytes; c) adipocytes;
d) fibroblasts; e) plasma cells
2. Which of the following properties is not characteristic of dense fibrous regular connective tissue:
a) it forms ligaments and tendons; b) fibres are the main component of its extracellular matrix; c) collagen fibres are aranged in regular patterns; d) the basic differon is represented by fibroblasts;
e) an amorphous component prevails in its extracellular matrix;
3. Mucous connective tissue is part of:
a) the umbilical cord; b) the chorion; c) the amnion
d) the yolk sac; e) the allantois
4. After treatment of the damaged Achilles tendon, the patient regained his function. How did the tendon regenerate?
a) adipose tissue formation; b) synthesis of hyaline cartilage;
c) collagen fiber synthesis; d) fibrous cartilage synthesis;
e) muscle tissue replacements;
5. The following type of tissue participates actively in heat production of newborn babies: a) white adipose tissue;
b) reticular connective tissue; c) pigmented tissue;
d) mucous connective tissue; e) brown adipose tissue;
6. Reticular connective tissue: a)forms fasciae and aponeuroses
b) underlies surface epithelia; c) forms the storma of the red bone marrow; d) goes along with blood vessels; e) participates in heat production.
7. Define a cell which is capable to synthesize fibrous proteins (collagen, elastin) GAG.
a) plasma cell b) fibrocyte c) fibroblast d) chondroblast
8. There was a skin injury with damage to the mesh layer. Due to the activity of which the cell spheroid will regenerate this layer?
a) Fibroblastic; b) Lymphoblastic; c) Neuroblastic;
d) Macrophagic; e) chondroblast;
9. In forensic practice, there is a periodic need to perform identification of a person. For this purpose, the fingerprinting method is used. Explain, the peculiarities of the structure of which layer is determined by an individual drawing of the skin of the fingers
a) epidermis, dermis and hypodermis; b) the epidermis;
c) papillary layer of the dermis; d) the mesh layer of the dermis;
e) the epidermis and dermis;
10. Patient A., 12 years old, has white spots on the skin that do not have a pigment. The spots appeared after 10 years, constantly increasing in size. The absence of any skin cells led to the appearance of such spots.
a) fibrocytes; b) adipocytes; c) melanocytes;
d) plasmocytes; e) monocytes
11. Three amino acids, the first one, the second proline and the third glycine, are involved in the construction of the fiber. Name this fiber
a) muscle tissue; b) elastic fiber; c) nerve fiber; d) collagen fiber;
12. Define tissue where fibers are presented in a large number and are closely located. Contain insignificant quantity of cells and the main substance. a) cartilage; b) bone;
c) dense connecting tissue; d) nervous tissue;
13. Specify connective tissue which meets only at a germ.
a) mesenchyme; b) mucous; c) pigmented; d) brown fat tissue;
14. Cell where organelles are well developed, especially granular endoplasmic reticulum, the nucleolus is located eccentrically, about a nucleolus there is a light zone?
a) basophil; b) plasmacell; c) chondrocyte; d) lymphocyte;
15. What tissue meets in skin sites in nipples, a scrotum, birthmarks, and also in a vascular cover of an eye? a) nervous tissue;
b) mucous tissue; c) pigmented tissue; d) cartilagenous tissue;
16. Specify what cell has a spherical form, the nucleus is located on the periphery, the center is occupied with a big vacuole of triglycerides.
a) adipocyte; b) pericyte; c) plasmacyte; d) lymphocyte;

17. The weakening of the blood supply of the organ causes the development of hypoxia, and it activates the function of fibroblasts. What kind of elements are being built up in this situation?
a) nerve elements; b) microvasculature vessels;
c) lymphatic vessels; d) intercellular substance;
e) parenchymal organ elements;
18. Which of the following connective tissue components is located in the ECM but not in the ground substance. a) collagen bundles;
b) fibronectin; c) GAGs; d) hyaluronan; e) proteoglecans;
19. What cell numerous in loose connective tissue are filled with secretory granules and stain with metachromasia?
a) fibrocytes; b) active fibroblasts; c) mast cell;
d) leukocytes; e) macrophages;
20. What is the first step of collagen production that occurs after the undergoes exocytosis?
a) cross-linking of collagen fibrils with a short linking collagen;
b) removal of the terminal nonhelical domains by peptidases;
c) hydroxylation of iysine and prolin;
d) assembly of subunits to form a larger structure;
e) disulfate bond formation;
21. Sulfated GAGs are important constituents of what extracellular structures? a) hyaluronan; b) elastic fibers; c) type II collagen; d) proteoglecans; e) multiadhesive glycoproteins
22. Which of the following contains binding sites for integrins and is an important part of the ECM in both loose connective tissue and dence irregular connective tissue? a) aggrecan; b) fibronectin;
c) perlecan; d) fibrillin; e) most type of collagen;
23. Dence regular connective tissue typically involves which of the following features?
a) contains mostly synthetically active fibroblasts
b) contains much ground substance;
c) contains a similar cell populationas areolar connective tissue;
d) predominant tissue type in the stroma of most organs;
e) predominantly located intendons and ligaments;
24. Specify the protein secreted by fibroblasts
1) collagen; 2) elastin; 3) glycosaminoglycans; 4) immunoglobulins
a) 1, 2, 3; b) 1 and 3; c) 2 and 4; d) 4; e) 1, 2, 3 and 4;
25. One of the rules of surgery is making cuts along the so-called Langer lines (skin tension lines). Which of the following tissues forms a reticular, durable layer of the dermis?
a) loose connective tissue; b) reticular connective tissue;
c) dense irregular connecting tissue; c) epithelial tissue;
e) dense regular connective tissue;

**Questions for preparation for practical training and stage control**

1. The main components of loose connective tissue and its localization.
2. Types of fibers that are part of the intercellular substance of loose connective tissue.
3. Components of the basic substance of loose connective tissue.
4. Functions of loose fibrous connective tissue.
5. Resident and migrating cells of loose connective tissue.
6. Cytophysiological characteristics of fibroblast.
7. Fibroblast functions.
8. Cytological characteristics of the mast cell.
9. The main chemical components of mast cell granules.
10. Functions of mast cells.
11. Cytological characteristics of the macrophage.
12. Morphofunctional characteristics of the plasmocyte.
13. Morphofunctional characteristics of pigment desmocyte.
14. Cytological characteristics of the adipocyte.
15. Varieties of dense connective tissues and their topography in the body.
16. The main differences between loose connective tissue and dense unformed.
17. Tissues with special properties and their topography in the body.
18. The constituent components of the reticular tissue.
19. Morphofunctional characteristics of reticular fibers.
20. Functions of reticular tissue and its localization.

