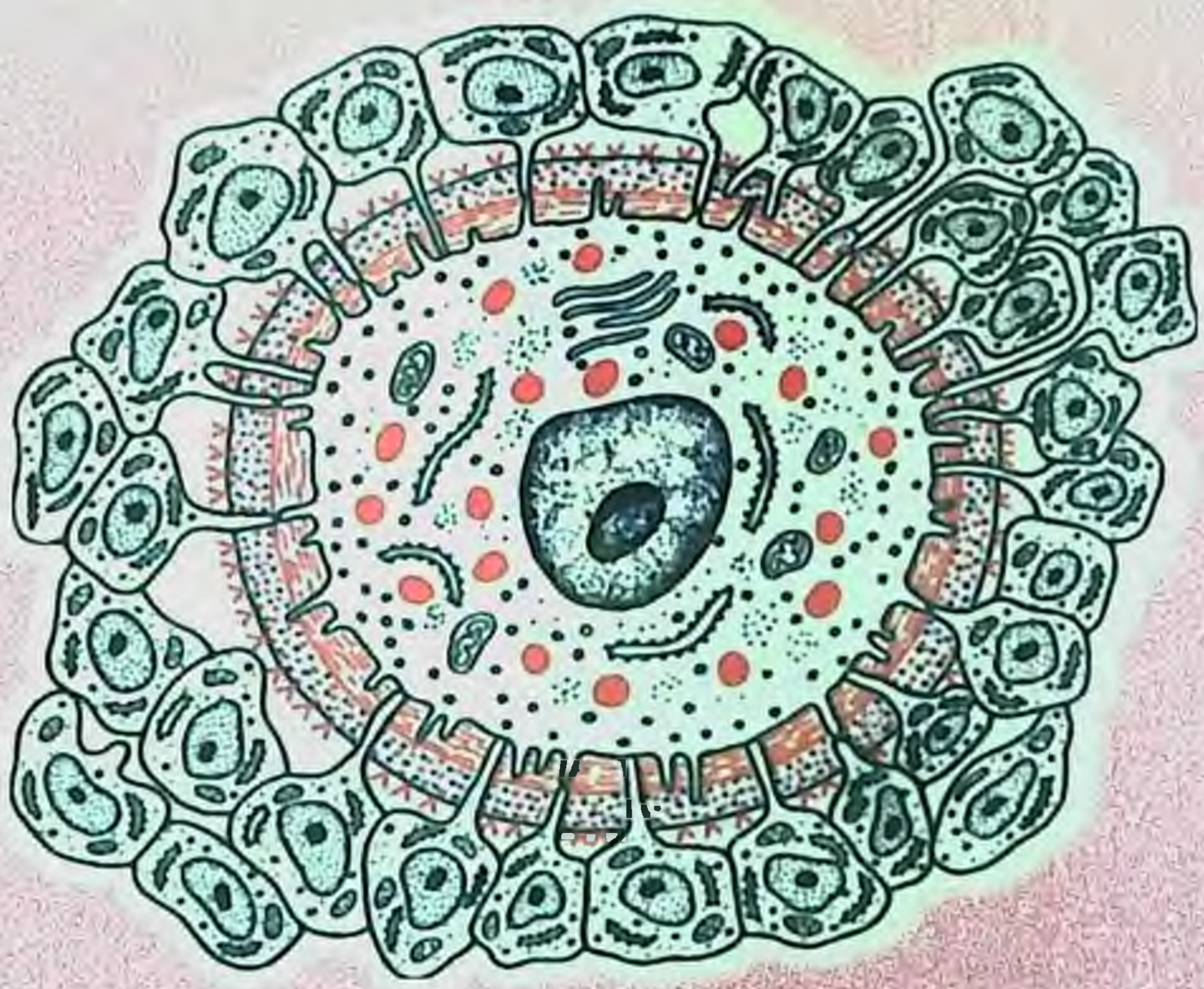
HISTOLOGY



THE MINISTRY OF HEALTH OF UZBEKISTAN

TASHKENT PEDIATRIC MEDICAL INSITITUT

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HISTOLOGY

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This manual is intended for undergraduate students of the first course medvuzov. The manual is written in accordance with the work program on the histology, cytology and embryology. The manual includes the following sections of the general histology cytology, private cytology, human embryology, histology, and three general chapters private histology. To compile the manual used by Internet data and drawings from textbooks Y. Afanasev, N.A.Yurina, K.A.Zufarov and others to the handbook.

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CHAPTER I. INTRODUCTION IN HISTOLOGY

1.1. Definition of histology as sciences. History of the subject

Histology - a science about a microscopic and submicroscopic structure, development and ability to live of fabrics of animal organisms. Hence, the histology studies one of levels of the organization of a live matter fabric. Distinguish following hierarchical levels of the organization of a live matter:

- Cellular;
- Fabric;
- Structurally functional units of organs;
- organly level;
- System level;
- organismly level.

Histology as the subject matter includes following sections:

The general cytology (studies the general laws a structure and cage functions: private cytology; embryology; the general histology (studies a structure and functions of fabrics); private histology (studies a microscopic structure of bodies)).

The basic object of studying of histology is the organism of the healthy person and consequently the given subject matter is called as histology of the person. The primary goal of histology consists in studying of a structure of cages, fabrics, bodies, establishments of communications between the various phenomena, an establishment of the general laws.

The histology, as well as anatomy, concerns the morphological sciences which main task is studying of structures of live systems. Unlike anatomy, the histology studies a structure of a live matter at microscopic and electro-microscopic level. Thus studying of a structure of various structural elements is spent now taking into account functions carried out by them. Such approach to studying of structures of a live matter is called histophysiologies, and the histology quite often is called as histophysiology. Cyto - and histochemicaly methods quite often use at studying of a live matter on cellular, fabric and organly levels. It is

thus considered not only the form, the sizes and an arrangement of interesting structures, but also structure of the substances forming these structures. At last, studied structures usually are considered taking into account their development, both in pre-natal (embryology) the period, and on an extent before embryology ontogenesis. Necessity of inclusion is connected with it embryology in a histology course. Histology as any science, has the objects and methods of their studying. Direct objects of studying are cages, fragments of fabrics and bodies, special way prepared for their studying under a microscope.

In history of development of histology conditionally allocate three periods:

1. Before microscope period (with IV century BC on 1665) is connected with names Aristotle, Galen, Avicenna, Vezaliy, Fallopiy, etc. and characterised by allocation attempts in an organism of animals and the person of non-uniform fabrics (firm, soft, liquid and so on) and use of methods anatomic preparation;

2. The microscopic period (since 1665 on 1950). The period beginning connect with a name of English physicist Robert Guka which, first, has improved a microscope (believe, that the first microscopes have been invented at the very beginning of XVII century) Secondly, used it for regular research various, including biological objects and has published results of these supervision in 1665 in the book "Micrography", thirdly, for the first time has entered the term "cage" ("cellyula"). Further continuous improvement of microscopes and their more and more wide use for studying of biological fabrics and bodies was carried out. The special attention was given to studying of a structure of a cage. Yan Purkine has described presence in animal cages of "protoplasm" (cytoplasm) and a kernel, and a little after R.Broun has confirmed presence of a kernel and in the majority of animal cages. Botanist M.Shlejden has become interested in an origin of cages cytogenesis. Results of these researches have allowed T.Shvannu, on the basis of their messages, to formulate the cellular theory (1838-1839) in the form of three postulates:

All vegetative and animal organisms consist of cages;

All cages develop by the general principle from cytoblastem;

-Each cage possesses independent ability to live, and organism ability to live is the sum of activity of cages.

However soon R.Virhov (1858) has specified, that development of cages is carried out by division of an initial cage (any cage from a

cage). The positions of the cellular theory developed by T.Shvan are actual till now though are formulated differently.

1.2. Modern positions of the cellular theory

- Cage is the least unit live;
- Cages of animal organisms are similar on the structure;
- Reproduction of cages occurs by division of an initial cage;
- Metaphytes represent difficult ensembles of cages and their derivatives, united in systems of fabrics and the organs, connected among themselves cellular, humoral and nervous forms of regulation.

The further perfection of microscopes, especially creation of achromatic objectives, has allowed to reveal smaller structures in cages:

-Cellular centre Gertvig, 1875;

The-mesh device or lamellar complex of Goldji, 1898;

-mitohondrii of Bend, 1898

Electronic-microscope (modern) period.

The present stage of development of histology begins since 1950 from the moment of the beginning of use **of an electronic microscope** for studying of biological objects though the electronic microscope has been invented before (E.Ruska, M.Knol, 1931). However for the present stage of development of histology introduction not only an electronic microscope, but also other methods is characteristic:

Cyto - and histochemical;

histopadiographic;

Other modern methods set forth above.

Thus complex is usually used

The various techniques, allowing to make not only qualitative representation about studied structures, but also to receive exact quantitative characteristics. Especially widely now are used various morphometric techniques, including the automated systems of processing of the received information with use of computers .

It is necessary to notice, that development histologists in Uzbekistan as includes three periods:

1. **Before microscope period** - lasts till 1918, i.e. before opening in Tashkent the Higher Medical school.During this period, Avicenna were made a number of discoveries in morphology. He is without a microscope suggested that the muscles contract due to thin filaments that are in them. The vessels have a shell structure: arteries have three, and two veins shell. Until the XVII century in European universities enjoyed his works as textbooks. EM Shlyakhtin organized in Tashkent, the first chair of histology.

EM Shlyakhtin - head first. cafes. histology TashMI

2. **The microscopic period**-begins since 1920-years. During this period, exceptmorphological methods Tashkent thanks to scientists K.A.Zufarov, D.H.Hamidov, M.S.Abdullahodzhayeva, Z.R.Ahmatulin developedhisto-cytochemical and fluorescent micro scopytechniqueswere created histology callaboratoryin Tashkentin Samarkand.

1968year K.A.Zufarov at an electronic microscope with his students

3. **The Electron-microscope period** - since 1960 and last twoperiodassociatedwith the nameof academician K.Zufarov, who could organize the famous school of Uzbek Histologists.

Objects of research of histology. Objects of research are subdivided on: **live** (cages in a drop of blood, a cage in culture and others), **dead** or fixed which can be are taken both from a live organism (biopsiya), and from corpses.

In any case after a capture of slices they are treated to action of fixing solutions or freezing. Both in scientific, and in the educational purposes the fixed objects are used. The preparations prepared by certain way used for studying under a microscope, are called as histologic preparations.

The histologic preparation can be in a kind: the thin painted **cut** of body or a fabric; **dab** on glass; **a print** on glass from a body break; **a thin film** preparation.

1.3. Research methods

Histochemicaland cytochemicalmethods allowto determine the compositionof chemicals, and eventheir numberin the studiedstructures. The method is basedonchemical reactionswiththe reagentsand chemical substances in thesubstrateto form areaction product(contrast or fluorescence), which was then determined byfluorescence microscopyorlight.

Gistoavtoradiografican method allows to reveal the composition of chemicals in the structure and intensity of the exchange to include radioactive isotopes to study the structure. The method most frequently used in experiments.

Differential centrifugation method allows us to study individual organelles or even fragments isolated from the cells. For this test piece was triturated body, pour normal saline and then dispersed in a centrifuge at different speeds (from 2 to 150 the). To give fractions of interest are then studied by various methods. **Interferometer method** to determine the dry weight of the materials in living or fixed objects. lymphocytes to determine the degree of foreign cells, to carry out histological

Immunomorfological method allow using pre-immune reactions carried out on the basis of antigen-antibody interactions, identify a subpopulation of lymphocytes to determine the degree of foreign cells, to carry out histological typing of tissues and organs (to determine histocompatibility) for organ transplantation. Typing of tissues and organs (to determine histocompatibility) for organ transplantation

The clinical significance of research methods of histology

*1.**Kultura cell** has been widely used in studies of metabolic processes in normalcy and cancerous cells and in the development of new drugs. This method has also proven useful in studies of the parasite, which grow only in cells, such as viruses, mycoplasma, and some pro-*

tozoa. In cytogenetic studies, the definition of human cerotype (the number of chromosomes and morphological features of the subject) dostigaetsya by short-term culturing of blood lymphocytes or skin fibroblasts. In re-result study of mitotic ally dividing cells in tissue culture can detect anomalies in the number and structure of chromosomes, which are interconnected and are important in the diagnosis of diseases mnogochislennyh, collectively called genetic disorders. In addition, cell culture is central to modern methods of molecular biology and recombinant DNA technology.

***2. A number of histochemical methods** often use in the laboratory diagnosis of diseases that lead to the accumulation of iron glycogen, glycosaminoglycans and other substances. Examples include Perls reaction for iron (eg, hemochromatosis and gemosideroze) Schick reaction with amylase for glycogen (glycogen storage disease with), coloring al-cyanic blue on glycosaminoglycans (with mucopolysaccharidosis) and color of lipids (at sfingolipidoze).*

***3. Immunocytochemistry.** She has made a significant contribution to research in the field of cell biology and in the improvement of diagnostics in medicine.*

1.4. Microtechnology

I. Goals and Objectives: Familiarization with the stages of micro technology

II. Questions for self-monitoring of students' knowledge:

1. Features alternately stages;
2. Taking the material;
3. Fixation;
4. Fill material;
5. Preparation of slices;
6. Paint and enlightenment sections
7. Types of microscopy;
8. The clinical significance of the topic.
9. Conclusion

The theoretical part

Preparation of histological preparations

Histological preparation of any form must meet the following requirements:

* save vivo state structures;

* Be sufficiently thin and transparent to study it under a microscope in transmitted light;

* Be a contrast, that is, to study the structure should be clearly defined under the microscope;

* Preparations for light microscopy have long maintained and used for re-examination. These requirements are achieved when properly prepared formulation.

Purpose of making preparations: scientific, educational, diagnostichesie.

Allocate the following stages of the preparation of histological preparation. Below is showed example with formalin fixation.

I.A material Capture (a fabric or body slice) for preparation. Following moments are thus considered:

The material-fence should be spent as soon as possible - after death or a face of an animal, and at possibility from live object (biopsy) that structures of a cage have better remained, a fabric or body;

The-fence of slices should be made by the sharp tool not to injure a fabric;

The-thickness of a slice should not exceed 5 mm that the fixing solution could get into thickness of a slice;

-Was obligatory slice marks (the body name, number of an animal or a surname of the person, fence date and so on is underlined) are made.

II. Material Fixing is necessary for a stop of exchange processes and preservation of structures from disintegration. Fixing is reached more often by slice immersing in fixing liquids which spirits and formalin and difficult Karnua solution , Canker's clamp can be simple, Brodsky and others. The clamp is caused denaturation by the squirrel and by that stops exchange processes and keeps structures in their lifetime condition. Fixing can be reached also by freezing (cooling in струеCO_2, liquid nitrogen and others). Duration of fixing steals up by practical consideration for each fabric or body.

III. Flushing - held under the tap water

IV. Seals can be achieved using alcohols of increasing concentrations (from 60 degree to 100 degree alcohol).

V. Pouring of slices in condensing environments (paraffin, celloidin, pitches) or freezing for the subsequent manufacturing of thin cuts.

VI. Preparation of cuts on special devices (microvolume or ultramikrotom) by means of special knifes. Cuts for light microscopy are pasted on subject glasses, and for electronic microscopy - are mounted on special mesh.

VII. Coloring of cuts or them contrasting (for electronic microscopy). Before coloring of cuts condensing environment leaves. Colouring reaches contrast of studied structures. Dyes are subdivided into the basic, sour and neutral. The basic dyes (usually haemotoxilin) and sour (eozin) are most widely used. Quite often use difficult dyes.

VIII. Dehydration of alcohols (100 градусный, in two portions)

IX. The Enlightenment of cuts (in xilol, toluene),

X. The Conclusion **(in pitches**-balm, polystyrene), **closing by integument glass.**

After these consistently spent procedures the preparation can be studied under a light microscope.

For electronic microscopy in stages of preparation of preparations there are some features, but the general same principles. The main difference consists that the histological preparation for light microscopy can is long to be stored and repeatedly to be used. Cuts for electronic microscopy are used unitary. Thus in the beginning interesting objects of a preparation are photographed, and studying of structures is made already on electro grams.

(Blood, a bone brain and others) are made of fabrics of a liquid consistence preparations in the form of dab on subject glass which also are fixed, painted, and then studied.

From fragile parenhimatoz organs (a liver, a kidney and others) are made preparations in the form of a body print: after a break or body rupture, to a place of a break of body subject glass on which some free cages are pasted is put. Then the preparation is fixed, painted and studied.

At last, from some bodies (mesenteries, a soft brain cover) or from a friable fibrous connecting fabric **film preparations** by extension or press between two glasses, also with the subsequent fixing, coloring and pouring in pitches are made.

1.5. Research methods

The basic method of research of the biological objects, used in histology, is **microscopy,** i.e. Studying of histological preparations un-

der a microscope. The microscopy can be an independent method of studying, but recently it is usually combined with other methods (histochemistry, historadiographicaly and others). It is necessary to remember, that for microscopy different designs of the microscopes are used, allowing to study different parametres of studied objects.

Distinguish following kinds of microscopy:

-Light microscopy (resolution 0,2 microns) the most widespread kind of microscopy;

-Ultra-violet microscopy (resolution 0,1 microns);

-Luminescent (fluorescent) microscopy for definition of chemical substances in considered structures;

-Fazovo-contrast microscopy for studying of structures in unpainted histologic preparations;

-Polarising microscopy for studying, mainly, fibrous structures;

-Microscopy in a dark field for studying of live objects;

-Microscopy in falling light for studying of thick objects;

The-electronic microscopy (resolution to 0,1-0,7 nanometers), its two versions appearing through (transmission) electronic microscopy and scanning or raster gives to microscopy display of a surface of ultrastructures.

Gistochemical and cytochemical methods allow to define structure of chemical substances, and even their quantity in studied structures. The method is based on carrying out of chemical reactions with a used reactant and the chemical substances which are in a substratum, with formation of a product of reaction (contrast or fluorescent) which then is defined at light or luminescent microscopy.

The method histoautoradiographik allows to reveal structure of chemical substances in structures and intensity of an exchange on inclusion of radioactive isotopes in studied structures. The method is used more often in experiments on animals.

The method differential centrifugal allows to study separate organelles or even the fragments allocated from a cage. For this purpose a slice of investigated body pound, fill in with a physiological solution, and then disperse in a centrifuge at various turns (from 2 to 150 thousand) and receive interesting fractions which then study various methods.

The interpherometric method allows to define dry weight of substances in the live or fixed objects

Immune morphological methods allow by means of preliminary spent immune reactions, on the basis of interaction an antigen-antibody, to define subpopulations lymphocytes, to define degree of foreignness of cages, to spend histologic typing fabrics and organs (to define histo-compatibility) for transplantation of organs.

Method of culture of cages (in vitro, in vivo) - cultivation of cages in a test tube or in special capsules in an organism and the subsequent studying of live cages under a microscope.

The units of measure used in histology. For measurement of structures in light microscopy micrometers are used basically: 1 micron makes 0,001 mm; in electronic microscopy are used nn: 1 nanometer makes 0,001 microns.

Clinical values of methods of research of histology

1. The culture of cages has found wide application in researches of exchange processes in normalandcancer cages and by working out of new medicines. This method also has appeared useful in researches of parasites which grow only in cages, such, as viruses, mycoplasmas and some the elementary. In cytogenetic researches definition karyotype the person (number and morphological features of chromosomes surveyed) is reached by short-term cultivation lymphocyte blood or phibroblasts of skin. As a result of studying mitosis sharing cages in cultures of a fabric also it is possibleto revealanomalies of number and a structure of chromosomes which are connected among themselves and matter in diagnostics of the numerous diseases named in aggregate genetic infringements. Besides it, the culture of cages takes the central place in modern methods of molecular biology and technology recombination DNA.

2.A number **histochemistry methods** often use in laboratory diagnostics of diseases which lead to iron accumulation, glycogen, glycosaminoglycans and other substances. As examples can serve reaction of Perls to gland (for example, at haemochromatoz and haemosideroz), the GLAMOUR-REACTION with amylase on glycogen(at glycogenosis), coloring al-cyanic dark blue on glikozaminoglikans (at mukopolisaharidoz) and coloring lipids (at sphingolipidoz).

3. Immunocytochemistry has brought the essential contribution to researches in the field of cellular biology and in perfection of methods of diagnostics in medicine. Examples immunocytochemistry revealings of molecules are resulted.Tab. 1-1 contains data about some most widespread purposes of use immunocytochemistry methods in clinical practice.

Practical exercises are conducted in the histology laboratory of the department. Studied laboratory equipment familiarization phases microtechnology, cooking clips. The objects under study: microtomes (toboggan for serial sections, light, fluorescence microscopy and electron microscopy

Sample tests

1. How much histology stages of development do you know?
a) 2; b) 3; c) 4; d) 5.
2. Founder school Histologists in Uzbekistan?
a) Shlyakhtin; b) Zufarov; c) Borovsky; d) Isayev;
3. How manyseveral stages of preparation technique consists of histological preparation (for formalin fixation)?
a) 5; b) 6 c) 7; d) 9.