**Date:**

# Topic: Skeletal tissues (cartilaginous and bony).

*Directions for work with micropreparations:*

1. At low magnification find the wide stripe of hyaline cartilage covered with perichodrium from both sides. At high magnification draw the narrow stripe of cartilage with perichondrium. That transfers to cartilage without distinct boundary. In the area of young cartilage intercellular substance is poorly stained in oxyphilic. Young chondrocytes have stretched form, basophilic cytoplasm. They lay in parallel with надхрящницей. In the area of mature cartilage chondrocytes are disposed in isogenic groups. Intercellular substance is not stained homogeneously: around isogenic groups it is slightly oxyphilic, further it is basophilic and outwards – slightly oxyphilic. Chondric (collagen) fibers in the intercellular substance are not observed, for they together with amorphous component have identical refraction index.

2. At low magnification find common external general lamellas and osteonous layer. Draw 2-3 osteons with intercalary (intermediate) bony lamellas located between. At high magnification specify the structure details paying attention to the bony cavities (lacunas) that contain osteocyte bodies and bony canaliculi with osteocyte processes placed within.

**Hyaline cartilage** (staining by hematoxilin-eosin)

1. Perichondrium
2. Chondroblasts.
3. Young cartilage area.
4. Young chondrocytes.
5. Intercellular substance (chondric fibers, chondromucoid).
6. Isogenic chondrocytes groups.

**Lamellar bony tissue (transverse section of decalcificated bone–** staining according to Shmorel)

1. Concentrated bony lamellaes. 2. Central osteon channel
3. Intercalated lamellaes. 4. Bone lacunaes. 5. Bone canaliculi.

Correct task_____

Date “___” _____

***Extracurricular self work.***

**Table 13.** Cartilaginous tissues.

| Types of cartilaginous tissues | Topography | Composition | | |
|---|---|---|---|---|
| | | Cells | Intercellular substance | |
| | | | Fibers | Amorphous substance |
| *Hyaline cartilaginous tissue* | | | | |
| *Elastic cartilaginous tissue* | | | | |
| *Fiber cartilaginous tissue* | | | | |

**Table 14.** Bony tissues.

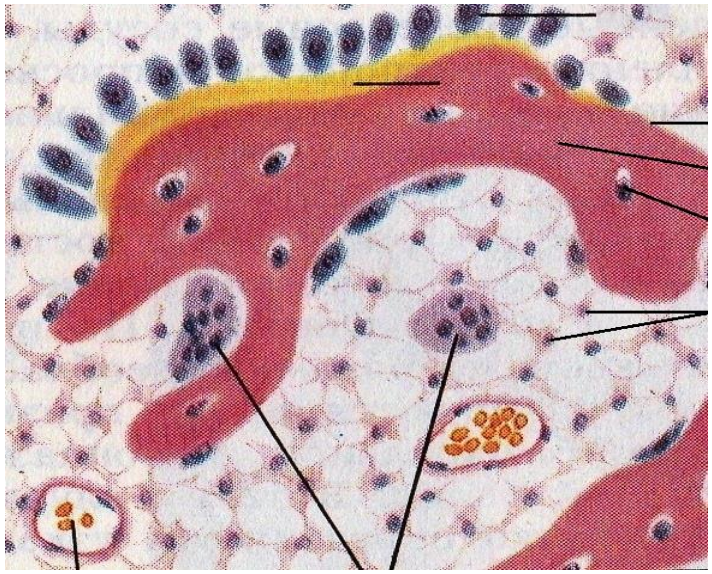
| Types of bony tissue | Topography | Peculiarities of structure organization | Composition | | |
|---|---|---|---|---|---|
| | | | Cells | Intercellular substance | |
| | | | | Fibers | Amorphous substance |
| | | | | | |
| | | | | | |

## Topic: Skeletal tissues. Bone development.

*Directions for work with micropreparation:*

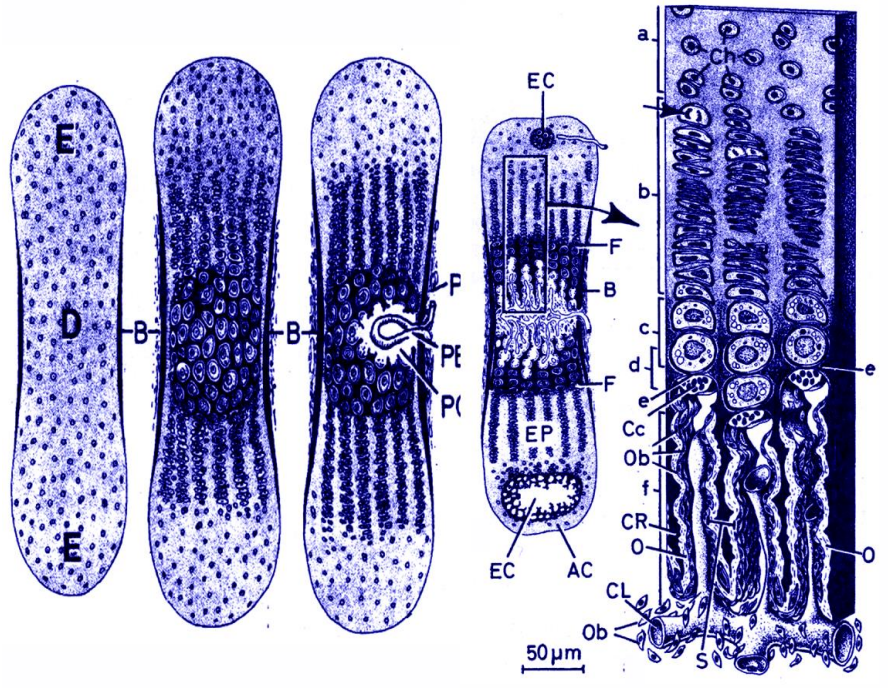
**1. Bone development from mesenchyme.** At low magnification in section of germ head find oxyphilically stained bony trabeculas, which anastomose with each other. Find mesenchyme with blood vessels between them. Draw a small area of bony trabecula with adjoining vessel and mesenchyme cells.

At high magnification pay attention to osteoblasts located along the bar periphery. Their magnitude is not identical, it being connected with cell activity degree. Osteocytes are located inside the bony trabecula. Osteoclasts are distinguished by large sizes and great number of nuclei.



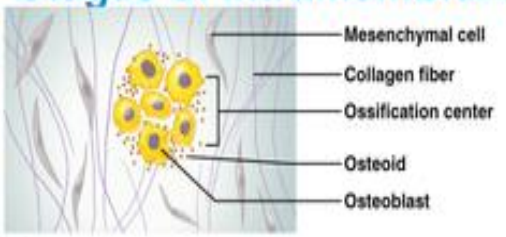
**Bone development from mesenchyme**
(staining by hematoxilin-eosin)
1. Bony trabecula. 2. Calcified bony substance. 3. Osteocyte. 4. Osteoblast. 5. Osteoclast. 6. Blood vessel. 7. Mesenchyme.

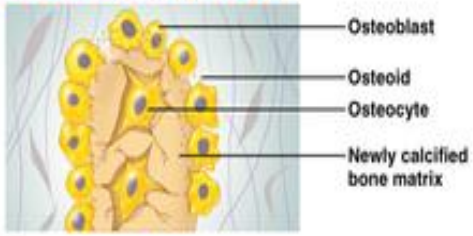
***Class self work.***




**Development of bone in place of hyaline cartilage**
(staining by hematoxilin-eosin)
1. Periosteum. 2. Perichondral bone. 3. Endochondral bone with intercellular cartilage substance remains. 4. Zone of cartilage calsification and destruction. 5. Zone of hypertrophied (dystrophic) chondrocytes. 6. Zone of chondrocyte columns. 7. Zone of cell proliferation (multiplication). 8. Zone of intact (reserve) cartilage (resting zone).

# Stages of Intramembranous Ossification



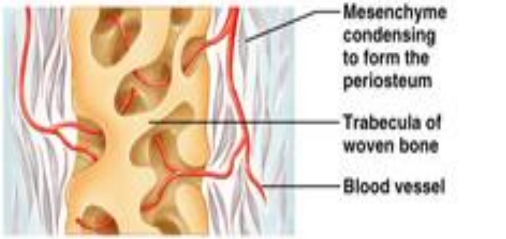



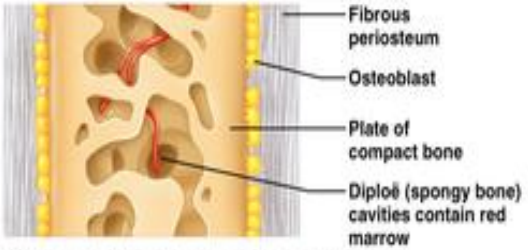

① **An ossification center appears in the fibrous connective tissue membrane.**

- Selected centrally located mesenchymal cells cluster and differentiate into osteoblasts, forming an ossification center.

② **Bone matrix (osteoid) is secreted within the fibrous membrane.**

- Osteoblasts begin to secrete osteoid, which is mineralized within a few days.
- Trapped osteoblasts become osteocytes.



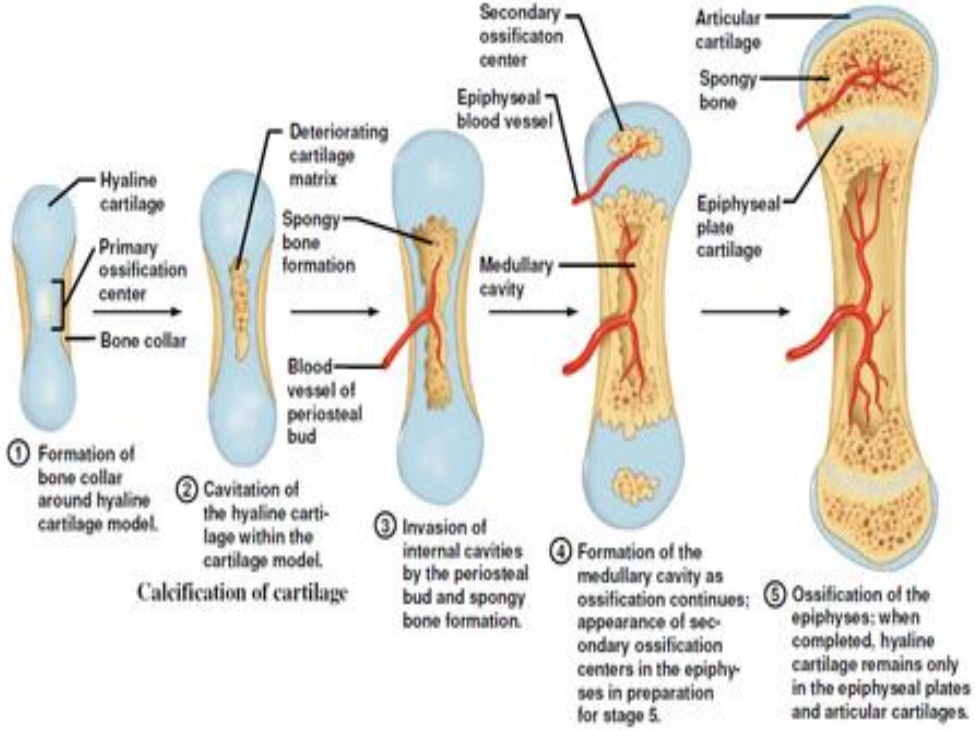

③ **Woven bone and periosteum form.**

- Accumulating osteoid is laid down between embryonic blood vessels, which form a random network. The result is a network (instead of lamellae) of trabeculae.
- Vascularized mesenchyme condenses on the external face of the woven bone and becomes the periosteum.