Approximate refereed paper on "Development of histology as science in Uzbekistan"

CHAPTER II. GENERAL CYTOLOGY

2.1. Concept of cytology

I. Aims and objectives: to give an idea of Cytology, familiarize with the functions and structure of plasmolemma.

II. Questions for self-control students

1. The term "cytology";
2. Sostavnye of the cell;
3. Major Features of the structure of the animal cell from a plant;
4. Types of cell shape;
5. Function plasmolemma, modes of transport of substances;
6. Structure plasmolemma;
7. Intercellular contacts;
8. The structure of plasmolemma free surface;
9. Clinical importance of the topic.

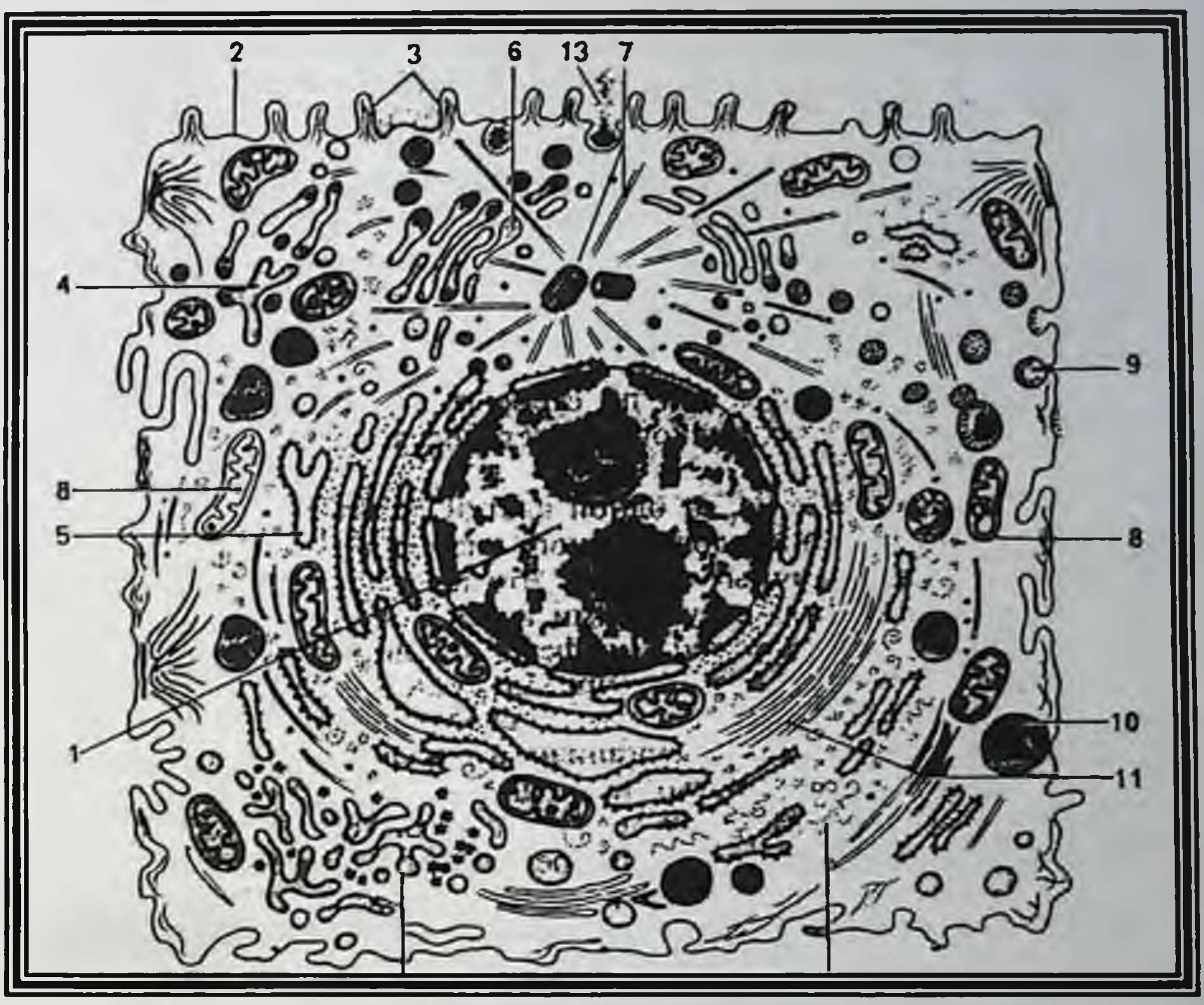
The theoretical part

Cytology - a science about a structure, development and ability to live of cages. Hence, the cytology studies laws of structurally - functional organization of the first (cellular) level of the organization of a live matter. The cage is the least unit of the live matter possessing independent ability to live and ability to self-reproduction. Subcellular formations (a kernel, mitochondria and others organelles) though are live structures, but do not possess independent ability to live.

The basic structural components of a cage are: **plazmolemma, cytoplasm and a kernel (picture-1).**

Cage - elementary unit live, consisting of cytoplasm and a kernel and being a basis of a structure, development and ability to live of all animal and vegetative organisms. The basic components of a cage: cytolemma - a cytolemma, cytoplasm, a kernel.

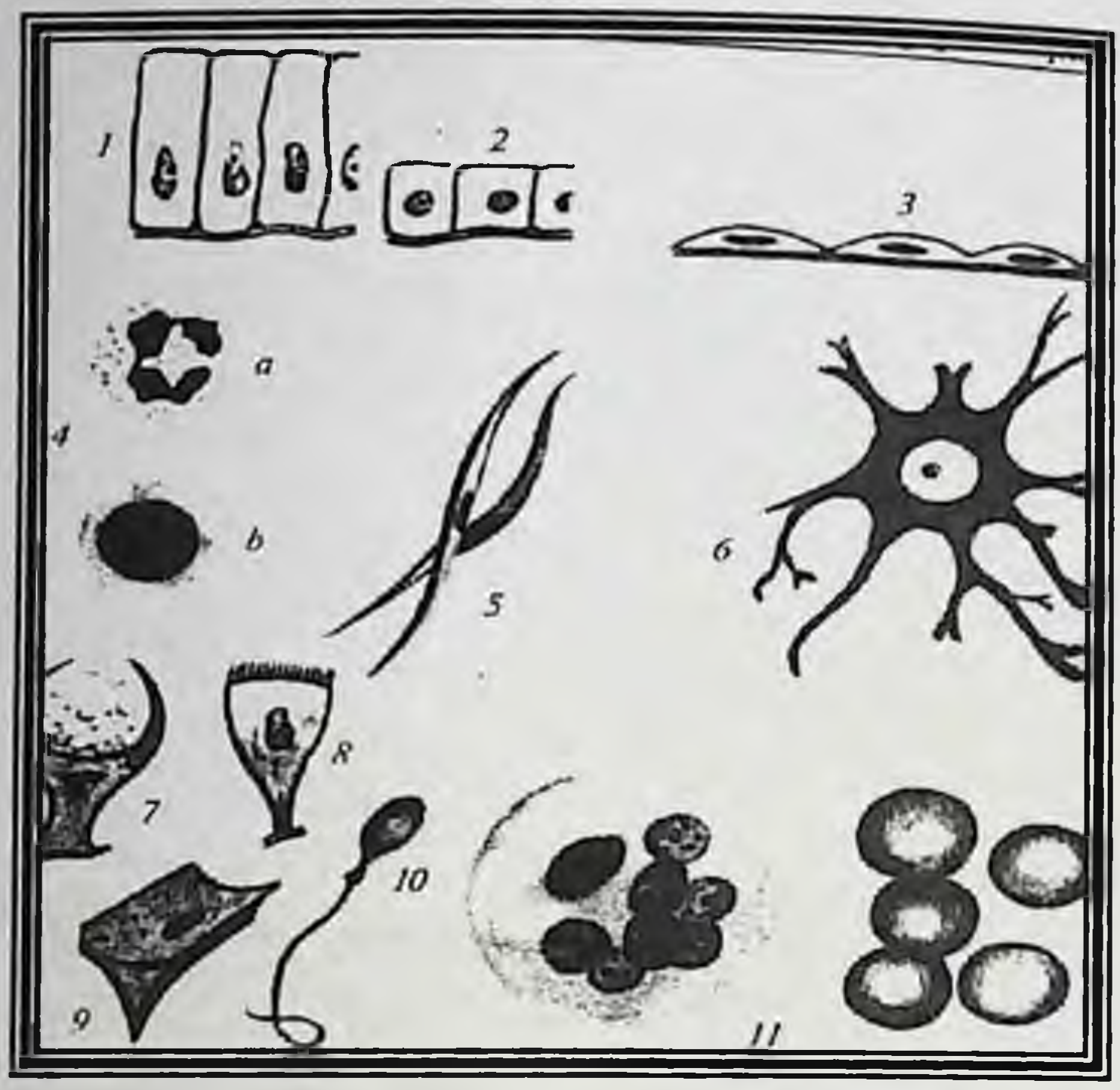
On a kernel and cytoplasm parity (the nucleus-cytoplasmic relation) cages are subdivided on: cages of nuclear type (the kernel volume prevails over cytoplasm volume); cages of cytoplasmic type (cytoplasm prevails over a kernel).



Picture-1. **The general organisation of a cage**
1-kernel; 2-cytolemma; 3-microfibers; 4-smooth reticulum; 5-granular reticulum; 6-complex of Goldie; The 7-cellular centre 8-mitohondry; 9-lizosoma; 10-fagolizosoma; 11-tonofibrilla

In the cage form happen: round (blood cells); the flat; cubic or cylindrical (cages different epithelium);

Spindle-shaped; offshootly (nervous cages) and others. The majority of cages contain one kernel, however there can be in one cage 2, 3 and more kernels - multinuclear cages. In an organism there are structures (simplast, sincit), containing some tens or even hundreds kernels. However these structures are formed or as a result of merge of separate cages (symplast), or as a result of incomplete cell fission (sincit). The morphology of these structures will be considered at studying of fabrics.



Picture-2. **Forms of cages:** 1-cylindrical; 2-cubic; 3-flat; 4a-segmentonucleus; 4b-roundish; 5-roundly; 6-polishootly; 7-goblet; 8-ciliate; 9-triangular; 10-tailed; 11-multinuclear; 12-spherical.

2.2. Structural components of cytoplasm of an animal cage. Plazmolemma

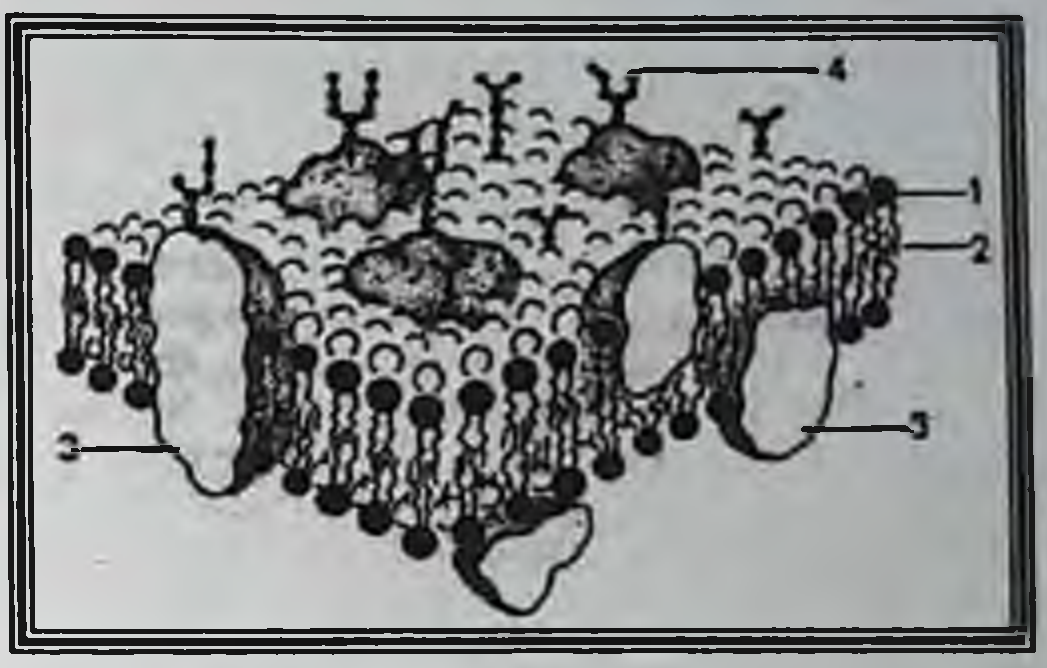
Functions plasmolemma (cattleman): differentiating, transport, barrier-receptor.

In those fabrics, in which cages or their shoots densely connect to each other (epithelium, smooth muscle and others) between plasmolemms contacting cages are formed communications - intercellular contacts. In a free surface plasmolemms there can be microfibers, lashes.

Chemical compound plasmolemms: fibers about 60 %, lipids 4-5 and about 5 % of carbohydrates. Receipt of substances in a cage - **endocytosis;** allocation of substances - **exocytose**. Transport of substances in a cage happen - **active** (by means of energy), **receptor-mediated and passive - by diffusion**. At endocytoz large molecules arrive

in a cage. Distinguish **phagocytosis-capture and receipt of large particles, pinocytosis-receipt of liquid particles.**

In a structure of plasmalemma distinguish external – glicocalix, average – bilipid and internal – cortical layers



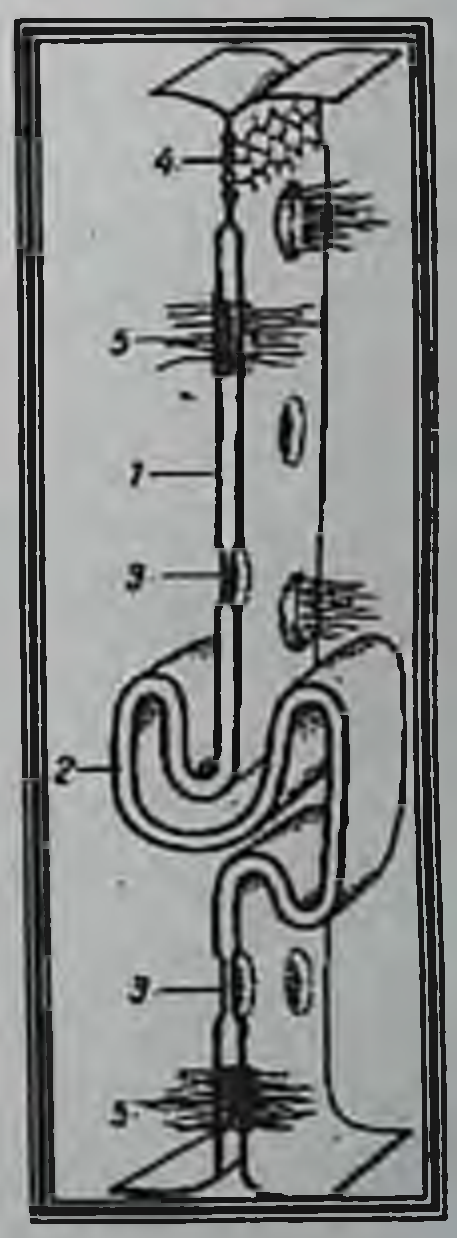
Picture-3. **A structure of plasmolemm**. 1-2 a bilipid layer; 3-integrated fiber; 4-receptor.

Structureof intercellular contacts

Types of intercellular contacts:

-Simple contact;
-Desmosomal contact;
-Dense contact;
-Interdigitations;
-Nexus;
-Synapse.

- **Simple contacts** occupy the most extensive sites of adjoining cages. The distance between bilipid membranes of the next cages makes 15-20 nanometers, and communication between cages is carried out at the expense of interaction of macromolecules adjoining glicocalix. By means of simple contacts weak mechanical communication - the adhesion which is not interfering transport of substances in intercellular spaces is carried out.



Picture-4. **Cellular contacts:** 1-tonofilamenty; 2-interdigitatsii; 3-half-desmosoma; 4-dense contact; 5-desmosoma; 7-simple contact

Version of simple contact is contact of "lock type" when plasmolemm the next cages together with a cytoplasm site as though enter to each other (interdigitation), than the big surface of contact and stronger mechanical communication is reached.

Dermatomes contacts or coupling stains represent small sites of interaction between cages, diameter about 0,5 microns. Each such site (desmosomes) has a three-layer structure and consists of two desmosomes sites located in cytoplasm in places of contact of cages, and a congestion a material in between membranes space (15-20 nanometers). The quantity desmosomes on one cage can reach 2000. Functional role desmosomes maintenance of mechanical communication between cages.

Dense connections or switching plates are usually localised between epithelium cages in those bodies (in a stomach, an intestines and others) in which epithelium delimits aggressive contents of these bodies (gastric juice, intestinal juice). Dense contacts are only between apical parts epitheliumcages, covering on all perimeter each cage. In these sites between membranes spaces are absent, and bilipid layers next plasmolemm merge in one general bilipid membrane. In connecting sites of cytoplasm of adjoining cages the congestion a material is marked.

A functional role of dense contacts - strong mechanical communication of cages, an obstacle to transport of substances on intercellular spaces.

Crackly contacts or nexus the limited sites of contact of the next cytolemma, diameter 0,5-3,0 microns in which bilipid membranes are pull together on distance of 2-3 nanometers, and both membranes are penetrated in a cross-section direction by albumins molecules connection, containing hydrophile channels. Through these channels the exchange of ions and micromolecules of the next cages is carried out, then and their functional communication (for example, distribution of biopotentials between cardio myocyte, them reduction in a myocardium) is provided.

Synapse contacts or synapse - specific contacts between nervous cages (interneural synapse) or between nervous and other cages (nervously-muscular synapse and others). The functional role synapse contacts consists in transfer of excitation or braking from one nervous cage on another or from a nervous cage on innervation a cage.

Interdigitation-compound lock type cells when one cell cytoplasm

The practical part

Compilation of logical structures, the study of drugs and a sketch of the principles of the structure plasmolemma into albums, view multimedia.

Studied drugs: 1. Animal cells. 2. Intercellular contacts (in the electron).

Sample tests

1. What is the plan of the structure of the universal biological membranes?

a) two-layer proteins, lipid layer there between;
b) bimolecular layer of lipids, proteins comprising;
c) the two-layer lipid layer there between and proteins;
d) protein group alternate with groups of lipids.

2. What structures cytolemma promote cell recognition signals?

a) cilia;
b) fold;
c) Membrane receptors;
d) tonofibrils;
e) microvilli.

3. What features of these does not perform plasmolemma?

a) barrier;
b) receptor;
c) Participation in endo- and exocytosis;
d) transport;
e) synthetic.

4. What structural elements of the cells are actively participating in exocytose?

a) tsitolemmy;
b) cytoskeleton;
c) Mitochondria;
d) ribosomes.

5. Glycocalyx (Choose the correct answer).

a) Located in the smooth endoplasmic reticulum;
b) Hotel is located on the outer surface of tsitolemmy;
c) Formed carbohydrates;
d) Participates in T-cell adhesion and cellular recognition;
e) located on the inner surface tsitolemmy.

Approximate refereed report on; "The history of the development of cytology as a science"

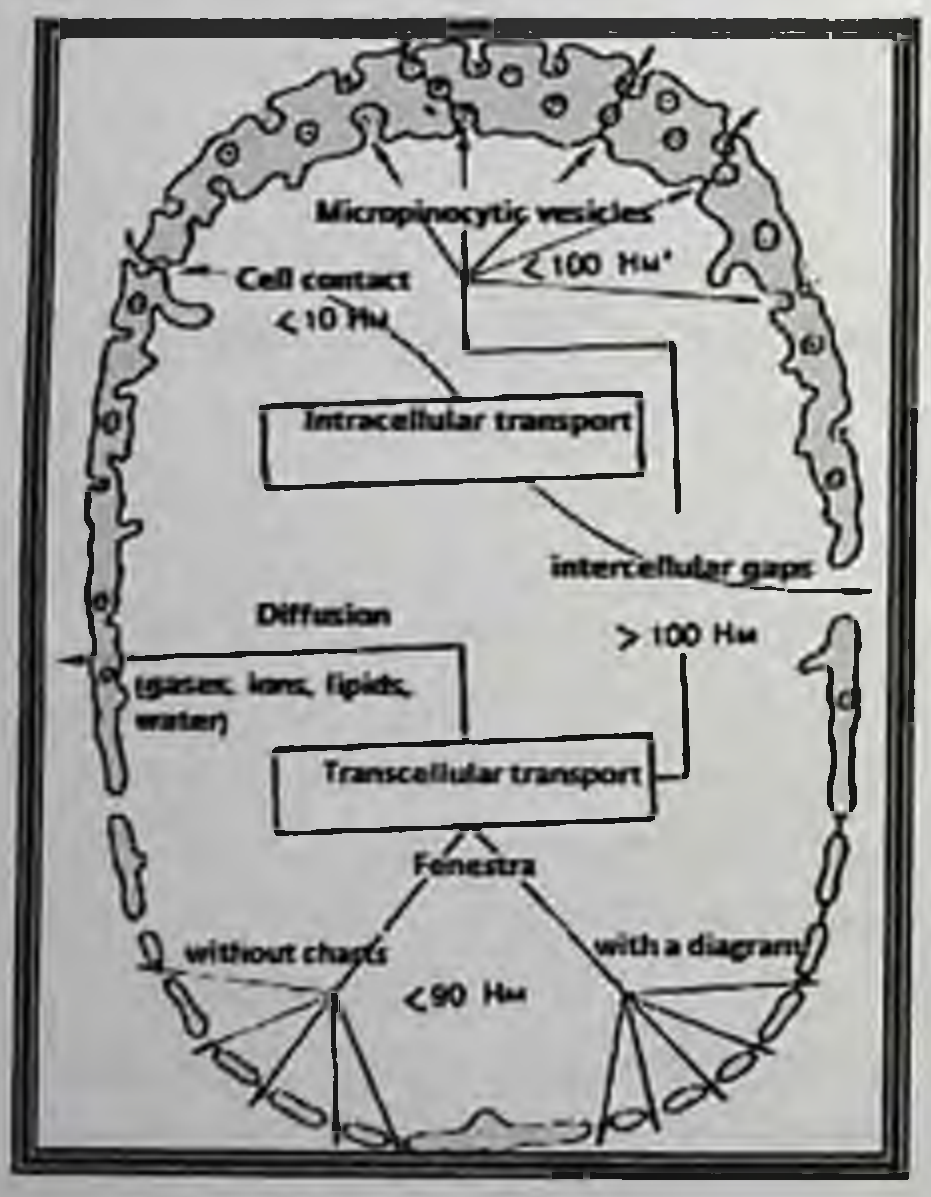
2.3. Cytoplasm and kernel

I. Aims and objectives:

1. To study the structure and function of the structures of the cytoplasm.
2. To study the structure and function of the structures of the cell nucleus.