④ **Bone collar of compact bone forms and red marrow appears.**

- Trabeculae just deep to the periosteum thicken, forming a woven bone collar that is later replaced with mature lamellar bone.
- Spongy bone (diploë), consisting of distinct trabeculae, persi internally and its vascular tissue becomes red marrow.

# Stages of Endochondral Ossification



## TEST CONTROL QUESTIONS. Skeletal tissues.

1. The embryonic origin of bone tissue is: a) notochord;
b) mesenchyme; c) ectoderm; d) endoderm; e) neural crest.
2. Woven bone tissue can be found in adults only as part of:
a) the epiphysis of tubular bones; b) the sutures of the skull;
c) intervertebral discs; d) the surface of joints;
e) the diaphysis of tubular bones;
3. The structural and functional unit of compact bone is:
a) an osteon; b) a collagen fibre; c) an osteocyte;
d) an osteoblast; e) a bone lamella
4. A structural and functional unit of compact bone is:
a) an osteon; b) a collagen fibre; c) an osteocyte;
d) an osteoblast; e) a bone lamella
5. The elongation of a bone is provided by:
a) the periosteum; b) the endosteum; c) the epiphyseal plate;
d) the epiphysis; e) the diaphysis;
6. The formation of bone on the site of the cartilage begins with:
a) perichondrial ossification; b)destruction of the cartilage model;
c) endochondral ossification; d) ossification of epiphysis;
e) calcification of the cartilage model;
7. The preparation is diagnosed with a tissue in which the cells are arranged singly and with isogroups, and fibrous structures are not visible in the extracellular substance. What tissue is present in the preparation? a) bone; b) hyaline cartilage;
c) epithelial tissue; d) smooth muscle tissue; e) fibrous cartilage;
8. In course of indirect histogenesis of tubular bone tissue a plate is formed between epiphyseal and diaphyseal ossification centres that provides further lengthwise growth of bones. What structure is it?
a) layer of interior general plates; b) metaphyseal plate;
c) osseous plate; d) osseous cuff; e) osteon;
9. In the histological preparation of the tubular bone at the fracture site, signs of the regenerative process (callus) are detected. What tissue forms this structure? a) reticular; b) loose connecting;
c) spongy bone; d) epithelial; e) compact bone
10. In contrast to the perichondral bone, the endochondral bone contains: a) residues of calcified cartilage; b) bone matrix;
c) osteo-blasts; d) osteocytes; e) osteoclasts.
11. The function of the epiphyseal plate is:
a) formation of the perichondral collar; b) formation of periosteal buds;
c) formation of the cartilage model; d) calcification of the bone matrix;
e) bone growth.
13. The patient was admitted to the clinic with a diagnosis: fracture of the clavicle. What cellular elements will take part in the regeneration of bone tissue? a) osteoblasts; b) osteocytes;
c) fibroblasts; d) chondrocytes; e) osteoclasts;
14. When analyzing the patient's radiographs, the doctor drew attention to the local resorption of the solid tissues of individual bones. With the increased activity of which cells can these changes be related?
a) chondroblasts; b) osteoclasts; c) osteocytes;
d) hondoblasts; e) osteoblasts;
15. At clinical examination of the patient of 70 years violations of motor functions are revealed, it is connected with age changes in hyaline cartilage. What age changes caused the limitation of movements in the joints? a) increased number of cartilage cells;
b) increase in the number of isogenic groups;
c) deposition of calcium salts in the intercellular substance;
d) thickening cartilage;
e) increase in the hydrophilicity of the basic substance;
16. In a patient with severe trauma to the upper limb, there is a disturbance in the processes of regeneration of the cartilaginous tissue due to damage to the little differentiated cells of the cartilaginous differon. Which cells were damaged?
a) cells that come from blood vessels;
b) cells of the inner layer of the perichondrium;
c) cells in the composition of isogenic groups;
d) cells of the outer layer of the perichondrium
e) cells of the zone of young cartilage;
17. The student was offered two drugs. On the first-elastic cartilage (stained with orsein), on the second-hyaline (stained with hematoxylin-eosin). On what grounds can they be distinguished?

a) If there is a zone of young cartilage;
b) In the presence of isogenic groups of cells;
c) In the presence of elastic fibers;
d) In the presence of an amorphous substance;
18. In what of the listed tissue in intercellular substance, the main (amorphous) substance has identical coefficient of a refractive index with collagenic fibers because of that fibers aren't visible?
a) hyaline cartilage; b) fibrocartilage;
c) elastic cartilage; d) bone tissue;
19. Which of the listed tissues settles down in a throat, in pneumatic ways, in junctions of edges with a breast?
a) elastic; b) hyaline; c) fibrous; d) the bone;
20. Which cells are present in cartilage tissue?
a) fibroblast; b) osteoblast;
c) osteocytes; d) chondrocyte;
21. On a preparation one of connective tissues in which there are no vessels of microcirculation. Tissue is:
a) pigment; b ) cartilage; c) bone; d) the fat;
22. In which tissues never happens calcifications?
a) hyaline cartilage; b) an elastic cartilage;
c) in a fibrous cartilage; d) bone tissue;
23. What do we call intercellular substance of bone tissue?
a) elastic fibers; b) chondrin fibers;
c) collagenic fibers; d) ossian fibers;
24. To what of the listed cells there corresponds the description: the cell has an irregular form, a compact relative large nucleus, centrioles are absent, cytoplasm poorly basophilic, lies in a cavity repeating it a form.
a) fibroblast; b) chondroblast; c) osteoblast; d) an osteocyte;
25. In which layer of compact lamellar bone tissue settle down haversian canals: a) endosteum; b) periosteum;
c) osteon; d) an inside layer general elastin;
26. One of basic tissues consists of three layers: external, Osteonic and inside layer. Called: a) coarse-fibered; b) compact lamellar bone;
c) spongy lamellar bone; d) collagenous cartilage;

**Questions for preparation for practical training and stage control**

1. Types of cartilage tissue.
2. Source of origin and types of cartilage growth.
3. Cells of cartilage tissue and components of intercellular substance.
4. Morphofunctional characterization of chondroblasts.
5. Layers of perichondrium with indication of the tissues that form them and their functions
6. Chemical components of the basic substance of cartilage tissue
7. Features of intercellular substance of elastic cartilage
8. Features of fibrous cartilage organization: chondrocyte topography and composition of intercellular substance.
12. Types of bone tissue.
13. Localization of woven and varieties of lamellar bone tissue.
14. Functions of bone tissue.
15. Components of intercellular substance of bone tissue.
16. Types of bone cells.
17. Morphofunctional characteristics of osteoblasts, osteocytes and osteoclasts.
18. Stages of bone development from mesenchyme.
19. Stages of bone development in place of hyaline cartilage.
20. The components of the periosteum.
21. The components of the osteon.
22. Structures, due to which the growth of bone in length and thickness takes place.
23. The components of the diaphysis.
24. Age-related changes in the lamellar bone tissue.

# Muscle tissue: smooth muscle tissue
striated skeletal muscle tissue
cardiac muscle tissue

Muscle tissues determine the contractile function that ensures the movement of the body in space, cardiac contractions and blood circulation through the vessels, the movement of food masses through the digestive tube, the movement of the embryo through the fallopian tubes and fetal expulsion during childbirth, urination, etc.

**The purpose of the lesson**

Able and willing to identify muscle tissue at the microscopic level. Can navigate normal and pathological conditions and be able to use this information in clinical practice and apply the learning material in his/her future profession of medicine

Learn to identify muscle tissues at the light and ultramicroscopic levels with the justification of diagnostic criteria.

**Tasks**

- To know the structural features of smooth, striated – skeletal and cardiac muscle tissues, their structural and functional units and contractile apparatus.
- Be able to identify the structural features of the structure of red and white skeletal muscle tissues on electronograms.
- To master the solution of situational problems that determine the knowledge of the studied theoretical foundations of the topic.

# Topic: Muscular tissues.

*Directions for work with micropreparations:*

1. At low magnification find muscular intestine coating. At high magnification study and draw a small fragment of longitudinally and transversely cut layers of muscular cells divided by connective layer. Pay attention to the fact that muscular cells (myocytes) closely adjoin each other forming a stratum. Myocyte nuclei are rod-shaped in longitudinal section, while in transverse they are oval being located in the center depending on the section level. smooth muscle cells could be met. Denuclearized sections of

4. Myocyte cytoplasm.
5. Loose connective tissue layer.

2. At low magnification find and examine tongue muscular fibers placed in different directions. At high magnification study and transversally, being divided draw two muscular fibers cut longitudinally by loose connective tissue layers. Pay attention to the transverse striation (in longitudinal section) and oval nuclei, located along periphery under the fiber sarcolemma. Myofibrils in the form of points Along the periphery nuclei are seen and observed in the transverse sections.

3. Sarcolemma 4. Myofibrils (in transverse section) 5.Isotropic (I) disc. 6.Anisontropic (A) disc. 7.Endomisium.

3. At low magnification examine entire preparation. Find muscular fibers composed of cardiomicytes being cut along transversely and obliquely. On high magnification pay attention to transverse striation and anastomoses between fibers (intercalated disc in the longitudinal section is also possible) and nuclei centered (in transverse section). Draw Two fibers connected by anastomose at high magnification.

**Smooth (non-striated) muscular tissue**
(staining by hematoxilin-eosin)

1. Longitudinal myocyte section.
2. Transverse myocyte section.
3. Rod-shaped nucleus

**Transverse-striated skeletal muscular tissue** (staining by hematoxilin-eosin)

1. Muscular fiber (myosinplast). 2.Sarcoplasm.

**Transverse-striated cardiac muscular tissue**
(staining by hematoxilin-eosin)

1.Muscular fiber. 2.Anastomose.
3.Isotropic discs. 4.Anisontropic discs.
5. Cells nuclei. 6. Intercalated disc.

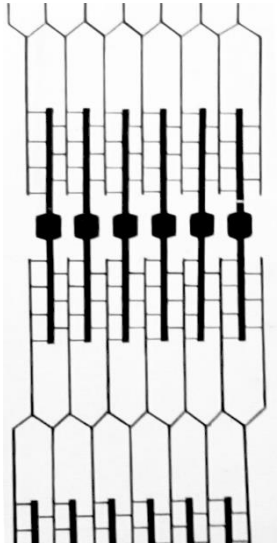
***Extracurricular self work.***

**Table 15.** Morphologic characteristics of muscular tissues.

| Types | Development source | Structural unit | Functional unit | Nuclei disposition | Presence of basal membrane | T-tubules or caveola | Contraction apparatuses | Regeneration |
|---|---|---|---|---|---|---|---|---|
| Skeletal | | | | | | | | |
| Cardiac | | | | | | | | |
| Smooth | | | | | | | | |