II. Sample questions for self-training:

1. The concept of the cytoplasm.
2. Hyaloplasm and its functions.
3. Membrane non membrane and cell organelles.
4. EPS.
5. Complex Golgi.
6. Ribosomes.
7. Mitochondria.
8. Lysosomes, peroxisomes, and microtubules mikrofillamenty.
9. The structure of the nucleus.
10. Chromatin and its species.
11. The cell cycle.



The theoretical part

Cytoplasm consists from hyaloplasm, organelles and inclusions.

Hialoplasm or matrix cytoplasm makes the internal environment of a cage. It consists of water (90 %) and various biopolymers (7 %) fibers, nucleus acids, poly sugars, lipids of which the basic part is made by fibers of various chemical and functional specificity. In hyaloplasm amino acids, mono sugar, nucleotide and other low-molecular substances contain also. Biopolymeric connections form with water colloid system, which depending on conditions can be more dense (in the form of gel) or more liquid (in shape) both in all cytoplasm, and in its separate sites. In hialoplasm are localized and co-operate among themselves and environment hia-

loplasm various organelles and inclusions. Thus their arrangement is specific to certain types of cages more often. Through bilipid a membrane hialoplasm co-operates with the extracellular environment. It is carried out transcellular transport of substances. Hence, hialoplasm is rather dynamical environment and plays the important role in functioning separate organelles and cage abilities to live as a whole.

Organelles- constant structural elements of cytoplasm the cages which

have a specific structure and carrying out certain functions.

Classification of organelles:

General organelles inherent in all cages and the providing various parties of ability to live of a cage. They in turn share on:

-Membranesorganelles: mitochondria, endoplasm a network, a lamellar complex, lysosomes, paroxysm;

Non-membran organelles: ribosomes, the cellular centre, microtubules, microfibrilles.

Special organelles, available in cytoplasm only certain cages and carrying out specific functions of these cages, share on:

The cytoplasmatic: myofibrils, neurofibrils, tonofibrils;

An organelles cellular surface: cilia, flagella.

2.4. General characteristic organelles of membrane

All versions organelles of membrane general principle of a structure: they represent the closed and isolated sites in hialoplasm (comparments), having the internal environment, their wall consists from bilipid membrane and fibers, similarly plazmolemm, however there are also some features a thickness bilipid membranes of organelles it is less (7 nanometers), than in plazmolemm (10 nanometers);

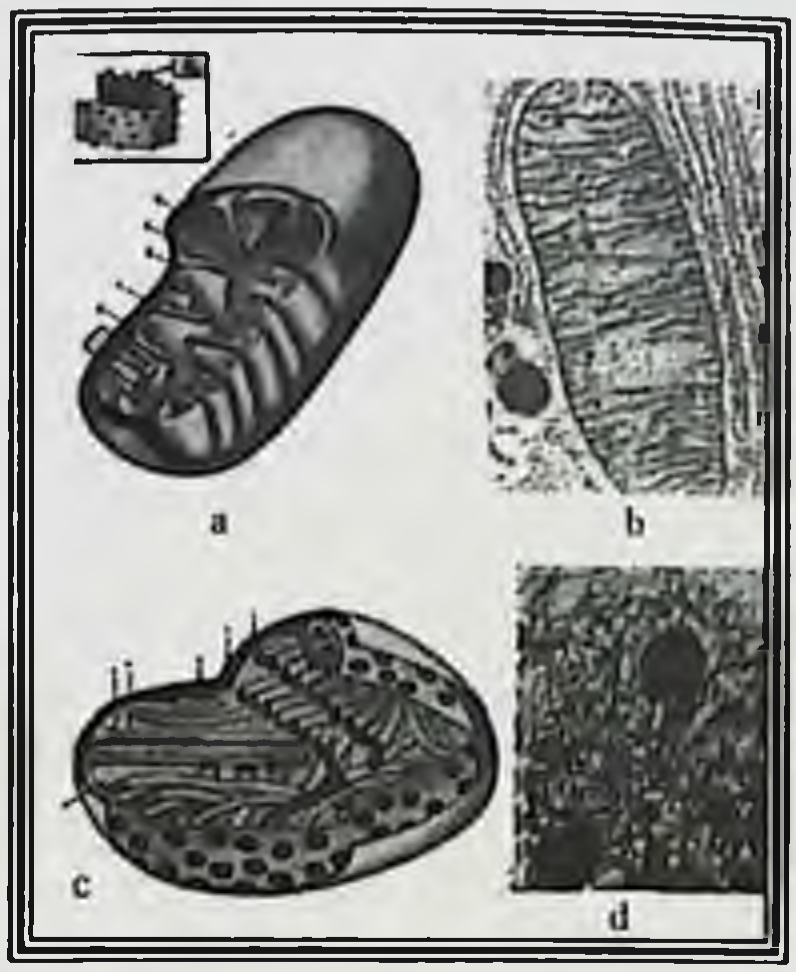
Membranes differ by quantity and quality of the fibers which have been built in membranes.

However that fact, that membranes have the general principle of a structure allows membranes of organelles and plazmolemm to co-operate with each other - to be built in, merge, separated. By it is reached recycle membranes. The general principle of a structure of membranes speaks that all of them are formed in endoplasm networks, and their structural and functional specialisation occurs basically in a lamellar complex.

Structure of mitochondria

Mitochondria- is the most isolated structural elements of cytoplasm the cages possessing substantially independent ability to live. There is even a point of view, that **mitochondria** in historical development in the beginning represented independent organisms, and then

Have taken root into cytoplasm of cages where conduct saprophyte existence. To it testifies, in particular, that fact, that in mitochondria is available the independent genetic device (mitochondria DNA) and the synthetic device (mitochondria ribosomes). However it is already authentically established, that the part mitochondria fibers is synthesized in a cage.



Picture-6. **Mitochondria and it Versions mitochondria**

The form mitochondria can be oval, roundish, extended and even branched out, but prevails is oval extended. The wall of mitochondria is formed by twobi lipid membranes, divided by space in 10-20 nanometers.

Thus the external membrane covers on periphery in the form of a bag all mitochondria and delimits it from hialoplazm

The internal membrane delimits internal mitochondria environment, thus it forms inside mitochondria folds - cristae. In some cages (cages cortex substances of an adrenal gland) the internal membrane forms not folds, and vesicular or tubules - tuba-vesicular cristae. Internal mitochondria environment (mitochondria matrix) has a fine-grained structure and contains granules (mitochondria DNA and ribosomes).

Functions of mitochondria - formation of energy in the form of mitochondria. A source of formation of energy in mitochondria (its "fuel") is pyruvate acid which is formed of carbohydrates, fibers and lipids in hialoplazm. Oxidation pyruvate occurs in mitochondria matrix in a cycle of acids, and on cristae mitochondria carrying over of electrons, phospholipid mitochondria and formation ATF is carried out. Formed in mitochondria and, partially, in hialoplazm ATF is the unique form of the energy used by a cage for performance of various processes.

Endoplasm network

The Endoplasm network in different cages can be presented in shape tanks, canals or separate vesicular. The wall of these formations consists from bilipid membrane and some fibers included in it and delimits internal endoplasm environment of a network from hialoplasm.

Two versions endoplasm distinguish networks: **granular (granular or rough), not granular or smooth.**

Picture-7. **Granularly reticulum**

On an external surface of membranes granular endoplasm networks contain the attached ribosomes. In cytoplasm there can be both versions endoplasm networks, but one form usually prevails, as causes the functional

Specificity of a cage.

It is necessary to remember, that the named two versions are not independent forms of an endoplasm network as it is possible to track transition of the granular

Endoplasm network in smooth and on the contrary.

Functions of a granular endoplasm network:

-Synthesis of the fibers intended for deducing from a cage ("for export");

-Branch (segregation) the synthesized product from hialoplazma;

-Condensation and updating of the synthesized fiber;

-Transport of the synthesized products in tanks of a lamellar complex or it is direct from a cage;

-Synthesis bilipidmembranes.

The smooth endoplasmnetwork is presented by tanks, wider channels and separate vesicular on which external surface there are no ribosomes.

Functions of a smooth endoplasm network:

-Participation in synthesis glycogens;

-Synthesis lipids;

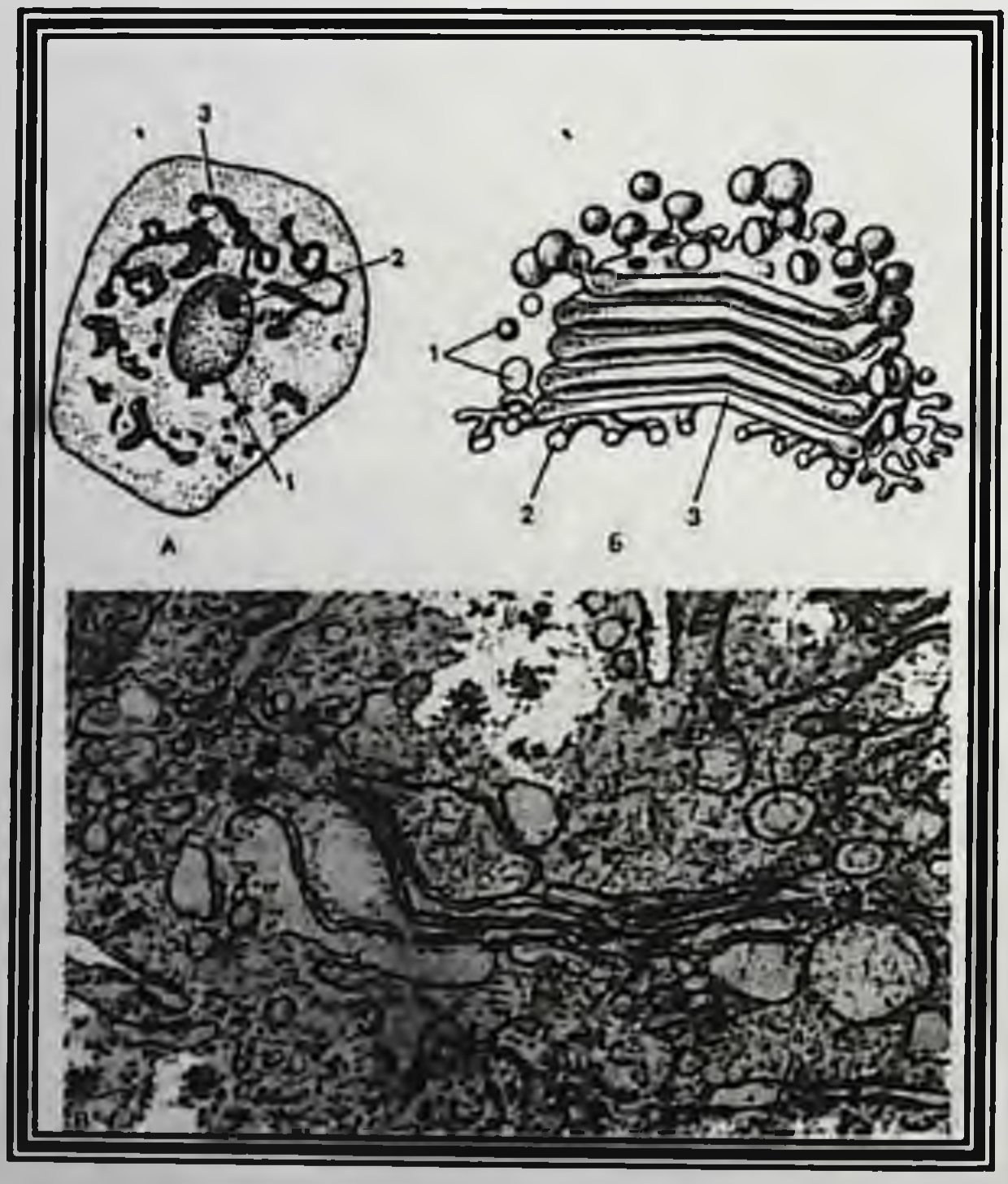
-deintoxication function

-Neutralisation of toxic substances, by means of their connection with other substances.

Lamellar complex Golgi

LCG for the first time it is described Kamillo Golgi (the mesh device) and it is presented by a congestion tanks and small vesicles, limited bilipid membrane. The lamellar complex is subdivided on dictiosoms. Everyone dictiosom represents a pile tanks on which periphery small vials are localized. Thus, in everyone to the tank the peripheral part is a little expanded, and central is narrowed.

In dictiosoma distinguish two poles: the tsis-pole - is directed by the basis to a kernel; the trans-pole - is directed towards a cytolemma.



Picture-8. **CG forms. Functions of a lamellar Complex**

It is established, that the products bearing in a lamellar complex synthesized in a granular endoplasm network approach to a tsis-pole transport vacuoles.

From a trans-pole disconnect the vials bearing a secret to plazmolemma for its deducing from a cage. However the part of the small vials filled with fibers-enzymes, remains in cytoplasm and carries the name lysosomes.

-Transport - deduces from a cage

The products synthesized in it;

-Condensation and updating of the substances synthesized in a granular endoplasm network;

-Formation of lysosomes (together with a granular endoplasm network);

-Participation in an exchange of carbohydrates;

-Synthesis of the molecules forming glycocalyx cytolemmas;

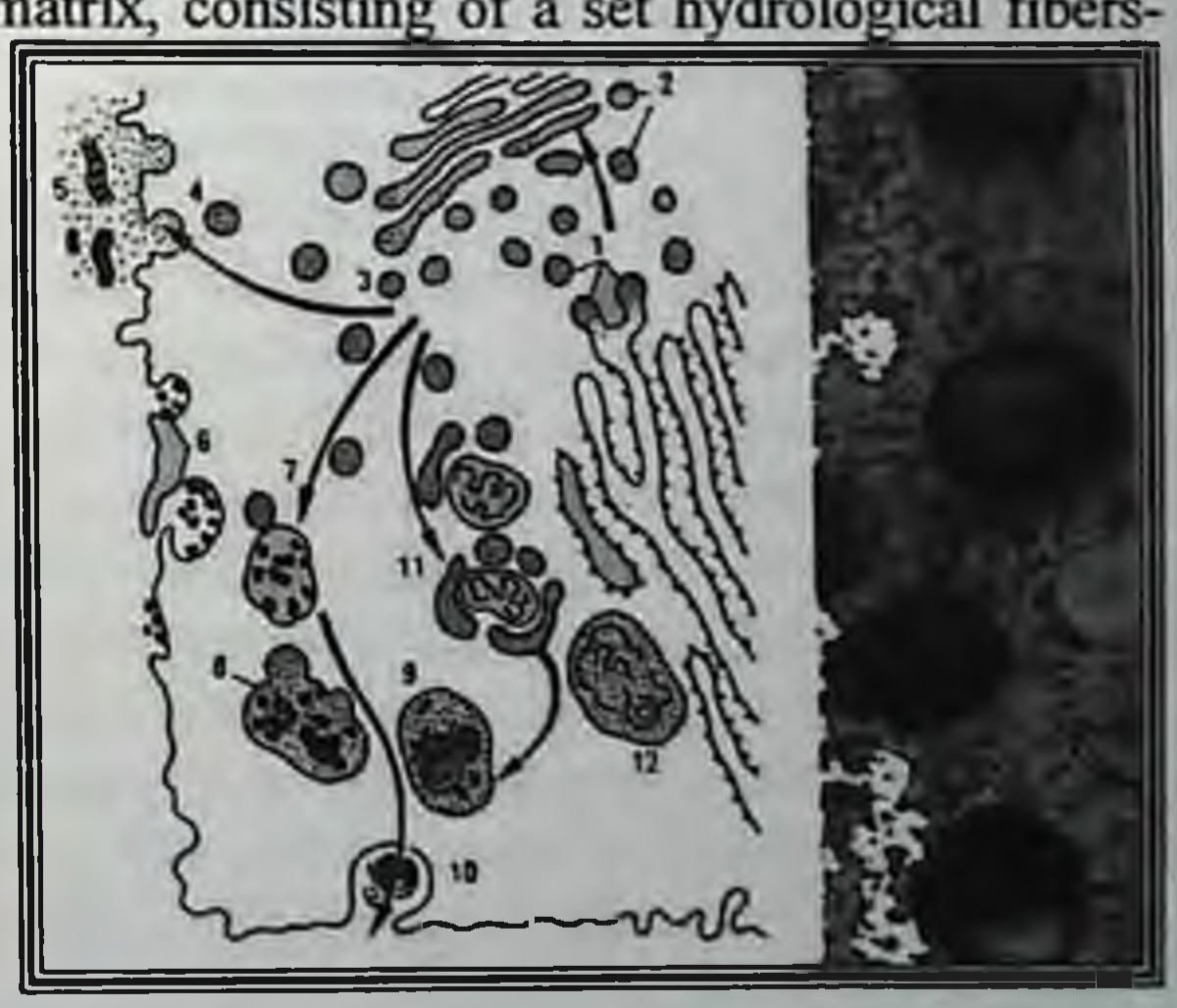
-Synthesis, accumulation and deducing mucin(slime);

-Updating of the membranessynthesized in an endoplasm networkand their transformationinto membranes of a plazmolemma.

Among numerous functions of a lamellar complex on the first place put transport function. For this reason it quite often name the transport device of a cage.

Lysosomes

Lysosomes the smallest organelles of cytoplazma (0,2-0,4 microns) and consequently opened (de Duv, 1949) only with use of an electronic microscope. Represent the little organs limited lipid to a membrane and containing electron-thick matrix, consisting of a set hydrological fibers-enzymes (50 hydrolases), capable to split any polymeric connections (fibers, lipids, carbohydrates and their complexes) on monomeasured fragments.



Picture-9. 2-3-firstable lysosome. 4-5-coming, substances, 7- geterophag 8-lizosoms, 9-secondary, 10-tertiary.

Marker's enzyme of lysosome is sour phosphatase. Function oflysosome - maintenance of endocellular digestion, that is splitting both exogenous, and endogen substances.

Classification of lysosome:

-Primary lysosome

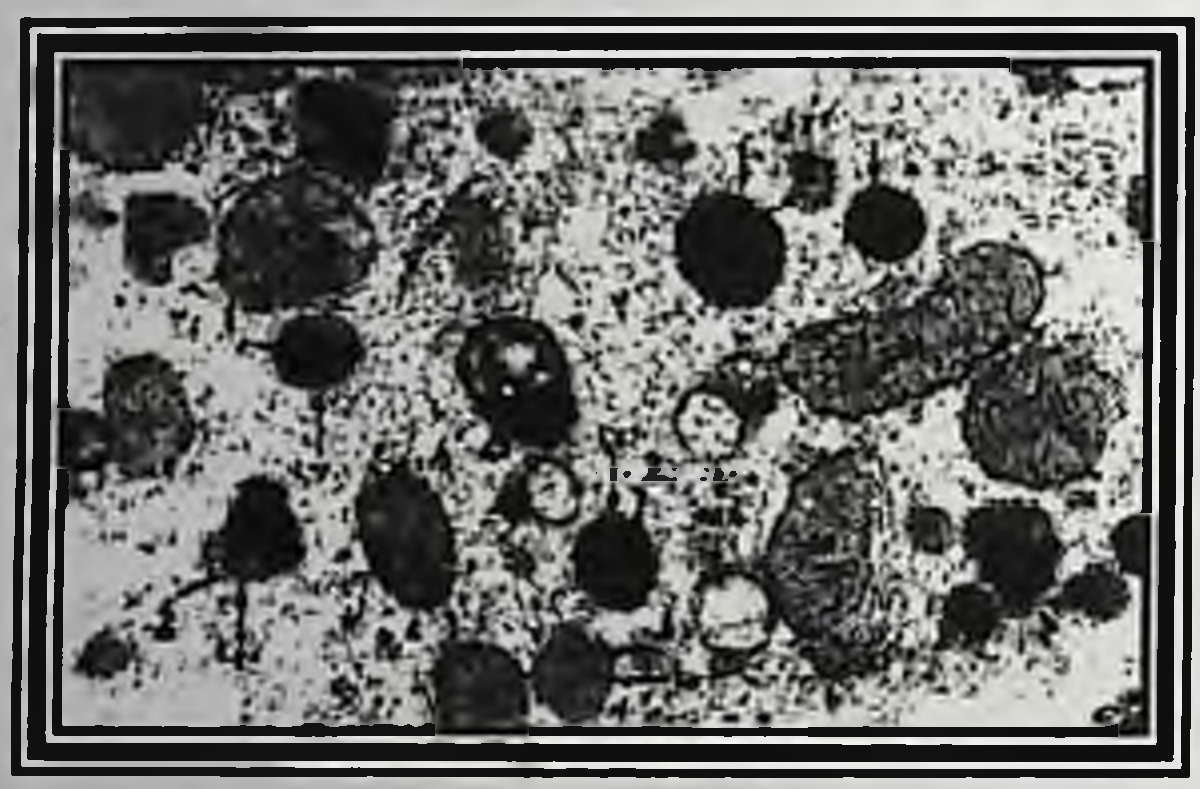
- electron-thick little bodies;

-Secondary lysosome

-phagolysosome, including autophagolysosome;-tertiary lysosome or residual little bodies.True lysosomes are small electron-thickthe little bodies formed in a lamellar complex.