***Class self work.***
**Myofibril structure:**

In light microscope



In electron microscope

Correct task_____

Date "___" _____

## TEST CONTROL QUESTIONS. Muscular tissues.

1. Which of the following properties is not characteristic of striad skeletal muscle tissue: a) the presence of a basement membrane;
b) the ability to contract; c) the presence of triads;
d) cellular composition; e) the presence of myosatellite cells;
2. Which of the following properties helps to differentiate between cardiac muscle and skeletal muscle?
a) the presence of myofibrils; b) extensive vascularization;
c) striation; d) cellular composition; e) acidophilic cytoplasm;
3. Sensory nerve endings in muscles are:
a) neuromuscle spindles; b) free endings; c) motor end plates;
d) tactile corpuscles; e) lamellar corpuscles;
4. A sarcomere is a segment of myofibril between two neighbouring:
a) M-lines; b) H-bands; c) Z-lines; d) I-discs; e) A-discs;
5. Patient with injured muscles of the lower extremities was admitted to the traumatological department. Due to what cells is reparative regeneration of the muscle fibers and restoration of the muscle function possible? a) Myoepithelial cells; b) Satellite-cells;
c) Myofibroblasts; d) Myoblasts; e) Fibroblasts;
6. In course of a conditional experiment the development of mesenchyma cells was completely inhibited. Development of the following muscular tissue will be disturbed:
a) skeletal muscular tissue; b) smooth muscular tissue;
c) epidermal muscular tissue; d) neural muscular tissue;
e) cardiac muscular tissue.
7. The basal lamina of a muscle fiber is part of which structure?
a) perimysium; b) epimysium; c) fascia;
d) endomysium; sarcoplasmic reticulum;
8. With the transmission EM skeletal muscle fibers can be seen to contain structures called triads. What do the two laterial components 0f triad represent?
a) attachment sites for thick myofilaments;
b) sites for calcium sequestration and release;
c) sites for impulse conduction into the fiber;
d) sites for ATP production;
e) sites for synthesis of proteins to be secreted outsite the cell;
9. Which characteristic is unique to cardiac muscle?
a) contain centrally located nuclei; b) striated; c) often branched;
d) multinucleated; e) lack T-tubules;
10. In smooth muscle calcium released by the smooth ER initiates contraction by binding to what protein?
a) actin; b) calmodulin; c) desmin;
d) myosin light chain kinase; e) tropomyosin;
11. Which feature typifies T-tubules?
a) evaginations of the sarcoplasmatic reticulum;
b) sequester calcium during muscle relaxation, relasing it during contraction;
c) carry depolarization to the muscle fiber interior;
d) overlie the A-I junctions in cardiac muscle cells;
e) rich supply of acetylcholine reseptors;
12. Which characteristic is unique to smooth muscle?
a) T-tubules lie across Z lines;
b) each thick filament is surrounded by six thin filaments;
c) thin filaments attach to dence bodies;
d) cells are multinucleated;
e) cells have centrally located nuclei;
13. In one type of muscle. Numerous gap junctions, desmosomes, and adherens junctions are specifically localized in which structures?
a) myofilaments; b) dence bodies; c) sarcomeres;
d) neuromuscular spindles; e) intercalated discs;
14. The main property of smooth muscular tissue is:
a) a variety of cell forms; b) existence of satellite cells;
c) ability to long (without noticeable exhaustion) to reduction;
d) well developed intercellular substance;
e) ability to carry out exchange reactions and to support a homeostasis;
15. Under the influence of negative environmental factors, the function of myosatelliteocytes was initiated. The change in which the functions of the whole muscle fiber should be expected in this case?
a) Reduction of contractive thermogenesis; b) Muscle fiber regeneration; c) Trophy of muscle fiber; d) Reduction of muscle fiber; e) Increase in contractive thermogenesis;

16. A 66-year-old man who lives alone has a severe myocardial infarction and dies during the night. The medical examiner's office is calledthe following morning and describes the man's body as being in rigor mortis. This state of rigor mortis is due to which one of the following?
a) inhibitions of $Ca^{2+}$ leakage from the extracellular fluid and ER; b) enhance retrieval $Ca^{2+}$ by the sarcoplasmic reticulum ;
c) failure to disengage tropomyosin and troponin from the myosin active sites; d) absence of ATP preventing detachment of the myosin heads from actin; e) increased lactic acid production;
17. A 5-year-old boy sustains a small tear in his gastrocnemius muscle when he is involved in a bicycle accident. Regeneration of the muscle will occur through which of the following mechanisms?
a) dedifferentiation of muscle cells into myoblasts;
b) differentiation of muscle satellite cells;
c) fusion of damaged myofibers to form new myotubes;
d) hyperplasia of existing muscle fibers;
e) differentiation offibroblasts to form myoblasts;
18. A healthy 32-year-old man lifts weights regulary as part of his work-out. In one of his biceps muscle fibers at rest, the length of the I band is 1,0μm and the A band is 1,5μm. Contraction of that muscle fiber results in a 10% shortening of the length of the sarcomere. What is the length of the A band after the shortening produced by muscle contraction?
a) 1,50μm; b) 1,35μm; c) 1,00μm; d) 1,90μm; e) 0,45μm;
19. A patient with a lower limb muscle injury was delivered to the trauma center. Due to what cells is possible reparative regeneration of muscle fibers and restoration of muscle function?
a) Fibroblasts; b) Myoepithelial cells; c) Myoblast;
d) Myofibroblasts; e) Myosatellite cytotoxic cel;
20. Smooth muscle tissue of inner organs and vessels is developed from: a) ectoderm; b) neural tube; c) mesenchyme;
d) entoderm; e) mesoderm;
21. Skeletal muscle tissue is developed from:
a) ectoderm; b) neural tube; c) mesenchyme;
d) entoderm; e) myotomes of mesodermal somites
22. Cardiac muscle tissue is developed from:
a) ectoderm; b) neural tube; c) mesenchyme; d) entoderm;
e) visceral layers of mesodermal splanchnotomes
23. Sarcoplasmic reticulum of muscle tissues structures is:
a) smooth EPR; b) rough EPR; c) Golgi complex;
d) lysosomes; e) mytochondria
24. The structures called muscle triads are characteris-tic for:
a) smooth myocytes; b) myoepithelial cells; c) myofibroblasts;
d) symplasts; e) cardiac myocytes
25. Endomysium, separating muscle fibers is a tissue:
a) dense irregular connective tissue; b) fat tissue;
c) dense regular connective tissue; d) mucous tissue
e) loose connective tissue;

**Questions for preparation for practical training and stage control**

1. Classification of muscle tissues with indication of localization in the body.
2. Proteins of thick and thin myofilaments, as well as regulatory proteins.
3. Morphofunctional characteristics of smooth muscle tissue.
4. The structural and functional unit of smooth muscle tissue and its localization in the body.
5. Specific structural formations of the plasma membrane of a smooth muscle cell.
6. Smooth muscle cell myofilaments.
7. The main organelles of smooth muscle cells.
8. Stages of myohistogenesis of striated skeletal muscle fabrics.
9. Special organelles of muscle fiber and the most developed organelles of general importance.
10. Components of the triad in striated skeletal muscle tissue and its function.
11. Types of skeletal muscle fibers with indication of histochemical features.
12. Skeletal muscle tissue stem cells and their localization.
13. Connective tissue formations that unite muscle fibers into an organ.