Digestive function of lysosome begins only after merge of a lysosome with phagosome, that is the phagocyte substance surrounded with a bilipids membrane. The uniform vial –phagolysosome in which mixes up phagocyte a material and lysosome enzymes is thus formed. After that splitting (rice-9, 10) begins.

(Hydrolysis) of biopolymeric connections phagocyte a material on monomeasured molecules (amino acids, monosugar and so on).



Picture-10. **A cage fragment: the primary** (1) and secondary (2) lysosome

These molecules freely get through a membrane of phago lysosome in a hialoplazma and then are utilized by a cage, that is used either for formation of energy or on construction of biopolymeric structures. But not always phagocyte substances are split completely.

The further destiny of the remained substances can be various

Some of them can be deduced from a cage by means of exocytosis, on the mechanism, the return phagocytosis. Some substances (first of all the lipid nature) are not split lysosome hydromanholes, and collect and condensed in a phagolysosome (picture-10).

Such formations are called as third lysosome or residual little bodies (picture-10).

In process phagocytosis and exocytosis regulation of membranes in a cage is carried out: in process phagocytosis the plazmolemma part disconnect also forms a phagosome cover, in process exocytosis this cover is again built in a plazmolemma. It is established, that some cages within an hour completely restore the membrane.

Except the considered mechanism of endocellular splitting of phagocyte exogenous substances, the same way endogen biopolymers - damaged or out-of-date own structural elements of cytoplasm collapse. In the beginning such organelles or the whole sites of cytoplasm are surrounded with a bilipids membrane and the vacuoles an autofagolysosome in which it is carried out hydrolit splitting of biopolymeric substances, as well as in a fagolysosome is formed.

It is necessary to notice, that all cages contain in lysosome cytoplasm, but in various quantity. There are specialized cages (macrofag) in which cytoplasm primary and secondary lysosome contain many. Such cages carry out protective functions in fabrics and are called as cages-cleaners, as they special on absorptionof the big number of exogenous particles (bacteria, viruses), and also broken up own fabrics.

Peroxisoma

Peroksisoms - Cytoplasm microlittle bodies (0,1-1,5 microns), similar on a structure with lysosome, however differ from them that in them matrix contain crystal structures, and among fibers-enzymes destroying peroxide of the hydrogen, formed contains catalase, at oxidation of amino acids.

2.5. Structure and functions not membrane organelles

Ribosome's - the device of synthesis of fiber and polypeptide molecules. On localization are subdivided on:

-Free (are in a hialoplazma);

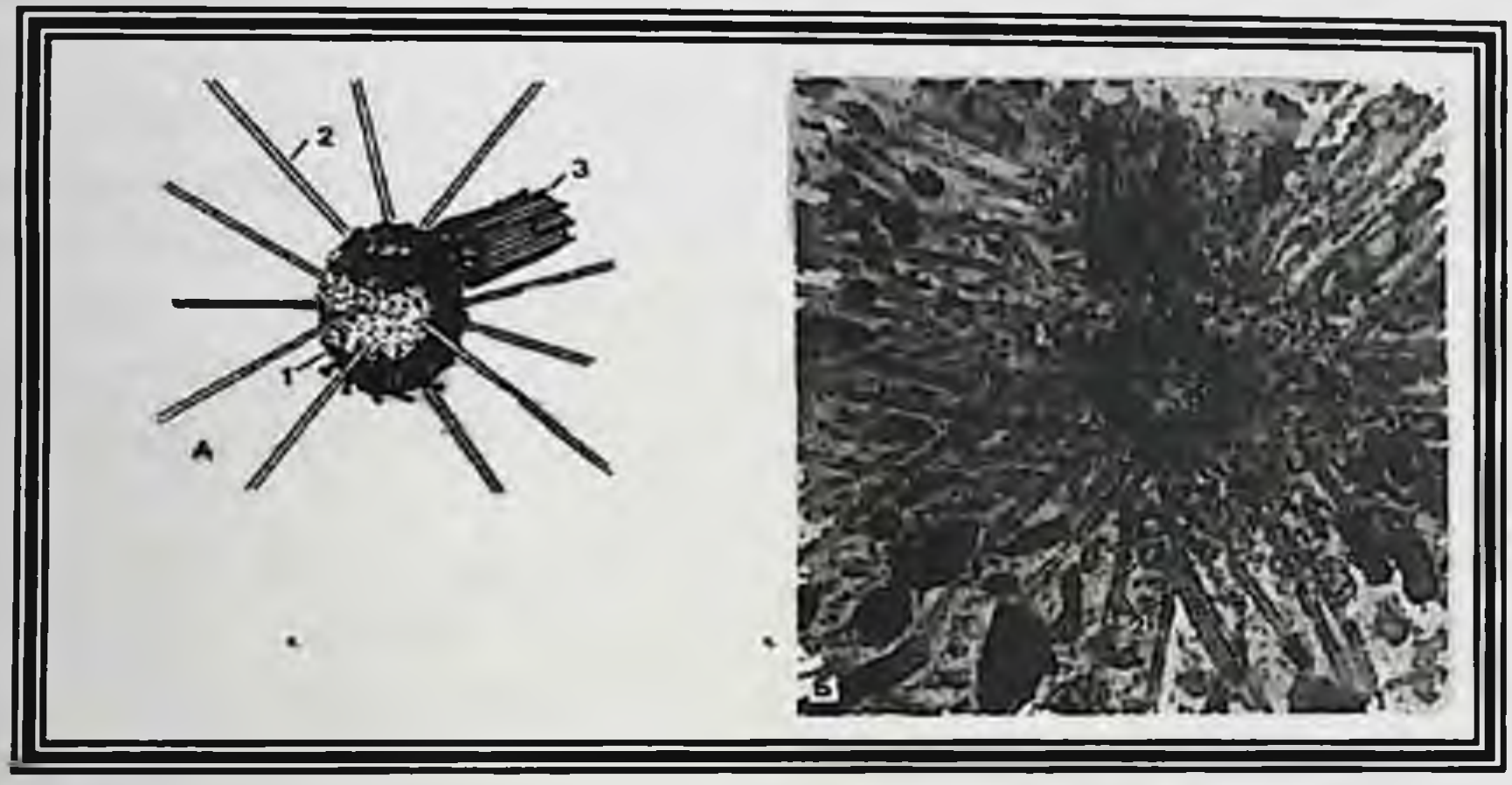
-Not free or attached (are connected with membranes of an endoplazma network).

Each ribosome consists from small and big subunits. Everyone subunit ribosomes consists from ribosomal RNA and the squirrel ribonucleoproteid which are formed in a kernel. Assemblage subunits in a uniform ribosome is carried out in cytoplasm. For fiber synthesis separate ribosomes by means of matrix or information RNA unite in chains of ribosomes - polycatfishes. The free and attached ribosomes, besides difference in their localisation, differ certain functional specificity: free

ribosomes synthesise fibers for internal needs of a cage (fibers-enzymes, structural fibers), attached synthesise fibers "for export".

The cellular center - the cytocenter, centrosome, centriole. In not sharing cage the cellular center consists of two basic structural components: diplosoma, centrospheres.

The diplosoma consists of two centrioles - parent and affiliated, located under direct corners to each other. Everyone centriole consists of the microtubules forming structure in the form of the hollow cylinder (diameter 0,2 microns, length 0,3-0,5 microns). Microtubules by means of "handles" unite in triplets.



Picture-11. **The cellular center**

(On three tubules), forming 9 triplets. A centrosphere - an unstructured site of a hialoplazma round a diplosoma from which microtubules (radiant sphere) (Picture-11) radially depart

Cytocenter functions:

-Formation of a spindle of division in a mitosis prophase;

-Position centrioles in some epithelium a cage is predetermined their polar differentiation;

-Participation in formation of microtubules of a cellular skeleton;

-In lashly epithelium cages centriole are basic bodies lashes.

Microtubules - hollow cylinders (external diameter - 24 nanometers, internal - 15 nanometers), are independent organelles, forming a cytoskeleton, or are a part of other organelles (centrioles, lashes). The microtubule wall consists from globular the squirrel tubulin which consists of separate roundish formations - globular, diameter 5 nanometers.

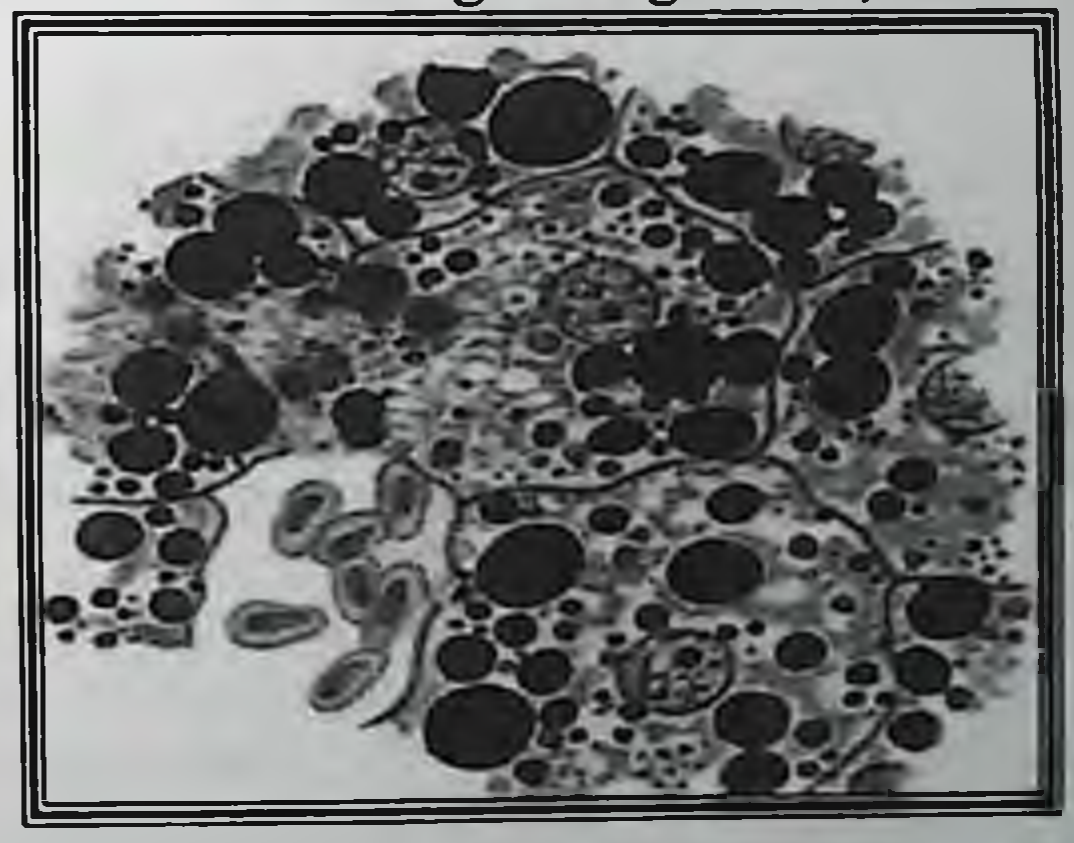
Such globules can be in a hialoplazma in a free condition or, under the influence of certain factors, to incorporate among themselves and to form microtubules, and then again to break up. So are formed, and then microtubules of a spindle of division in different phases of a mitosis break up. However, in structure centrioles, lashesand microtubules are steady formations. The most part of microtubules participates in formation of an endocellular skeleton which supports the cage form, causes certain position of organelles in cytoplasm, and also predetermines a direction of endocellular moving. Fibers tubulin do not possess ability to reduction and consequently also microtubules are not reduced. However in structure lashes there is an interaction between microtubules and their sliding rather each other, as provides movement lashes.

Microfibrills or intermediate filaments, represent thin (10 nanometers) non-branch threads localized mainly in cortical a layer of cytoplasm. They consist of fiber, but a miscellaneous in different cages (in epithelium cages keratin, in fibroblast vimentin, in muscular cages desmin and others). The functional role microfibrills consists in participation, along with microtubules, in formation of a cellular skeleton, carrying out basic function. In some cages (epidermocytes skin) microfibrills unite in bunches and form tonofibrills which are considered as the special organelles which are carrying out a basic role.

Microfilaments even more thin for thread structures (5-7 nanometers), consisting from contractility fibers (actin, miozin, tropomiozin), unequal in different cages. Are localized mainly in cortical a cytoplasm layer.

In aggregate microfilaments make contractility the device of a cage providing various kinds of movements: moving of organelles; a hialoplazma current;

Change of a cellular surface; formation psevdopodobiy and cage moving. The congestion microfillaments in muscular fibres forms special organellas – miofibrills.



Picture-12. **Fatty inclusions**

2.6. Inclusions

Inclusions - changeable structural components of cytoplasm

Classification of inclusions:

-Trophic: lecithin in eggcytos, the glikogen, lipids,

(Picture-12) are available almost in all cages,

-Secretory: (granules in secrets granule cages-zimogen in acinoz pancreas cages, secret granules in incretorius cages and others;

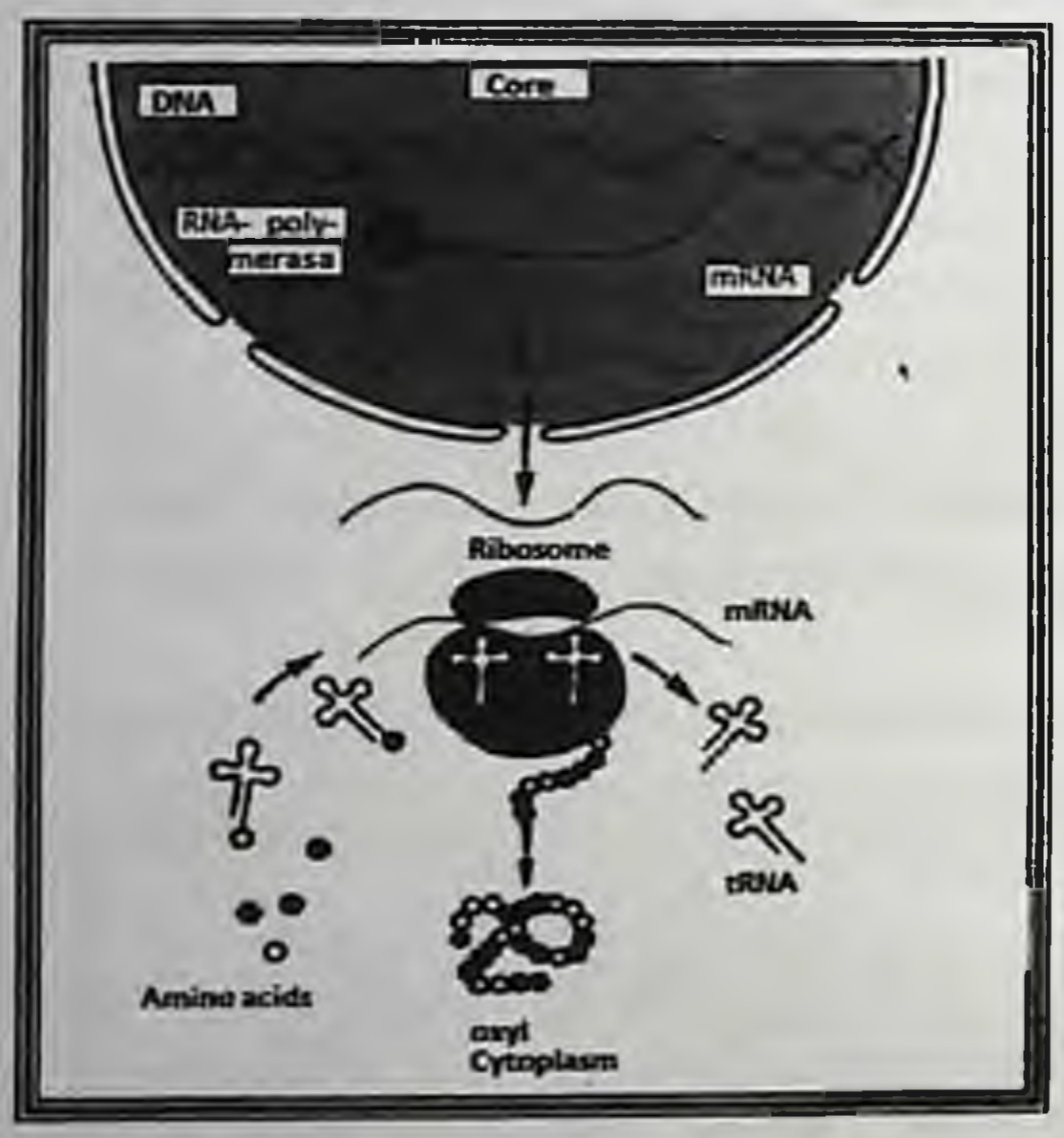
-Excretory: the substances which are subject to removal from organism (for example, granules of uric acid in epithelium nephritic canals);

-Pigmentary: melanin, hemoglobin; lipofuscin; bilirubin and others.

In the course of ability to live in some cages casual inclusions collect:

-Medicamentous, parts of coal, silicon and so on. These inclusions have certain colour and give colouring to all cage (melanin - black or brown, haemoglobin - yellow-red and so on). It is necessary to notice, that pigmentary inclusions are characteristic only for certain types of cages (melanin contains in melanocytos, haemoglobin - in eritrocytos). However, lipofuscin can collect in many types of cages usually at their ageing.

Its presence in cages testifies to their ageing and functional inferiority.



Picture-13. **The given scheme specifies in a kernel role in fiber synthesis**

2.7. Kernel. Reproduction cells

Function of cages:regulation of protein synthesis and the transmission of hereditary characteristics.In overwhelming majority of cages one kernel contains, but there are two-nuclear and even multinuclear cages. The kernel form in the majority of cages round (spherical) or

oval. In some cages of a kernel have extended form. In granular leukocytes the kernel is subdivided into segments (segmentonucleus leukocytes). The kernel usually in the cage center is localized, but in cages of epphthelium fabrics of a kernel are quite often shifted to a basal pole. Kernel function is regulation synthesis of fiber and transfer of hereditary signs

Structural elements interphase kernels

In the period of cell division (mitosis or during the period of meiosis) some structural elements disappear, others significantly transformed. structural elements are the interphase nucleus chromatin, nucleolus, and karyoplasm kariolemma-hromatin, a nucleus, karioplazma, kariolemma.

Hromatin represents the substance well perceiving dye (hromos), whence there was its name. Hromatin consists from hromatin's fibril, in the thickness of 20-25 nanometers which can settle down in a kernel or it is compact. On this basis distinguish two kinds of hromatin:

-euhromatin - friable or

Decondensationly hromatin, it is poorly painted by the basic dyes;

-geterohromatin - compact or condensed hromatin, it is well painted by the same dyes.

By preparation of a cage for division in a kernel occurs spiral hromatin's fibrils and transformation hromatin in chromosomes. After division in kernels of daughter cells occurs despiral hromatin's fibril and chromosomes again will be transformed in hromatin. Hence, hromatin and chromosomes represent various phases of the same substance.

On a chemical structure hromatin consists from:

-Deoxyribonucleic acid (DNA) of 40 %;

-Fibers about 60 %;

-Ribonucleic acids (RNA) of 1 %.

Nuclear fibers are presented by forms:

-Alkaline or giston fibers of 80-85 %;

-Sour fibers of 15-20 %

Histone fibers are connected with DNA and form polymeric chains (DNP) which represent chromatin fibril, clearly visible at electronic microscopy. On certain sites chromatin fibril the transcription from DNA of various RNAs with which help it is carried out is carried out then synthesis of albuminous molecules (pic-13) transcription Processes in a kernel are carried out only on free chromosomal fibril, that is in euchromatin. In condensed hromatin these processes are not carried

out and consequently geterohromatin is inactive hromatin. The parity euchromatin and geterohromatina in a kernel is an indicator of activity of synthetic processes in the given cage. On hromatin fibrills in the S-period interfaze it is carried out also processes reduplication DNA. These processes occur both in euhromatin, and in geterohromatine, but in geterohromatine they proceed much later.

Endosome - spherical formation (1-5 microns in diameter) well perceiving the basic dyes and settling down among hromatin. In one kernel can contain from 1 to 4 and even more kernels. In young and often sharing cages the size of kernels and their quantity are increased. The kernel is not independent structure. It is formed only in interphase in certain sites of some chromosomes - nucleus organizers in whom the genes coding a molecule contain ribosomes the RNA. In area nucleus the analyzer the transcription from DNA ribosomes the RNA is carried out.

In Endosome there is a connection ribosomes the RNA to fiber and formation of subunits of ribosomes.

Microscope in a kernel distinguish:

- the fibril component - is localized in the central part of a kernel and represents threads ribonucleoproteid (RNP);

-granular a component - localized peripheral part of a kernel also represents a congestion of subunits of ribosomes.

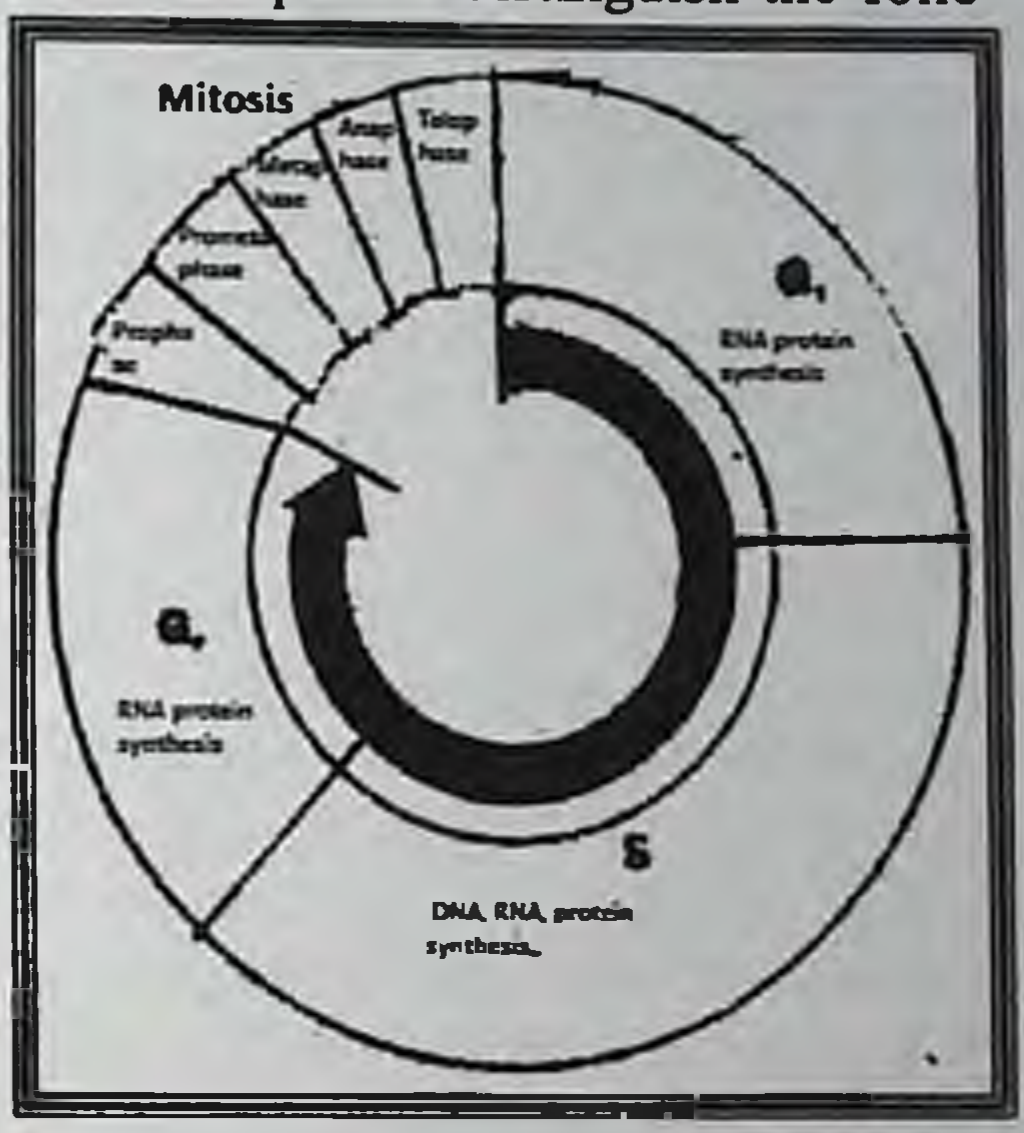
In a mitosis prophase when occurs spiral hromatin fibrills and formation of chromosomes, processes of a transcription of the RNA and synthesis of subunits of ribosomes stop also a kernel disappears. Upon termination of a mitosis in kernels of again formed cages occurs decondesation chromosomes and there is a kernel.

Carioplazma (nucleoplazma) or nuclear juice consists of water, fibers and albuminous complexes (nucleoproteids, glicoproteids), amino acids, sugars. Under a light microscope carioplazma antistructure, but at electronic microscopy in it granules (15 nanometers), consisting of ribonucleoproteids are defined. Fibers carioplazma are basically fibers-enzymes, including enzymes, glicoliz, carbohydrates carrying out splitting and formation ATF. Non-histone (sour) fibers form in a kernel a structural network (the nuclear Albuminous matrix) which together with a nuclear cover takes part in creation of an internal order, first of all in certain localization hromatin.With the participation of carioplazma metabolism in the nucleus, the nucleus and cytoplasm interaction.

2.8. Cage life cycle

Cellular, or vital, the cage cycle is time of existence of a cage from division before following division, or from division to death. For different types of cages the cellular cycle is distinguished.

In an organism of mammals and the person distinguish the following three groups of cages.



Localized in the different
Fabrics and organs:
-Is frequent sharing cages
(undifferentiated)
Cages epithelium intestines,
basal cages epidermisa
And others);
-Is rare sharing cages
(Liver cages - gelatocytes);
-Not sharing cages
(Nervous cages the central nervous · systems, melanosites and others).

Life cycle at these
Cellular types it is distinguished.
Life cycle at often shari
Cages are time of their existence a cage Cycle
From the beginning of division to the following divisions. Life cycle of the such cages quite often name mitosis a cycle. Such cellular cycle is subdivided into two basic periods:

-Mitosis or the division period;
-Interphase- an interval of a life of a cage between two divisions.

Reproduction of cages

Distinguish two basic ways of reproduction of cages:

-Mitosis - indirect cell fission which is inherent basically in somatic cages;

-Meiosis or reduction division - is characteristic only for sexual cages.

In the literature quite often describe the third way of cell fission - amitotic division or direct cell fission which is carried out by means of

necking kernels and cytoplasms, with formation of two daughter cells or one two-nuclear. However now it considered to be, that the direct way of division is characteristic only for old and degenerating cages and is reflexion of pathology of a cage. The fourth type of a reproduction of a cage

- Endoreprodustion is possible, is characterized by increase in volume of a cage, increase quantity of DNA in chromosomes, the quantity of functional organellas increases. The cage is hypertrophied, but in increase in number of cages endoreproduction does not result, and functional activity of cages only raises. It observed in liver cages - hepatocytes, in epitheliuma bladder.

Two basic periods noted above in life cycle of often sharing cages (a mitosis and interphase) are in turn subdivided into phases or the periods.

The mitosis is subdivided into 4 phases and in each phase there are certain structural transformations

1. Prophase is characterised by morphological changes of a kernel and cytoplasm. In a kernel occurs: condensation hromatin and formation of the chromosomes consisting from two hromatides, kernel disappearance, disintegration cariolemmas on separate vials. In cytoplasm formation from microtubules of a spindle of division, a reproduction granular is marked reduplication (doubling) of centriols and their divergence to opposite poles of a cage Endoplasm network, and also reduction of number of the free and attached ribosomes.

2. In metaphase there is a formation of a metaphase plate, or a parent star, incomplete isolation sisterly hromatides from each other.

3. Anaphase is characterized by full isolation (divergence) hromatides and formation of two equivalent diploid sets of chromosomes, a divergence of chromosomal complements to poles mitozly spindles and a divergence of poles.

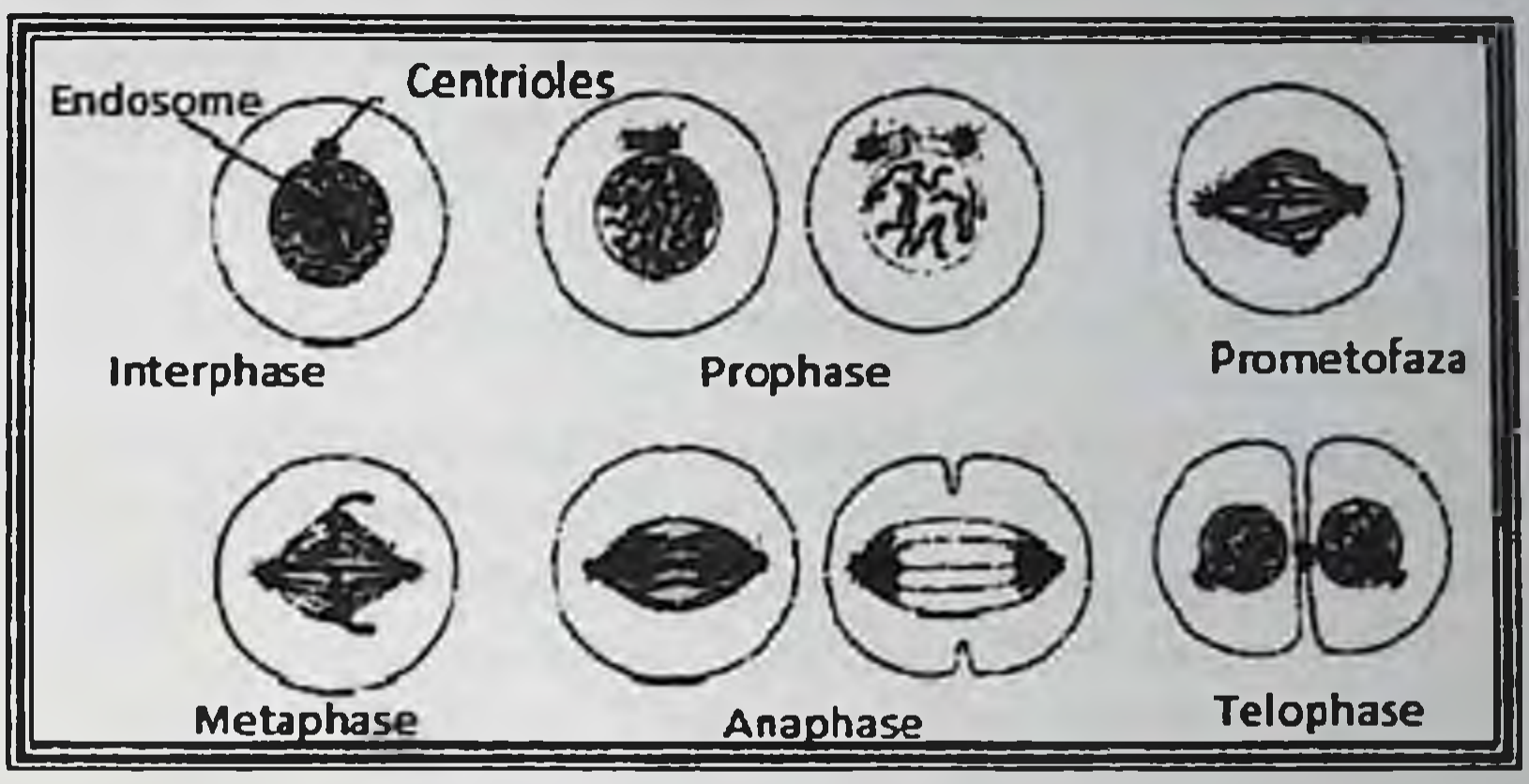
4. Telophase is characterized decondensation chromosomes of each chromosomal complement, formation from vials of a nuclear cover, cytotom - a reheavy two-nuclear cage on two affiliated independent cages, kernel occurrence in kernels of daughter cells.

Interphase divided into 3 periods:

-J1, or pre-synthetic;

-S, or synthetic;

-J2, or postsynthetic.



Features of the periods of a mitosis

Each period of mitosis is characterized first of all by some functional features. In J1 (pre-synthetic) the period occurs:

The-strengthened formation of the synthetic device of a cage - increase in number of ribosomes, and also quantities of various kinds of the RNA (information, ribosomes, transport);

-Strengthening of synthesis of the fibers necessary for growth of a cage;

-Preparation of a cage for the synthetic period - synthesis of the enzymes necessary for formation of new molecules of DNA.

For the S-period doubling (reduplication) DNA that leads to doubling ploid diploid kernels is characteristic and is an obligatory condition for the subsequent mitozly cage divisions.

The J2-period (postsynthetic, or pre-mitosis) is characterized by the strengthened synthesis of the information RNA, and also the strengthened synthesis of all cellular fibers, but especially the fibers-tubulinov necessary for subsequent (in a mitosis prophase) formations mitozly division spindles. The described laws of life cycle are characteristic first of all for often sharing cages.

However cages of some fabrics (for example, cages of a hepatic fabric - gelatocytes), after an exit from a mitosis, enter the so-called J0-period during which time they carry out the numerous functions for many years, not entering in the S-period. However under certain circumstances (at defeat or removal of a part of a liver) they enter a normal cellular cycle, that is during the S-period, synthesise DNA, and then mitosis share.

Such cages concern seldom sharing cages and their life cycle is subdivided on:

-Mitosis;

The-J0-period;

The-S-period;

The-J2-period.

The majority of cages of a nervous fabric, especially neurocytos the central nervous system, after an exit from mitosis still in embrion the period, further do not share. Life cycle of such not sharing cages consists of following periods:

-Mitosis;

-Growth;

-Long functioning;

-Ageing and death.

However throughout long life cycle such cages constantly recycle on endocellular type: the albuminous and lipid molecules entering into various structural components of cages, are gradually replaced new and consequently such cages are gradually updated. At the same time throughout life cycle in cytoplasm of not sharing cages various, first of all lipid inclusions, in particular lipofuscin which is considered as an ageing pigment gradually collect.

Except the considered two basic ways of reproduction (reproduction) of cages distinguish even the third way - endoreproduction which though does not lead to increase in number of cages, however leads to increase in number of working structures and increase in functional ability of a cage. For this reason it also is called endoreproduction. This way is characterised by that after a mitosis neogenic cages enter as usually the J1-period, then and during the S-period. However after DNA doubling such cages do not enter the J2-period and in a mitosis. As a result the quantity of DNA appears twice increased 4н, 4с and such cages are called poliploid. Poliploid cages can enter again the S-period and again increase the poliploid (8н, 8с; 16н, 16с and so on). In poliploid cages the size of a kernel and cytoplasm increases, that is such cages are hypertrophied. Some poliploid cages after reduplication DNA enter a mitosis, however it does not come to an end cytotom and such cages become two-nuclear. Thus, at endoreproduction increases in number of cages do not occur, but the quantity of DNA, number of organellas and consequently functional ability poliploid cages increases also increases. Ability to endoreproduction all cages possess not. Most

typical endoreproduction for hepatic cages, especially with age increase (in an old age of 80 % gelatocytes at the person are poliploid), and also for acinoz pancreas cages, epitel a bladder.

2.9. Cell response to the external environment

The described morphology of cages is not stable (constant). At influence on an organism of various adverse factors in a structure of various structures various changes are shown. Depending on factors of influence of change of cellular structures are shown unequally in cages of different organs and fabrics. Thus changes of cellular structures can be adaptive (adaptive) and reversible, or dezadaptiv, irreversible (pathological). However to define an accurate side between adaptive and dezadaptiv changes not always probably as adaptive changes can pass in the pathological. As object of studying of histology are cages, fabrics and organs of a healthy human organ here will be considered, first of all, adaptive changes of cellular structures.

Changes are marked as in a cytoplasm and kernel structure.

Changes in cytoplasm:

-Consolidation, and then swelling;

-degranulation a granular endoplazma network and then and a fragmentation canalis on separate vacuols;

-Expansion of tanks, and then disintegration on a vacuol of a lamellar complex Goldji;

-Swelling of lysosomes and activation their hydromanhole;

Number-increase autophagosomes ;

In the course of a mitosis - disintegration of a spindle of division and development of pathological mitoses.

Cytoplasm changes can be caused structural changes of a plazmolemma that leads to strengthening of its permeability and hialoplazma hydration, metabolism infringement, that is accompanied by decrease in maintenance ATP, decrease in splitting or increase in synthesis of inclusions (a glikogen, lipids) and their superfluous accumulation.

Changes in a kernel:

-Swelling of a kernel and its shift on cage periphery;

-Expansion perinuclear spaces;

-Formation invagination cariolemmas (emboly in a kernel of its cover);

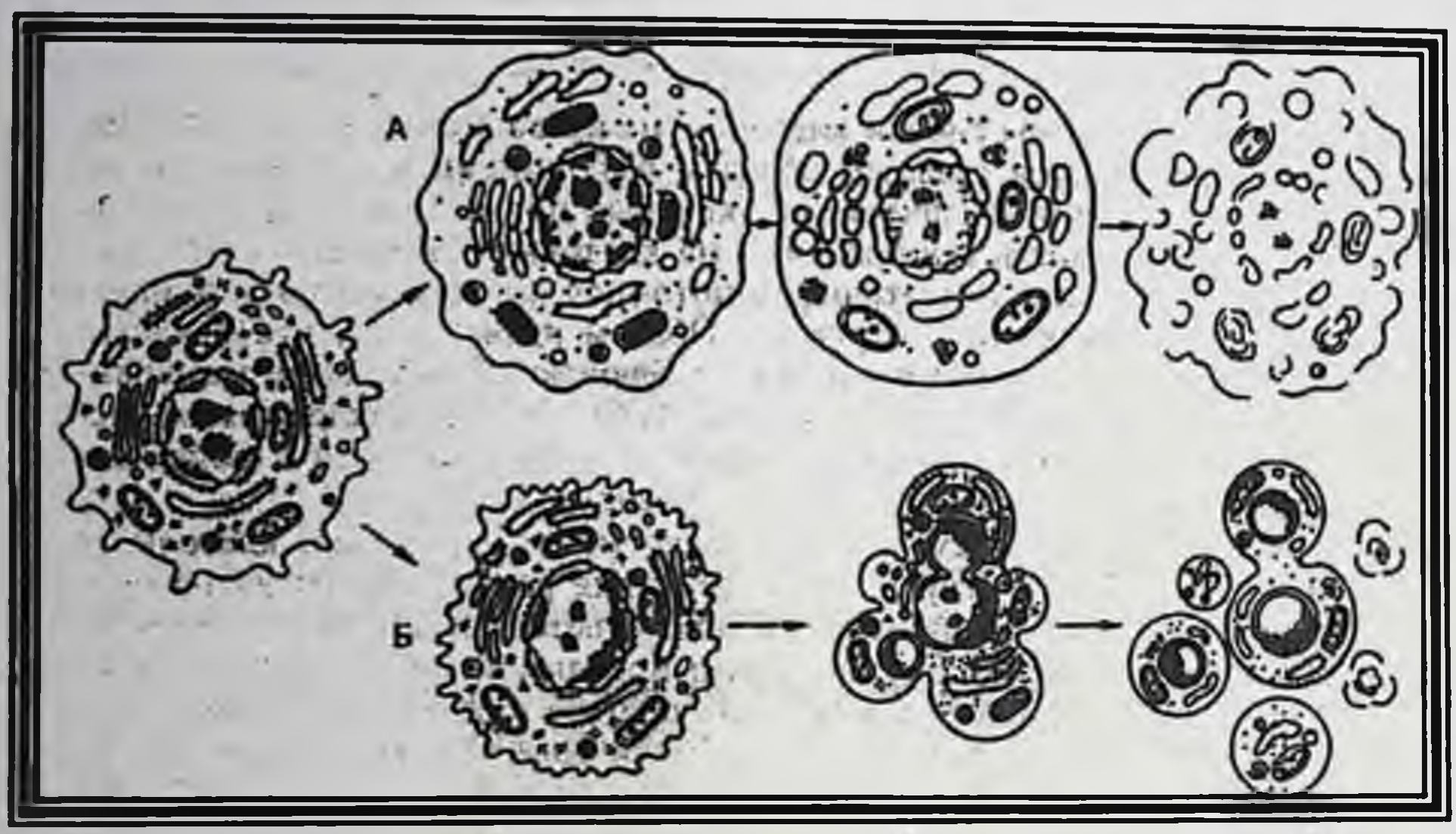
-Condensation hromatin.

To pathological changes of a kernel carry:

-piknoz - corrugation kernels and coagulation (consolidation) hromatin;

-karioreksis - kernel disintegration on fragments;

-kariolizis - kernel dissolution.



Picture-16. **A-Necrosis cages B-Apoptosis cages**

After elimination of adverse influences on an organism jet (adaptive) changes of structures disappear also cage morphology is restored. At development pathological (dezadaptiv) changes even after elimination of adverse influences structural changes accrue also a cage pershes.

Death of a cage. Distinguish natural dies- apopthosis and pathological destruction **necrosis** cages. Necrosis occurs under the influence of various external factors-mechanical, chemical, physical, biological (microbes, viruses, etc.) factors which first of all operate on a plazmolemma, and cause furtherswellingof cellular structures with endingsynthetic processes, there is an activation of lizosomly enzymes and lisys cages.

At apopthosis genes cages responsible for destruction, under the influence of made active ferments breaks the DNA, a fragmentation of a kernel and then cytoplasm become more active, are formed "apoptoz little organs", which fagocyting by macrofags.