## Nerve tissue

Nervous tissue is the basis of the structure of the organs of the nervous system. Topographic features of the structural components of the nervous tissue determine the characteristics of the functioning of organs and integrative processes necessary in modular education for the formation of clinical thinking, combining knowledge at the level of normal physiology, pathophysiology, pathanatomy, pharmacology, nervous and psychiatric diseases.

**The purpose of the lesson**

Able and willing to identify different types of neurocytes and gliocytes. Explain the cytological features of nerve cells, neurogliocytes and their outgrowths at microscopic and ultramicroscopic levels. Can navigate normal and pathological conditions and be able to use this information in clinical practice and apply the learning material in his or her future profession as a physician.

- Know and understand the morphofunctional features of neurons and neuroglia and be able to identify them at the light-optical level.
- To be able to substantiate the degree of functional activity of neurons by morphological and cytological criteria and identify myelinated and unmyelinated nerve fibers on microscopic and ultramicroscopic level.
- Master the solution of situational tasks determining the knowledge of the studied theoretical foundations of the topic.

**Date:**

# Topic: Nervous tissue.

*Directions for work with micropreparation:*

1. On low magnification in transverse section of spinal cord find gray matter located in the section center. It will remind a butterfly with stretched wings or letter H. Pay attention to large multipolar neurons situated in more voluminous prominences (anterior horns) of gray matter. Nervous cell bodies have different shape depending on processes partly occurred in section. Neuron nuclei are large and bubble-shaped with big nucleolus. On high magnification examine and draw one neuron. In its body there is a net of filaments (neurofibril) running in different directions; in processes running more or less parallel.

## Multipolar neuron (neurocyte)

(silver impregnation)

1. Neuron body (perikaryon). 2. Nucleus. 3. Processes.
4. Nuerofibrils (nuerotubules, nuerofilaments).

*Directions for work with micropreparation:*

2. On low magnification find large multipolar neurons. Their bodies have dendritic form, typical bubble-shaped nucleus with big nucleolus. Basophil substance projections of different form and size stained in blue are equally distributed in cell cytoplasm. Basophil projections are predominantly located in pericaron and dendrites, but they never appear in axons and cone-shaped bases – axon hillocks. On high magnification examine and draw one nerve cell.

## Basophil substance in neurons (chromophilic substance)

(staining by metilen blue according to Nissl method)

1. Basophil (chromatophilic) substance (Nissl bodies).
2. Axonal hillock.

Correct task_____

Date “___” _____

*Directions for work with micropreparation:*

**1. Myelin nerve fiber.** On low magnification find isolated myelin (medullated) fiber. On high magnification examine and draw small field of nerve fiber in the area of "node of Ranvier". Note the unstained central part of nerve fiber that presents a nerve cell process – an axial cylinder surrounded by medullated or myelin sheath stained by osmium. There is a fine fairly stained layer named nuerolemme, which is located outwards the myelin sheath. Along the fiber sharp gaps can often be seen – nodes of Ranvier corresponding to the adherent lemmocytes borders, and some oblique fair clefts – Schmidt-Lantermann clefts.

**Myelin nerve fiber** (osmium acid treatment)

1. Axial cylinder. 2. Myelin sheath. 3. Node of Ranvier. 4. Neurolemme. 5. Schmidt-Lantermann clefts.

*Directions for work with micropreparation:*

**2. Receptive nerve ending (lamellated corpuscle).** On low magnification find a lamellated corpuscle shifting the preparation. It resembles transparent layered structures of oval or circular form and large size. Sketch general contours. At high magnification study and draw the detailed structure. Note the inner flask (capsule) in the center formed by altered lemmocytes. Also note outer connectively knotted capsule formed by collagen (elastic) fibers and fiberblasts being oriented spirally.

**Lamellar corpuscle (Pacinian corpuscle)**
(staining by hematoxilin-eosin)

1. Outer bulb (connectively knotted capsule). 2. Inner bulb (glial capsule). 3. Fibrocytes nuclei. 4. Oligodendroglial cells nuclei.