2.10. Clinical value

Some illnesses caused by insufficient activity mitochondries are described, and the majority of them is characterised by infringement of function of muscles. Owing to high activity of a power exchange to mithohondries to defects fibres of skeletal muscles are very sensitive. Mutations of DNA or defects which can arise in mithohondries or a cellular kernel cause mithohondries illnesses. Inheritance mitochondries is carried out on a parent line as in zygote cytoplasm mithohondries spermii remain in individual number or disappear. In case of defects of nuclear DNA their inheritance can occur from any of parents or from both parents. Usually at such illnesses mithohondries morphological changes would come to light. Defects of fibers peroxis are the reason of a considerable quantity of diseases as this organella actively participates in several metabolic ways. Possibly, the most widespread period illness is connected with the H-chromosome adrenoleucodistrofic (X-A1_O). It is caused by defect integrated membran the squirrel who participates in transport of fat acids with very long chain in periods for their r-oxidation. Accumulation of these fat acids in organ liquids causes destruction mielin covers in a nervous fabric, causing heavy neurologic semiology. Insufficiency of enzymes peroxis serves as the reason of syndrome of Cellveger which causes death of patients. This syndrome proceeds with heavy damage of muscles, a liver and kidneys and disorganisation central and peri-fericheskoy nervous system. At such patients the electronic microscopy reveals "empty" periods in cages of a liver and kidneys.

6. Some mutations of fibers of a lash and offshoot are described. They are responsible for a syndrome of motionless lashes (syndrome Kartagner) which symptoms include an immovability spermies, man's barreness and the chronic infections of respiratory ways caused by absence of clearing action of lashes in a respiratory path.

. Presence of concrete type of intermediate filaments at tumours can specify in what cages have given rise to a new growth. This information is important for their diagnostics and treatment Identification of fibers of intermediate filamentses by means of immuno-tochemistry methods is standard diagnostic procedure.

The practical part

Compilation of logical structures, the study of drugs, electron diffraction, and view multimedia sketch pintsipe structures in the cytoplasm and nucleus albums

The objects under study:

1. Organelles (in electron diffraction) and inclusion (fat. Pigment) cytoplasm.

2. Kernel (on preparation and electron diffraction).

Sample tests

1. What functions are performed by the granular endoplasmic reticulum?

a) assembly of cell membranes;

b) Protein synthesis for export;

c) synthesis of carbohydrates;

d) transport in the cell to synthesize protein;

e) DNA-synthesis.

2. In what cells are particularly well developed smooth cytoplasmic network?

a) synthesize proteins for the needs of the cell;

b) synthesizing lipids;

c) synthesizing proteins for export;

d) synthesizing carbohydrates.

3. Specify what does the Golgi complex:

a) protein;

b) complex formation of chemical compounds (glycoproteins, lipoproteins);

c) Education of primary lysosomes;

d) Participation in removing from the cell secretory product;

e) Formation hyaloplasm.

4. What structural elements of the cells are most actively involved in exocytosis?

a) tsitolemmy;

b) cytoskeleton;

c) Mitochondria;

d) ribosomes.

5. What are the structural elements are actively involved in the implementation of phagocyte function?

a) Kariolemma;

b) endoplasmic reticulum;

c) tsitolemmy;

d) lysosomes.

6. What are called heterochromatic regions of chromosomes?

a) Annular;
b) Despiralizovannye;
c) branching;
d) preserving spiralization in fissile nucleus;
e) functionally inactive.

7. What euchromatic regions of chromosomes are called?

a) helical;
b) Despiralizovannye;
c) functional inactive;
d) functional activity.

8. What is the significance in the life of the cell nucleus?

a) storage of genetic information;
b) Center of energy storage;
c) Center intracellular metabolism;
d) place education lysosomes;
e) Play and transfer of genetic information to daughter cells.

9. What type of cell division leads to the formation of two cells with equal diploid set of chromosomes?

a) meiosis;
b) Mitosis;
c) endomitosis;
d) polyploidy;
e) amitosis.

10. Structural components of the cytoplasm:

a) organelles;
b) Inclusion;
c) nucleoli;
d) Hyaloplasm;
e) tsitolemmy;
f) Kariolemm.

Approximate refereed report on "Mechanisms of apoptosis" Cellular components and illnesses

CHAPTER III. PRIVATE CYTOLOGY

Secretary, suction, contractile and ciliated cells

I. Goals and Objectives: To study the function and structure of the secretory, suction, transport and immune cells.

II. Questions for self-training.

1. Objects of private study cytology;
2. Sektretornye kletki.Ekzokrinotsity;
3. Secretory cells. Endocrinocytes;
4. Phase secretion;
5. Mucosal and serotsity;
6. Types of secretion;
7. Features of suction cells, their structure;
8. Transportation cells.
9. Immune T cells and B cells.
10. The plasma and macrophage cell contractile cells;
11. Reduction mechanism and the structure of the sarcomere;
12. Factors responsible for the reduction of myocytes.

The theoretical part

The private cytology studies morphological features of a structure and physiology the properties of specialised cells which are carrying out the vital functions of an organism. In an organism many specialised cells form the special organs, some meet in single diffusionly kind. Without specialised cells the organism cannot exist. Specialised cells it is possible to divide into 8 groups:

1. Secret cells
2 Soaking up cells,
3. Transport cells
4. Reduced cells,
5. Impulse forming and impulse spending cells
6. Immune cells.
7. Lashing cells
8. Sexual cells

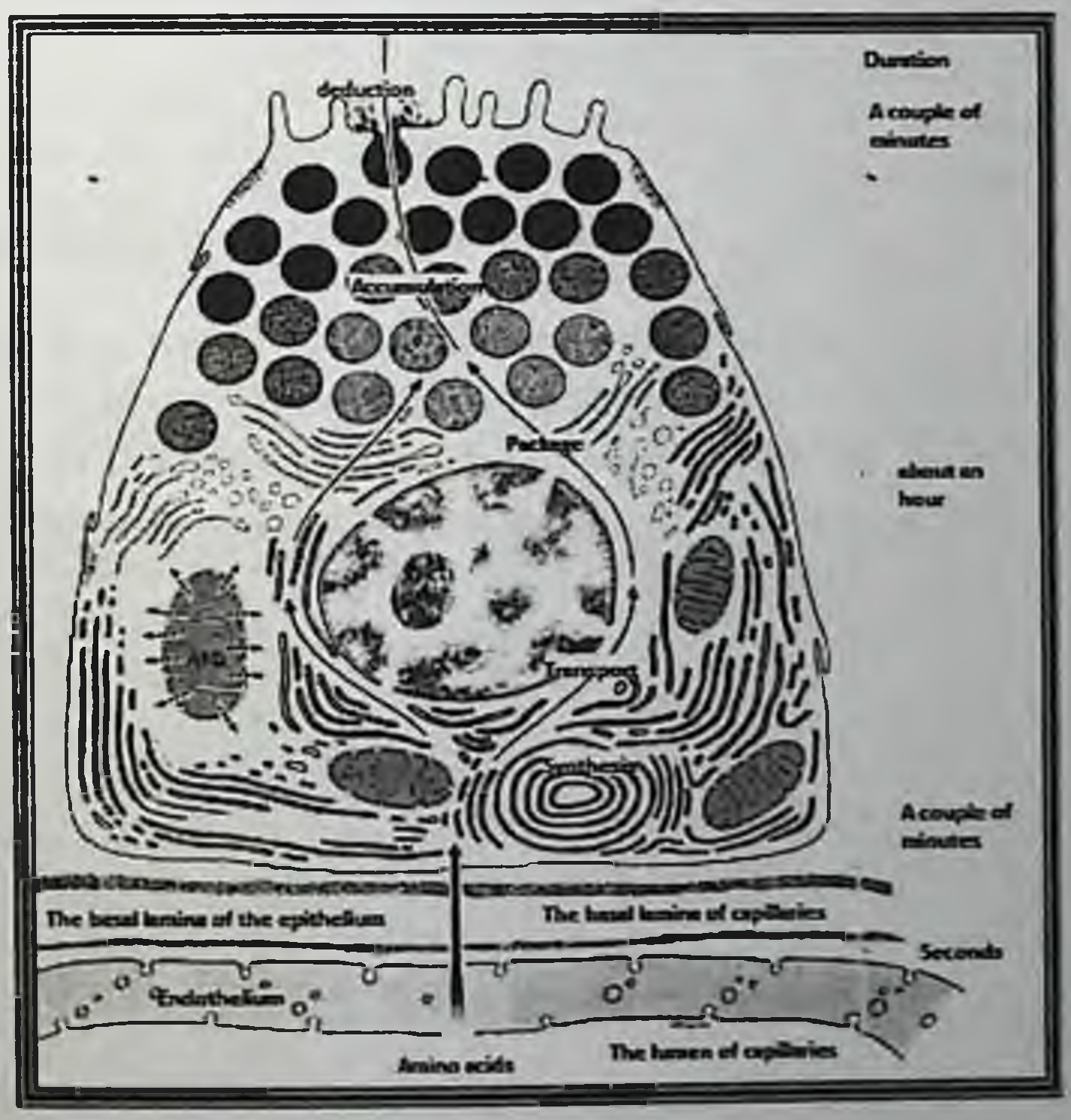
It is necessary to notice, that some functions as secretion, soaking up, reduction, transport can occur and in other cells, but it is them not

the basic function For example, smooth miocytes, cells of channels are capable secreting, and some other cells are capable to reduction, migration, but it is not their specific function.

3.1. Secret cells

General characteristic. Secret cells develop a secret (hormones, enzymes, slime, ions, etc. biological active substances) and are called glandulocytes-sekretor as cells. The general for these cells are: presence in cytoplasm secreting granules and development of the organelles, participating in development of this or that secret.

Depending on a structure and where the secret is allocated, they share on **ekzocrinocytes** and **endocrinocytes.** The secret ekzocrinocytes is allocated outside, or in a cavity (there from in channels), or at once in channels or for a body surface. The secret endocrinocytes is allocated in blood capillaries, either in lymph, or in interstices-surrounding connecting fabric.



Picture-17. **The structure Scheme of a secret cell (pancreas)**

Pay attention to the expressed polarity of a cell in which extensive EPN occupies a basaling part, and a complex Goldjis and zimogening of a granule - apicaling. On the right the scale which specifies in the approximate time necessary for each stage of synthesis and secretion is resulted. Phase absorption of a necessary material

Granulocytes on an arrangement can meet single or form organs which are called as glands.

Ekzocrinocytes. They are on a basaling membrane, have polarity, have various forms, from cylindrical to the roundish form, on apical cytolemma there can be the microfibers (18-pic), different height and the different size, obligatory are presence secreting granules in apical parts of cytoplasm, **a granule of the various size and density depending on a stage a secreting cycle,** sometimes meet klazmatozing structures.

Ekzocrinocytes are classified on single and organoforming.

Process secret a formation-secretor cycle has phase character and consists of several stages:

-Phase formation of a secret,

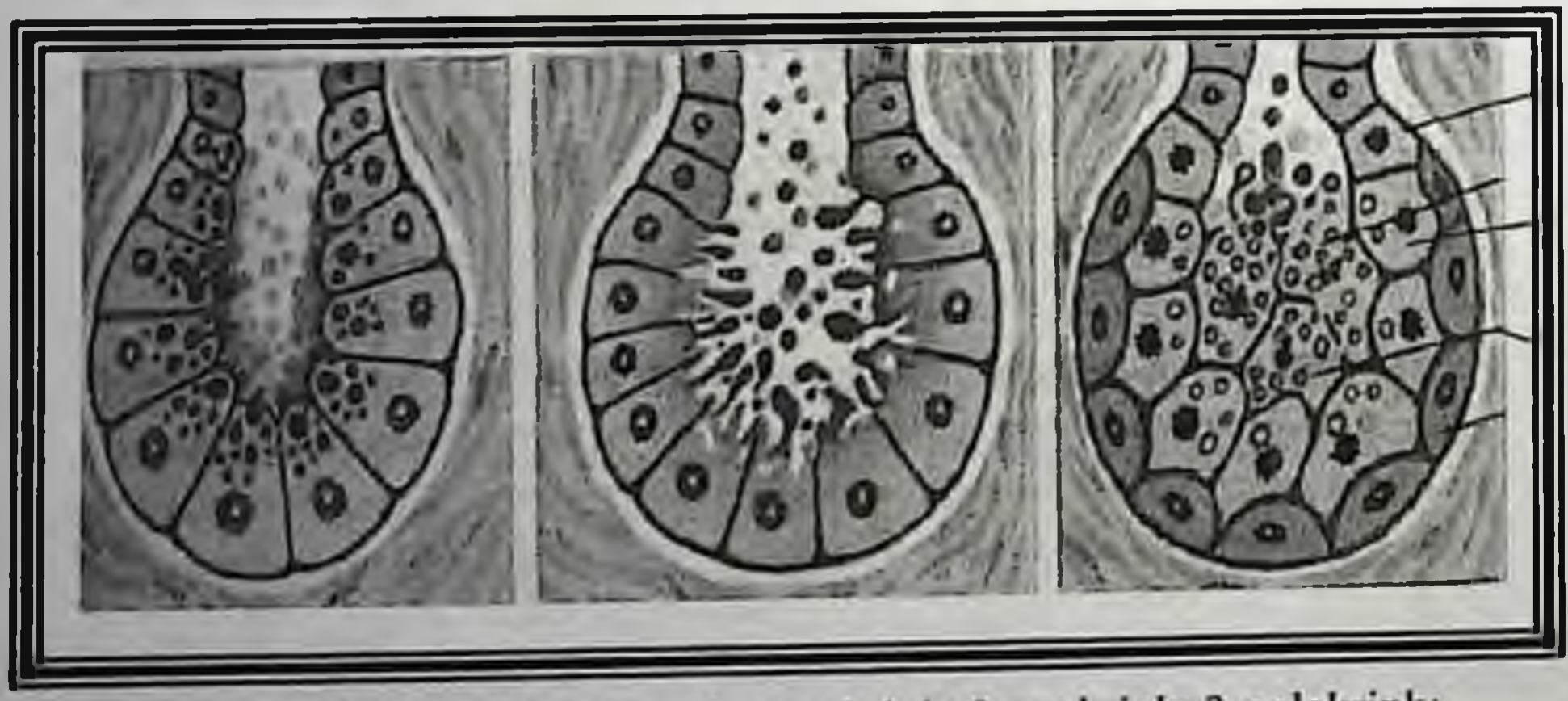
-Phase accumulation of a secret,

-Phase allocation of a secret,

-Phase restoration.

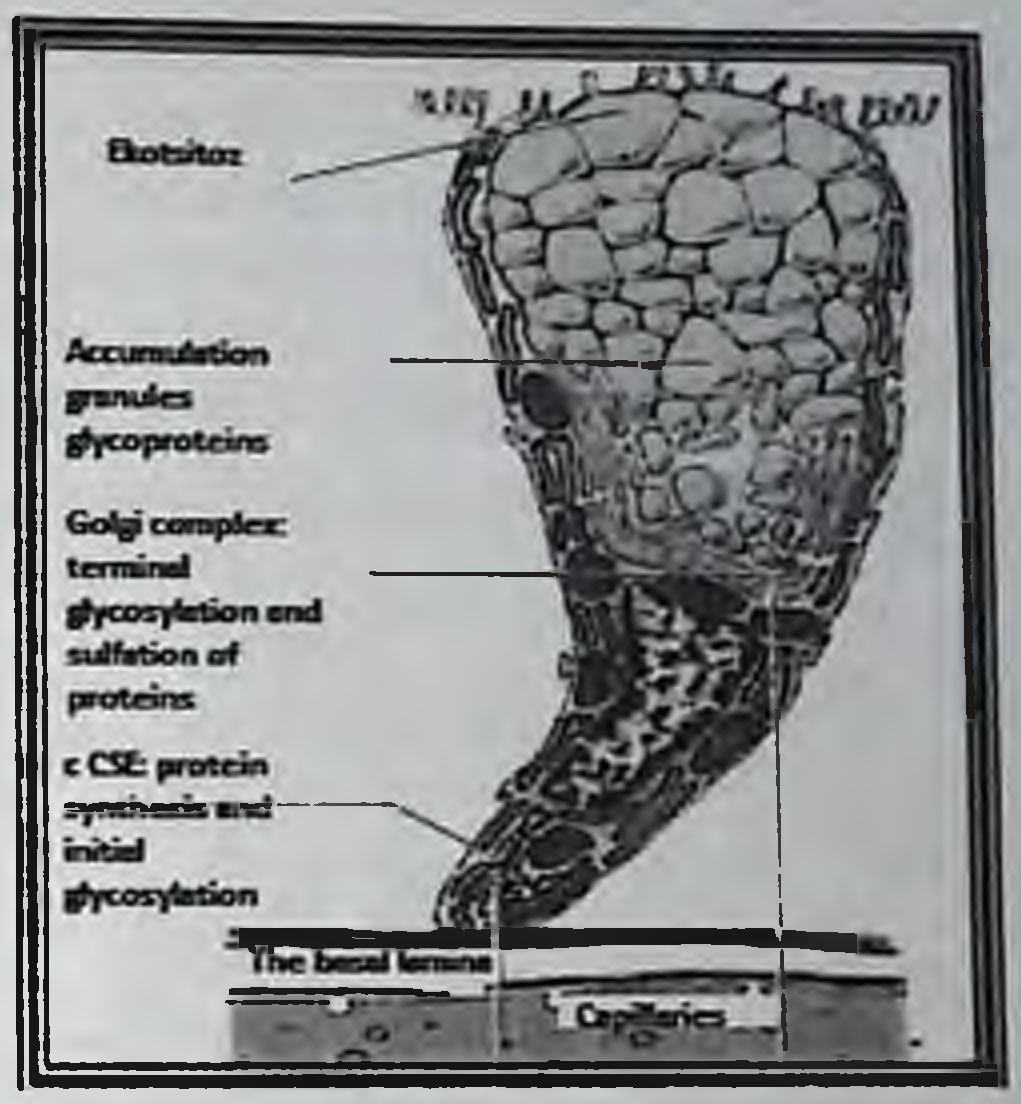
Secreting konveer - it is a chain of the structures participating in a secreting cycle.

Allocation types secret in various cells the different: **merokrinly-without** destroying apicaling cytolemmas, **apokrinly** - with destroying apical cytolemmas, **and full-golokrinly** destroying cells (30-pic).



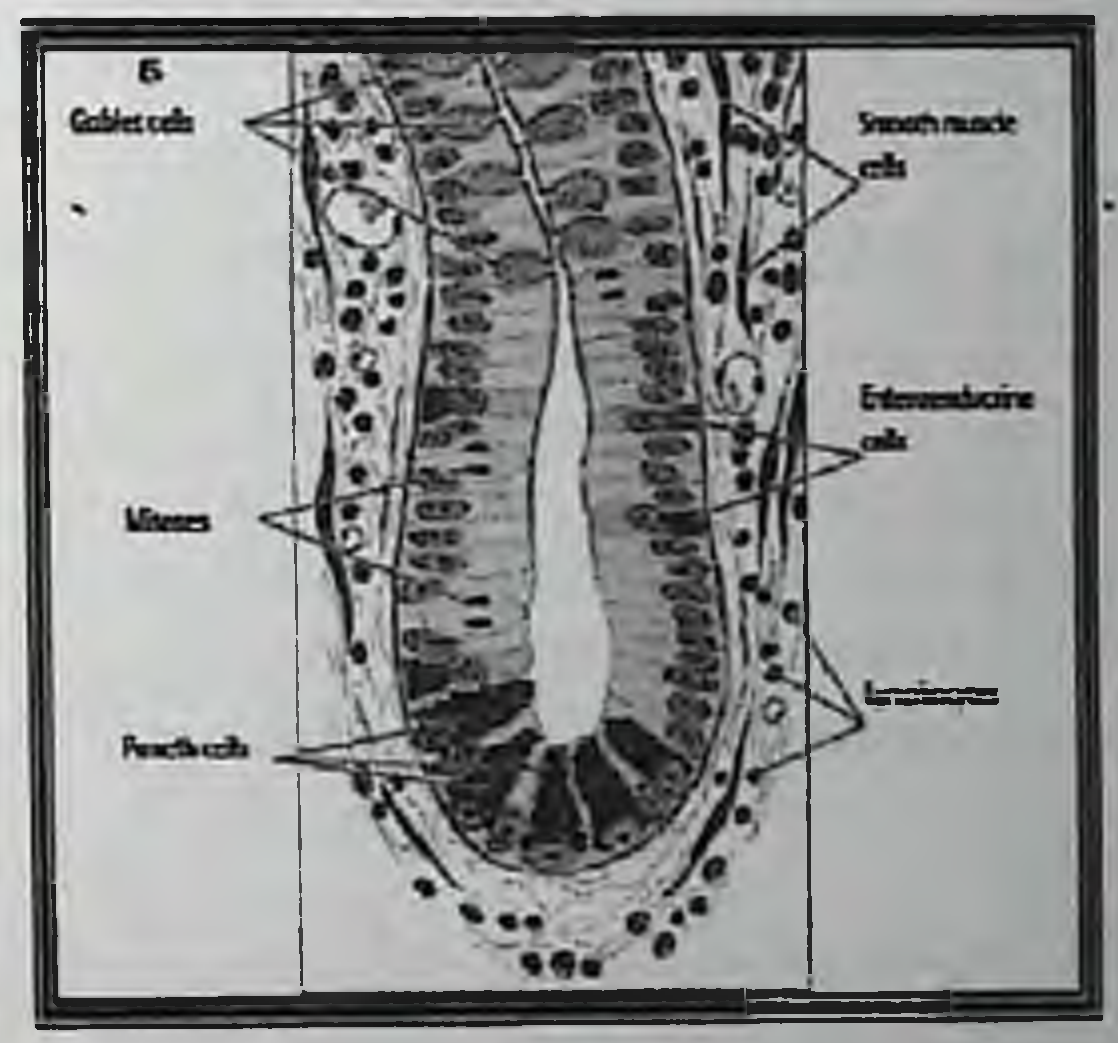
Picture-18. **Secretion type:** 1-merokrinly 2-apokrinly 3-golokrinly

Picture-19. **Cells of Panet**
Cells of Panet (cells with acidofilling granules



Single-they basically meet as a part of fabrics of organs. Them concern:

Gobletly cells (cells similar on a glass) are in epitelies intestines (pic-20), respiratory ways, channels and allocate slime-mukopoligluko-zes for a surface epitelies which protects epitelies and subject fabrics from infectious, toxic, mechanical influence. Gobletly cells participate in a thin gut in digestion, in respiratory ways has protective character. Slime contains an antibody and, participating in immune process. German scientist Panet Joseph has described for the first time), settle down (groups or one by one) at the bottom kript intestines (21-pic).



Picture-20. **Intestinal kripta**
(L.K.Zhunkejra, Z.Karnejro, 2009)

Apikalingcytoplasm contains dense granules, the Cell develops enzyme dipeptidaz, splitting dipeptids to amino acids, lisocym operating antimikrobly.

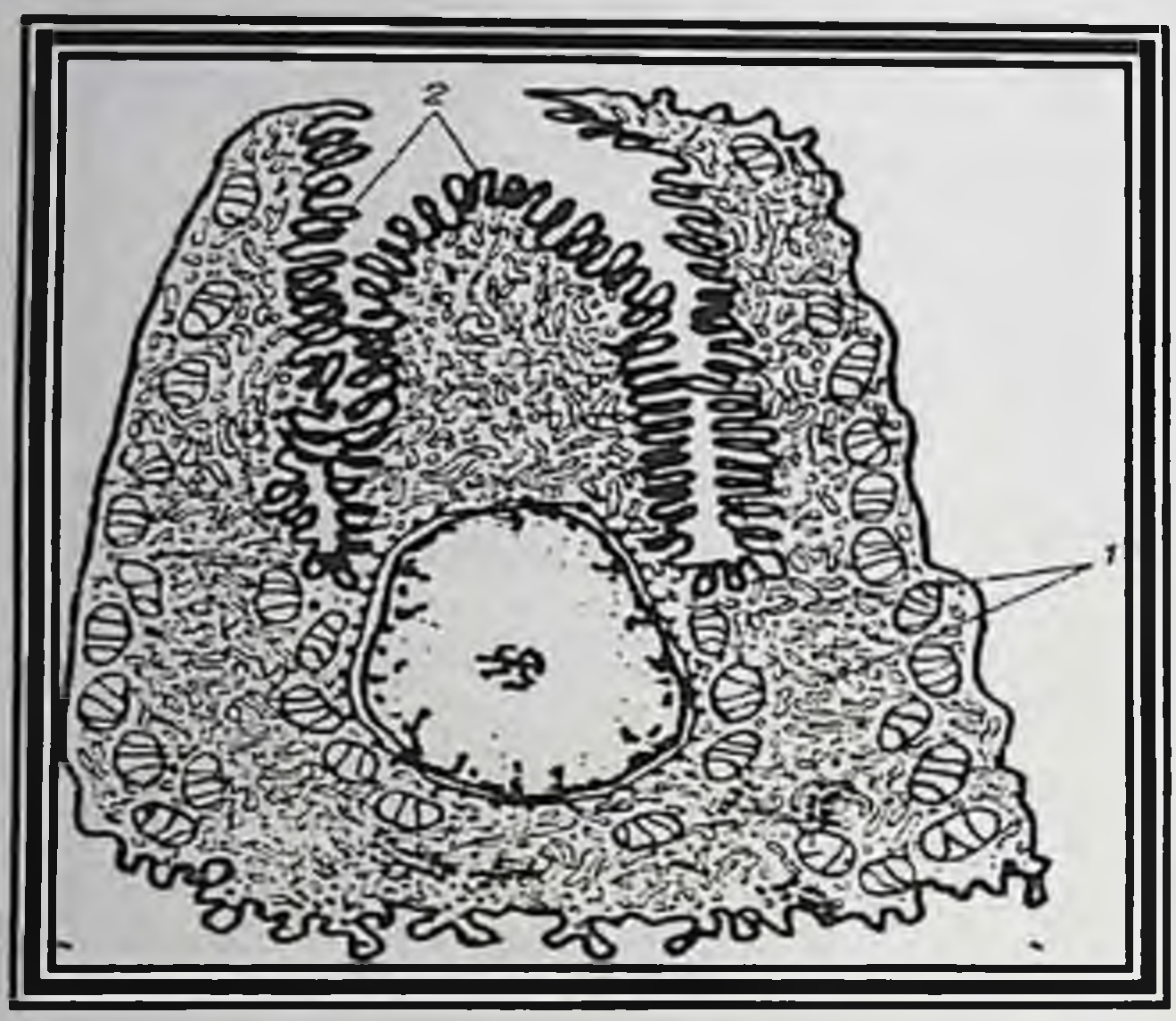
In cytoplasm ions of zinc and a number ofsour phosphatazas are found out. Acidofilling cells it is connected with fiber (more arginin).

Ion-forming cells

Ion-forming cells meet in a stomach and collective canalis kidneys. In a stomach they are called **parietaling** or **coating cells** and often lay

one by one. Their cytoplasm is painted oxyfilling, have one or two kernels of the roundish form.

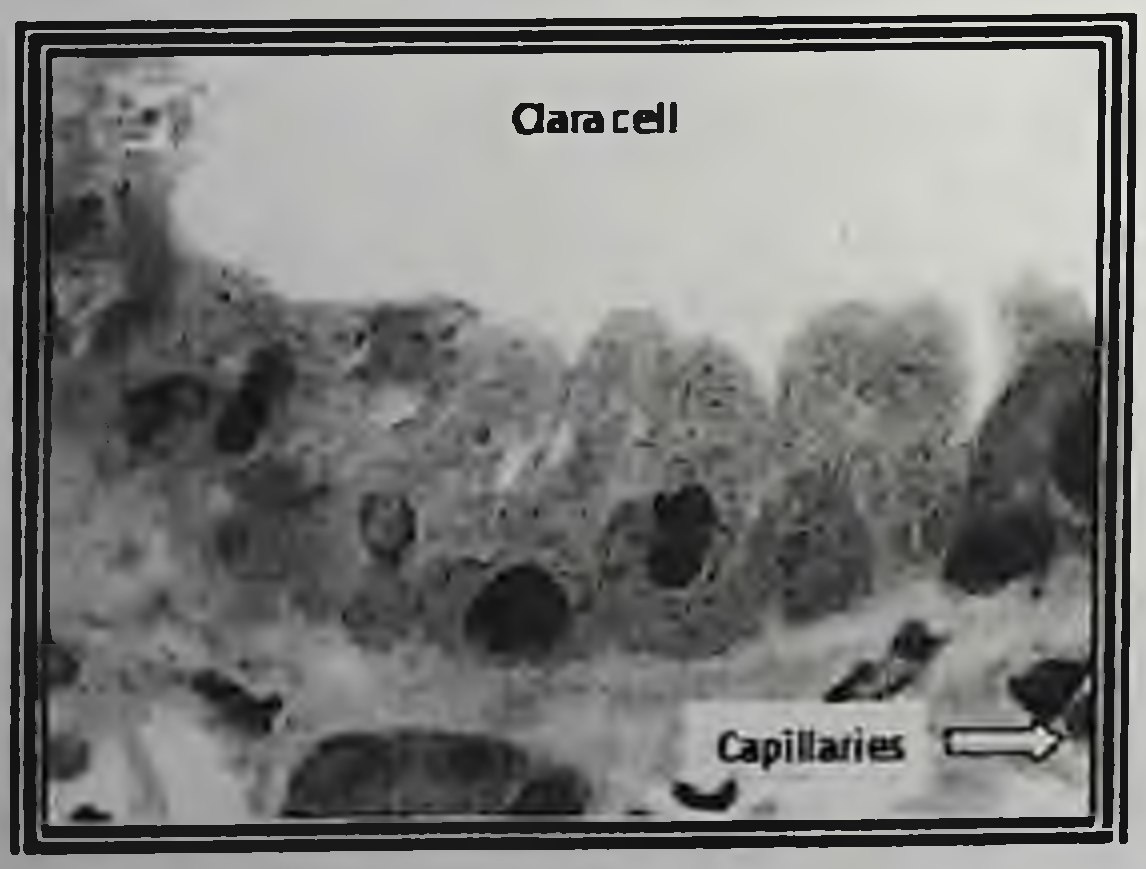
Cytoplasm contains system endocellular canalis with numerous microfibers, it is a lot of mitohondries and smooth veziculas (22-pic). The role parietalingcells consists in development of ions of hydrogen and these ions incorporating chlorine ions form hydrochloric acid.



Picture-21. **Ultrastructure parietaling (coating) cells of a bottom of a stomach**: the 1-avtomic power station; 2-microfibers pressing in a gleam end celhular canalis

Similar cells on a structure are available in collective tubules of a kidney and they name **dark cells**. They develop ions of hydrogen for aciding urine.

Alveolocytes 2 types are called secretly as cells of alveoluses. These cells (still are called **pneumocytes 2 - type**) have the cubic form, on apical surfaces have microfibers develop surfactant, substance preventing falls of alveoluses after an exhalation, penetrations through alveoluses of microorganisms from exhaled air and transition of a liquid from around laying capillaries in alveoluses. Cytoplasm of cells except organellas, characteristic for secretly cells, have osmiofilling-lamellar little organs which develop a secret (pic 23).

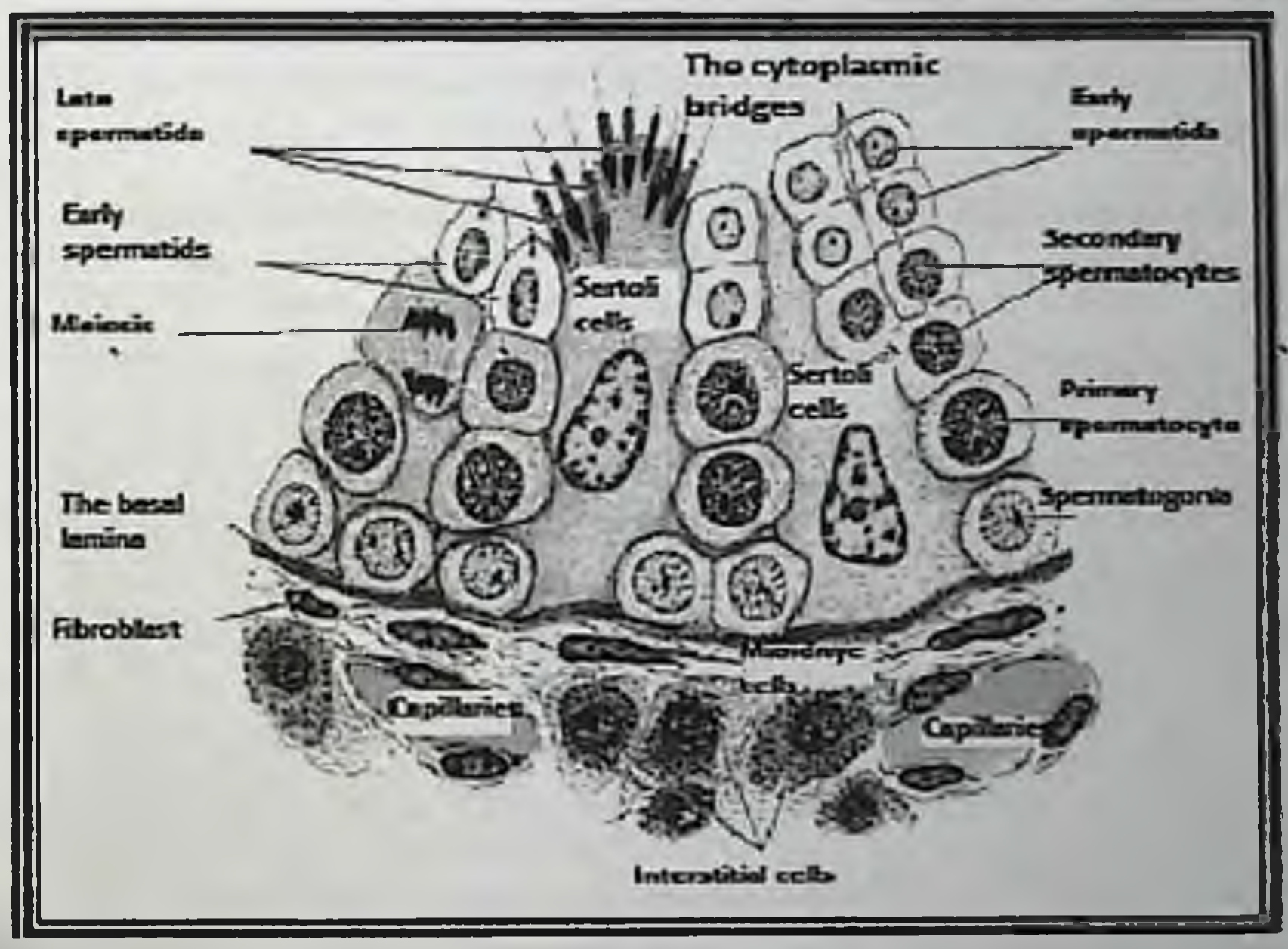


Picture-22. **In picture is shown part of alveolus:**
1-alveolocytes; 2-types

Cells Clara

Cells Clara (for the first time has described Austrian scientists Clara Max)-it without lashing a cell terminal bronchiols lungs, the form dome-shaped, does not contain lashes in apical to cytoplasm contains dense granules, and granules - the specific fiber (enzymes), participating in detoxication. Cells of Clara contains set of vials and multivessiculing little organs (pic-24).

Picture-23. **Of the Cell Clara in epitelies terminal bronchioles. These cells contain Secret's granules and have convex apicaling surfac**



Picture-24. **Sustentocytes in structure spermatogenly epitelies**

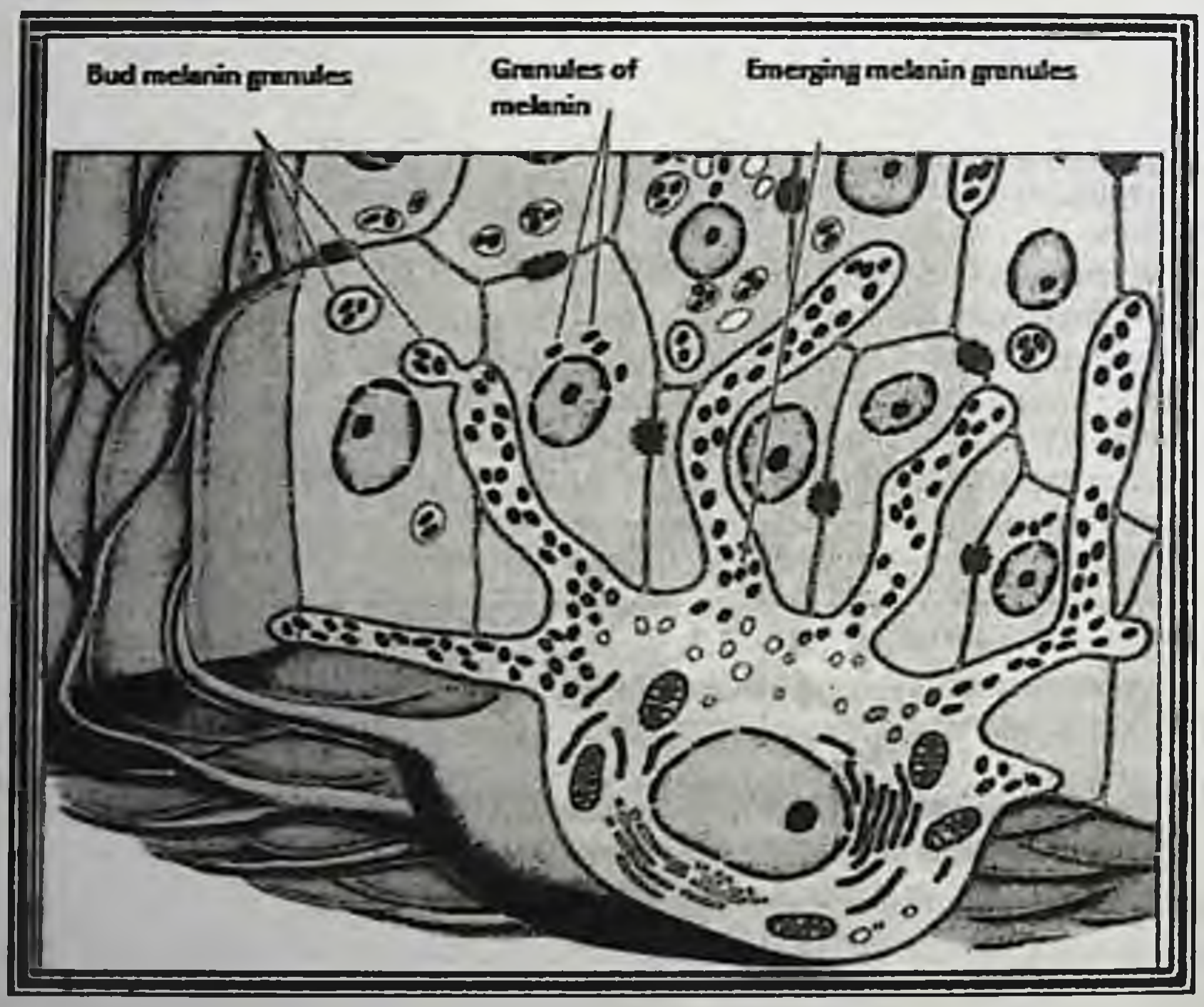
Sustentocytes - cells Sertoli

These cells (for the first time are described by Italian scientist Sertoli Enriko in 1865) synthesise androgen binding fiber-ASB, a transporting man's sexualhormone-testeron to spermatid then spermatids turn in spermatozoids - to mature sexual cells.

Cells have piramidly the form (pic-25). Lay on basaling a membrane, among spermatogenly epitelies in seed canalis egg. To cytoplasm the endoplazma network, the device Goldjis is well developed agranular. Inclusions of lipids, carbohydrates, lipofuscin are found out.Cells incorporating among themselves by means of shoots (dense contacts) forms two departments - external and internal) these departments lay spermatogenly cells. Cells of the top department eat at the expense of cells Sertoli and consequently they these cells are called as supporting.

Besides Sustentocytes are capable to a fagocytoz, create a microhabitat and for formation of sexual cells and isolate them from external antigenes.

To secreting ekzocrynocytes it is possible to carry **fibroblasts** (develop intercellularing substance of a connecting fabric), **hondroblasts** (develops intercellular substance cartilago fabrics), **osteoblasts** (develops intercellular substance of a bone fabric), **osteodentin** (work out **dentin**).



Picture-25. **Melanocytes among epiteliocytes epidermis skin, in granule shoots melanocytes**

Melanocytes

Melanocytes-melanin (pigment) developing cells, settle down in an eye retina, in papillas a mammary gland (here form a pigmentary fabric), as in structure epidermis (pic-26)

Off shooting cell. Pigment granules have blackish color and basically are in cell shoots. They define color of a skin.

Ependymocytes

Ependymocytes cover the spinal channel and venticulis of a brain, cells of the cylindrical form. Develop a spinal liquid, the majority of them I have the mobile lashes causing a current of a liquid. Among ependymocytes there are cells-tannicytes, without lashes and a basaling part of these cells have the long shoot connecting with neurons.

II. Organoforming ekzocrinocytes

2.1. Form independent ferruterous organs: a liver, salivary glands, ekzocrinly a part pancrea glands etc.

2.2. Form glands as a part of organs: duodenum (Brunnerovye- for the first time has described Brunner Yohan, the Swiss scientist in 1672) glands settle down in submucilago to a basis duodenum guts, gastric glands - in a stomach, пищеводные glands - in a gullet etc.

Endocrinocytes. They often have roundish (sometimes oval) the form, seldom are on basaling membrane, them Secret granules are extended on all cytoplasm, granules of the various size and density depending on a stage secreting a cycle. Endocrinocytes share on: single **and organoforming.**

1. **Intersticialing cells of Leydig**

Cells Leydig settle down between loops seed of canalis (for the first time has described background Leydig, the German scientist in 1850), Cells large, are located round capillaries, cytoplasm acidofilling, contains numerous mitohondries with tubular and vesicularing krist, is well developed a smooth endoplazma network of Cell Leydig develop a man's sexual **hormone-testesteron**

2. Secret cells of an auricle of heart

Atrium of miocytes hearts have offshooting the form, and it is less than sizes. And it is less mitohondries, miofibrills and sarcoplasmaly than a network, it is badly developed T system. In cytoplasm the endoplazma network and the device Goldjis and secreting granules is well developed granular. Granules contain gormonly substance - sodium of ureticus the factor which participates in regulation of an extracellular liquid and blood pressure level.