## TEST CONTROL QUESTIONS. Nervous tissue.

1. Neurons and glial cells of the central nervous system organs develop from: a) neurogenic placodes; b) the neural crest;
c) the neural tube; d) the myotome; e) the dermatome;
2. The neurons and glial cells of the spinal and autonomic ganglia are the derivatives of: a) neurogenic placodes; b) the neural crest; c) the neural tube; d) the myotome; e) the dermatome;
3. The cytoplasm of an axon doesn't contain:
a) microtubules; b) mitochondria; c) the smooth endoplasmic reticulum; d) the rough endoplasmic reticulum; e) vesicles;
4. The morphological classification doesn't include the following types of neurons: a) unipolar neurons; b) bipolar neurons;
c) pseudounipolar neurons; d) multipolar neurons; e) interneurons;
5. A nerve impulse is transmitted in only one direction across the synapse which is conditioned by:
a) the system of myofibrils and neurotubules
b) the presence of mitochondria
c) axoplasmic transport of substances
d) the presence of a receptor protein on the postsynaptic membrane
e) the presence of glial cells
6. A neurotransmitter typical for a neuromuscular junction is:
a) acetylcholine; b) noradrenaline; c) serotonin;
d) gamma-aminobutyric acid; e) histamine;
7. A sensory nerve ending associated with the perception of pain is:
a) Phater-Pacini's lamellar corpuscle; b) Meissner's (tactile) corpuscle; c) a free nerve ending; d) Ruffini's (bulbous) corpuscle; e) neurotendon spindles;
8. The following is a non-free, non-encapsulated nerve ending:
a) Ruffini's (bulbous) corpuscle; b) Phater-Pacini's lamellar corpuscle; c) the axial cylinder of a nerve fibre;
d) Meissner's (tactile) corpuscle; e) a dendrite surrounded by the cytoplasm of a Schwann cell;
9. What is the minimum number of neurons found in the complex reflex arc? a) 2 neurons; b) 3 neurons; c) 4 neurons;
d) 5 neurons; e) 6 neurons and more;
10. Where are motor nerve endings located?
a) in epithelia; b) in connective tissues;
c) in neurotendon spindles; d) in motor end plates;
e) in nueromuscle spindles;
11. The Nissl bodies seen by light microscopy as basophilic clumps are:
a) sER; b) the Golgi apparatus; c) mitochondria;
d) microtubules; e) rosettes of polysomes and rER.
12. The neurofibrils seen by light microscopy are a fixation artefact and represent aggregated;
a) mitochondria; b) Golgi apparatus; c) microtubules and microfilaments; d) rER; t) sER.
13. The glial cells arising from blood monocytes are:
a) microglia; b) oligodendrocytes; c) potoplasmic astrocytes; d) fibrous astrocytes; t) ependymal cells.
14.The glial cells lining the brain ventricles and the spinal canal are:
a) microglia; b) oligodendrocytes; c) protoplasmic astrocytes;
d) fibrous astrocytes; e) ependymal cells.
15.The glial cells forming sheaths around the neuronal processes in nerve fibres are:
a) protoplasmic astrocytes; b) fibrous astrocytes; c) microglia;
d) oligodendrocytes (lemmocytes); e) ependymal cells.
16. In case of traumatic injury of the upper extremities, it is possible to develop degeneration of the nerve fibers, which is accompanied by a breakdown of the axial cylinders, the breakdown of the myelin. Due to which nerve structures is myelin regeneration during regeneration?
a) Perinewrites; b) Mezaxone; c) Neurolematocyte (Schwann cells) d) Endoneuritis; e) Astrocytes;
17. Neurons vegetative ganglia develop from: a) mesoderms b) nervous tube c) ganglionic plate d) endoderm
18. Structures of a myelin cover of nervous tissue are formed by:
a) ependymal cells; b) astrocytes; c) oligodendrocytes; d) microglia;
19 . nervous excitement on nervous cells, which component takes part:
a) neurofibrills ; b) lysosomes ; c) mitochondrions ; **d) synoptic** bubbles ;

### *Questions for preparation for practical training and stage control*

1. The composition of the nervous tissue.
2. The most developed organelles of the neuron and their significance for nerve cells.
3. The light-optical equivalent of the granular endoplasmic network of a neuron.
4. Processes of neurons and their functional significance.
5. Features of the axon structure and its function.
6. Features of the structure of the dendrite and its function.
7. Features of the structure, localization and function of receptor (sensitive) neurons.
8. Structural features, localization and function of insertion (associative) neurons.
9. Features of the structure, localization and function of effector neurons.
10. Localization and function of bipolar neurons.
11. Localization and function of multipolar neurons.
12. Classification of neurons by the number of processes (indicating their function and localization).
13. Classification of neurons depending on the function performed.
14. The receptor is.
15. Function of neurons: receptor, associative, effector.
16. The source of gliocyte formation: macroglia and microglia.
17. Functions of neuroglia.
18. Signs of fibrous astrocytes, localization, function.
19. The main signs of protoplasmic astrocytes, their localization and function.
20. The main signs and localization of ependymocytes.
21. The main features of the structure and localization of astrocytes.
22. The main signs of oligodendrogliocytes, their localization and function.
23. The main signs of lemmocytes, their localization and function. 24. Origin and function of microglia.
25. Components of a myelin-free nerve fiber.
26. The layers of the shell of the myelin nerve fiber and the features of their structure.
27. The structure of the myelin nerve fiber in the longitudinal section (at the light-optical level).
28. The source of formation and chemical composition of myelin.
29. The main groups of nerve endings by functional significance.
30. Morphological types of receptors.
31. Groups of receptors depending on the specificity of the stimulus.
32. Variants of non-free nerve endings.
33. The main components of the tactile body and their function.
34. Types of effector nerve endings.
35. The main parts of the neuromuscular termination.
36. Localization of synapses.
37. Types of interneuronal synapses.
38. The main synapses, which differ depending on the mediator and, in this connection, the structure of synaptic vesicles.
39. Components of the presynaptic part of the synapse.
40. The main components of the postsynaptic part of the synapse.
41. Types of nerve endings characteristic of the epithelium.
42. The main types of connective tissue receptors.
43. Structures of secretory nerve endings.
44. The main components of the motor nerve endings in striated skeletal muscle tissue.

45 The main components of the presynaptic part of the motor nerve ending (in striated skeletal muscles).

46. The main components of the postsynaptic part of the motor termination of striated skeletal muscles.

***Extracurricular self work.***

**Table 16.** Classification of nervous cells (neurons).

| | |
|---|---|
| On a structure | |
| On function | |
| On transmitter | |

**Table 17.** Classification of neuroglia.

| | Macroglia | | | Microglia |
|---|---|---|---|---|
| | astroglia | oligodendroglia | ependimoglia | |
| Variants | | | | |
| Topography | | | | |
| Functions | | | | |

***Extracurricular self work.***

**Table 18.** Morphological classification of the nerves endings.

| Classification of neuroneuronal synapses (examples) | Receptors (topography, examples) | | | The effectors nerves endings (examples) | |
|---|---|---|---|---|---|
| | Nonfree | nonencapsulated | | Neuro-muscular | |
| | | encapsulated | | | |
| | Free | | | Neuro-glandular | |
| | Sense organs | | | | |
| | | | | | |

# FOR THE NOTES

# THE LIST
# of obligatory practical skills for students of IIMEC «General medicine» while histology learning

1. Working with microscope and identification of histological and embryological micropreparation cellular and tissue content.
2. Leucocyte formula count in the blood smear.
3. Identification of cellular and tissue content in histological and embryological microphotograms and pictures.
4. Identification of subcellular structures in electron microphotograms of cells, tissues and organs.
5. Histological micropreparation drawing.
6. Solving of situational problems with cyto- and histophisiological levels.

► With the list of practical skills **COMPLITED**

Student _____group_____
Name, signature

► Practical skills **GOT ACQUENTED**

Tutor _____
Signature