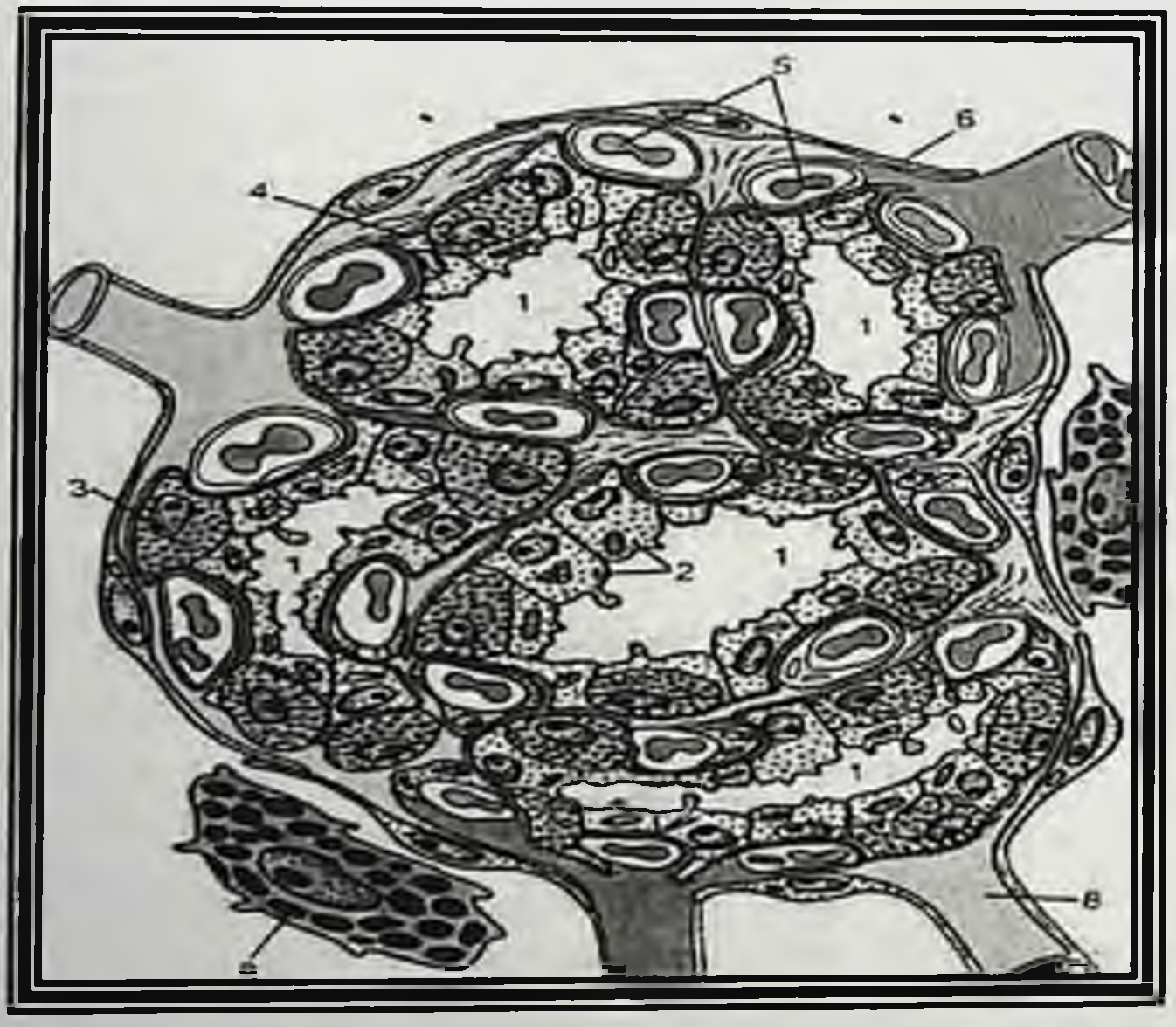
3. Single hormon-producing cells - apudocytes.

These ferruterous cells contain in a mucous membrane of ventricul - an intestinal path, respiratory, uric ways and in a nervous fabric (versions of these cells reaches more than 20 kinds and forms diffusionly endocrinly system - DES or apudsistem). Apud system-it set endocrinly cells, secreting peptidly hormones. Predecessors amins (in english are inherent in these cells ability to absorb and to decarboxylirate. Abbr. APUD). For these cell are characteristic presence specific granules, secreting various hormonly substances which have local regulating an effect.

The description of structure and function of cells apudocytes various organs is given in corresponding heads

4. Calcinocytes of the thyroid gland.

These cells are called as parafollicular endocrynocytes or calcinocytes (To a cell) and settle down between follicles or in a wall a follicle of a thyroid gland among cells-tirocytes (pic-27). They are larger tirocytes, Secret than a granule densely Fill cytoplasm, at them the endoplazma network and the device Goldjis are well developed granular, develop a hormone calcitonin, somatostatin. The hormone calcitonin increases concentration of calcium in blood.



Picture-26. **Pay attention on granuly of a cell number.** The A-scheme. A follicle 1-cavity. 2-follicular endocrinocytes (tirocytes). 3. A structure of a microsegment of a thyroid gland (on N.P.Fedchenko). 3-parafollicular endocrinocytes (calcinocytes). 4-a bazal membrane. A 5-haemocapillary. 6-connectionly of texti of a microsegment cover. 7-arteriola. 8-limfokapillars. A 9-corpulent cell.

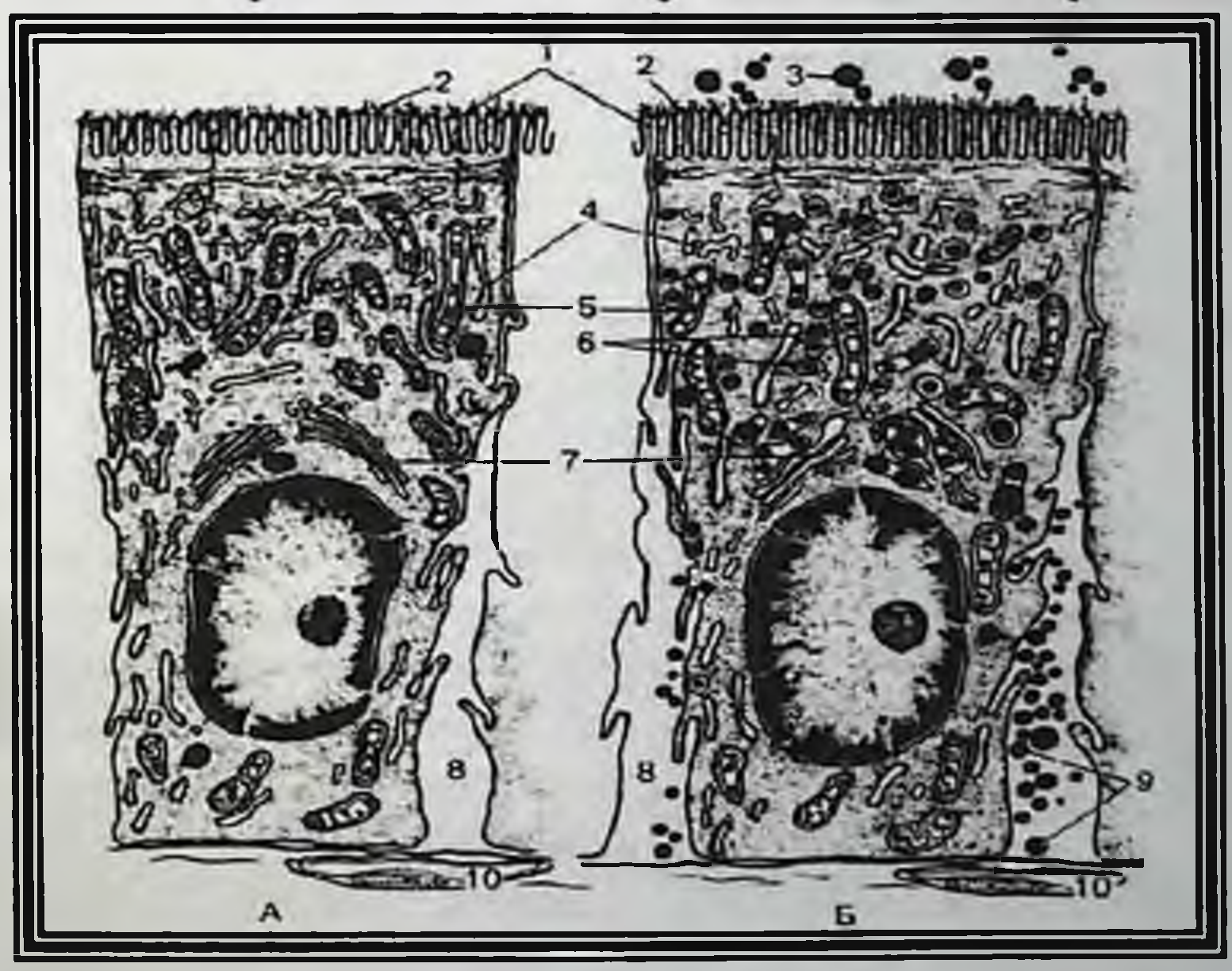
5. Epitelioreticulocytes вилочковой glands

It is known, that T-limfocytes are differentiated in timus in interdigiting cells («cells of nurses»), stimulation of this process occurs by means of hormones timopoetin , timozin, timalin which are developed epitelioreticulocytes glands. These cells have staring the form, cytoplasm has tonofibrills (therefore are called as epitelial cells), Secret granules.

To endocrinly secreting cells can carry **mioepitelioiding** cells (renin forming cells) kidneys, as on character of secretion of corpulent and plasmatic cells of a connecting fabric. They will be described in corresponding heads.

3.2. Suction-type cells

Soaking up cells are in a thin gut, in nephritic canalize and a bilious bubble. They often happen cylindrical, have polarity, lay in basaling to a membrane, and the main thing-in **apical surfaces have a brushing border consisting of densely laying microfibers (pic-28).** Quantity of microfibers happen from 2 to 4 thousand and they increase soaking up surface, the height of microfibers are from 0.5 to 1.5 micron, and reaches their diameter 1micron. The matrix of microfibers is more dense some cytoplasm and consist from densely packed fibrils.



Picture-28. **Process soaking up fat through epitel a thin gut**

In parallel in the length of an axis. On a surface brushing borders are digestive enzymes which split food himus tomonomers. Monomeasures by means of active transport arrive in a cell. Carbohydrates and fibers pass in blood a trance cellularing, and fats through lateral surfaces (Pic-29).

Hence, the border not only increases a resorbing surface and participates in digestion subject soaking up substances. Forming monomeasures are transported in a cell. A plasmatic membrane of lateral surfaces of epitelial cells near to their free surface form a coupling zone. Further there are simple contacts, desmosoms, interdigitation, in the bottom parts there are intercellular lacunas. The majority of organellas are in upnucleus to a zone.

edging epiteliocyt after starvation of an animal edging epiteliocyt after reception of fat food (the scheme on Kardel , etc. with changes) hilomicrons in limphocappilars submucilago bases duodenum guts of a rat through 6ч after food intake (on A.N.Jatskovskomu): 1-mikrovorsirki of borders 2-glikokalliks 3-drops of lipids 4 endoplazma network 5-mitohondrii 6-hilomikrony the 7-device Goldjis 8-intercellular space 9 (10) - hilomicrons , arriving through intercellular space in a lymphatic capillary 11-hilomikrony in a connecting fabric 12-hilomikrony in limphocappilars

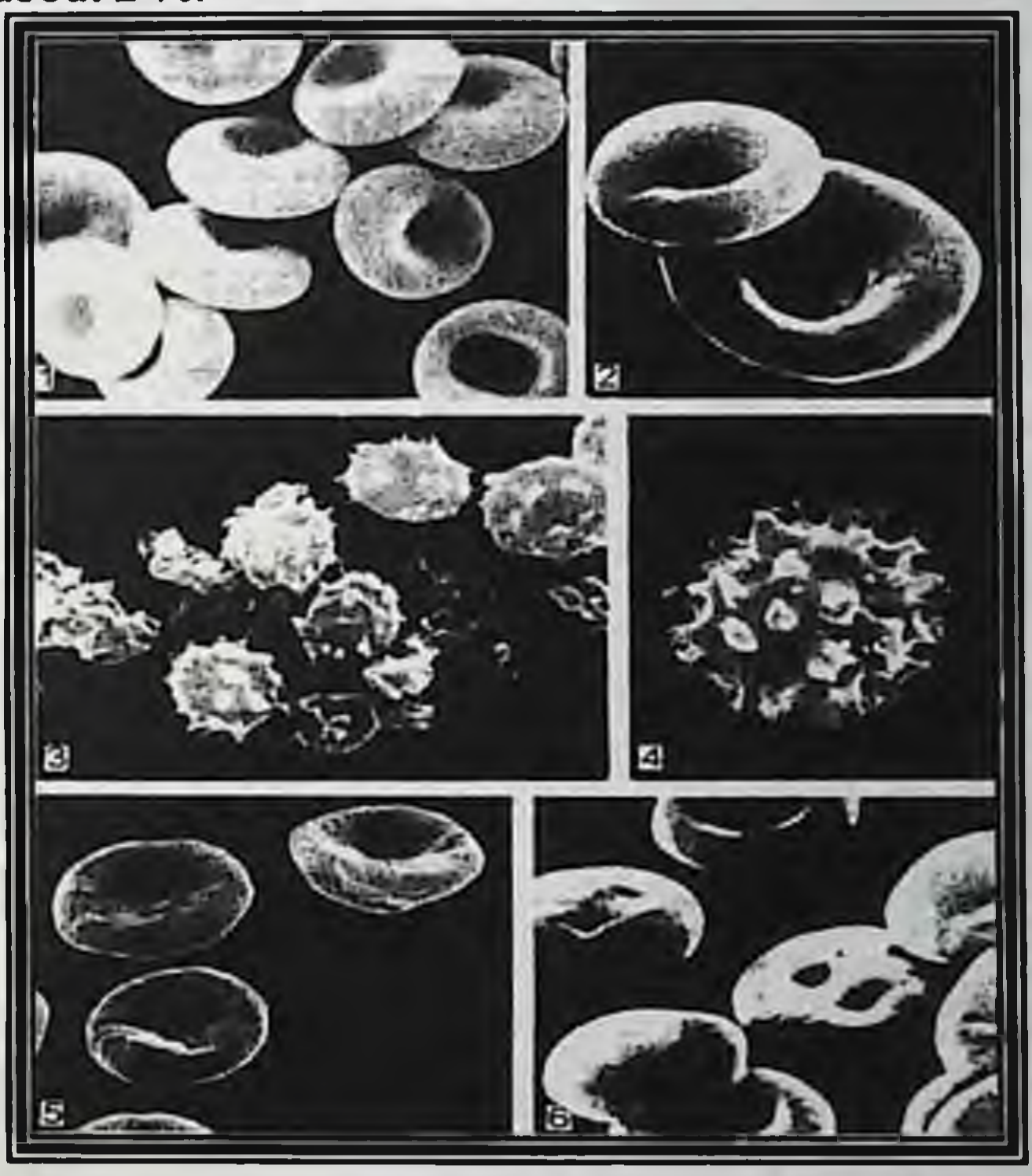
3.3. Transport cells

They concern erythrocytes. Erythrocytes the person it - without nuclear cells (33-rice). The basic function erythrocytes is carrying over of oxygen from alveolus's of lungs to fabrics, carbonic gas from fabrics to alveolus's.

Transport function is a carrying over of various substances: oxygen, carbonic gas, nutrients, hormones e.t.c. In transport of substances matters special aluminous molecules of a membrane and hemoglobin erythrocytea. Erythrocytes have the disk form (80 %) and are called discocytes, there are other forms (33-rice). In erythrocytes 60 % of water and 40 % of the dry rest contain. In a pa-

thology there are their various abnormal forms.Quantityerythrocytes at men 4,0-5,0 x 1012/l, at women 4,9-4,7 x 1012/l., quantities of haemoglobin 120-160 г/л. Haemoglobin consists of fiber globin and 4 molecules gemma. Gem contains bivalent iron which participates in transport of gases.

Connection of haemoglobin with oxygen-oksigemoglobin occurs in capillaries of lungs. Haemoglobin has more than 15 kinds of fiber globin and fetaling. By the moment of a birth of child NbF-fetaling haemoglobin makes 80 % and НвА-20 % at adults NvF-fetaling haemoglobin about 2 %.



Picture-29. **Erythrocytes and their various forms.** 1-diskocytes. 2-diskocyt-makrocytes. 3,4, ehinocytes.5-stomatocytes. 6-sferocytes.

In blood meet to 5,0 % young eritrocytes-retikulocytes, poor haemoglobin. Life expectancy erythrocytes about 120 days, daily collapse about 200 million erythrocytes. Thus iron is used for formation new erythrocytes.

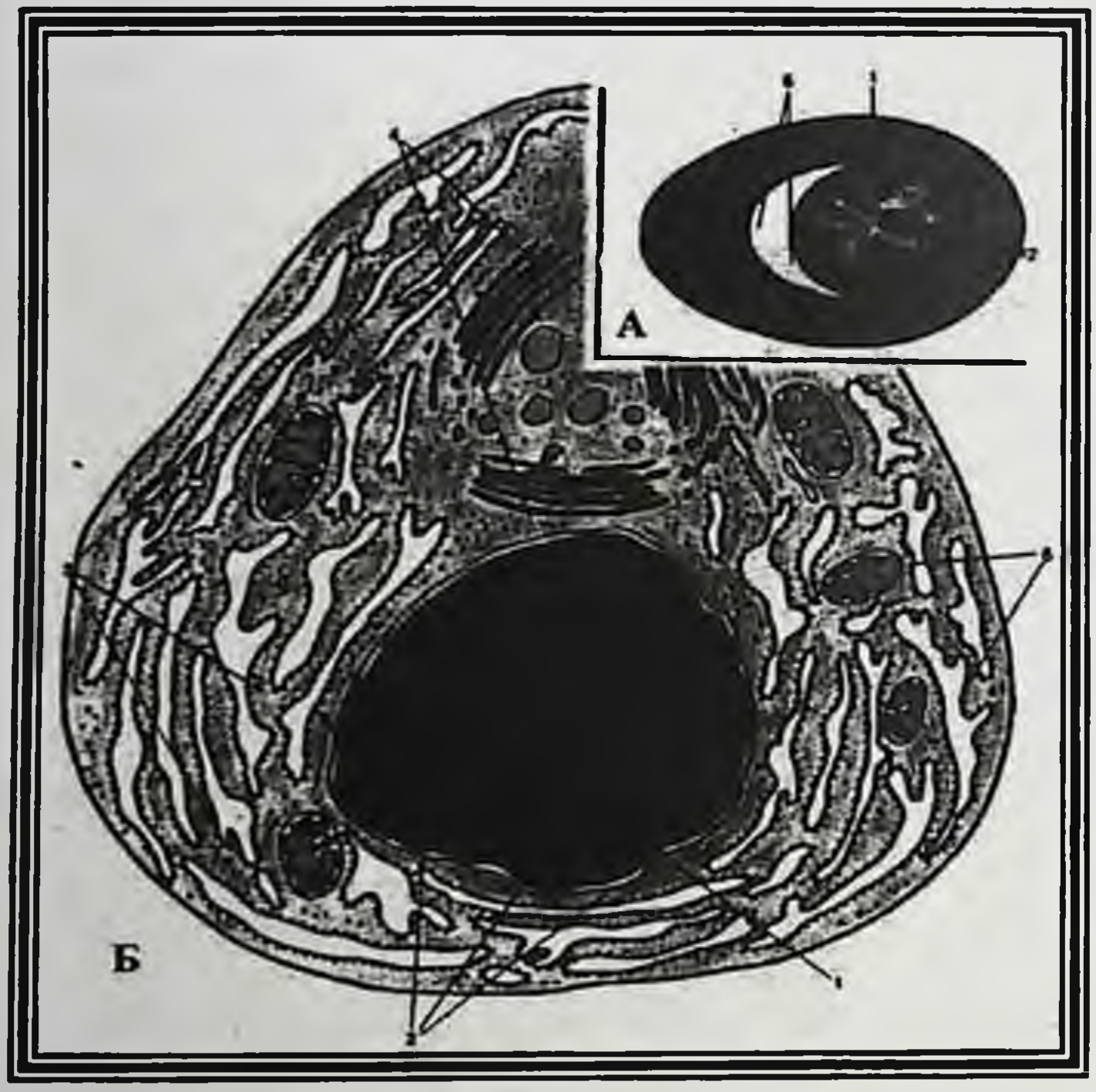
3.4. Immune cells, immune cells

Specialized immune cells are T-lymphocytes, B-lymphocytes, plasma cells (Figure 41). Also, there are a number of cells involved in immune responses, macrophages,neutrophils, mast cells, eosinophils andT-lymphocytes, etc. constitute 70-90% of lymphocytes in the thymus and are formed, the thymus. T cells provide cellular immunity. There are several groups of cells* **T-killers, the most cytotoxic, and destroy antigens.**

*** T-helper helpers stimulate B cells.**

*** T-suppressors inhibit the differentiation of B lymphocytes,**

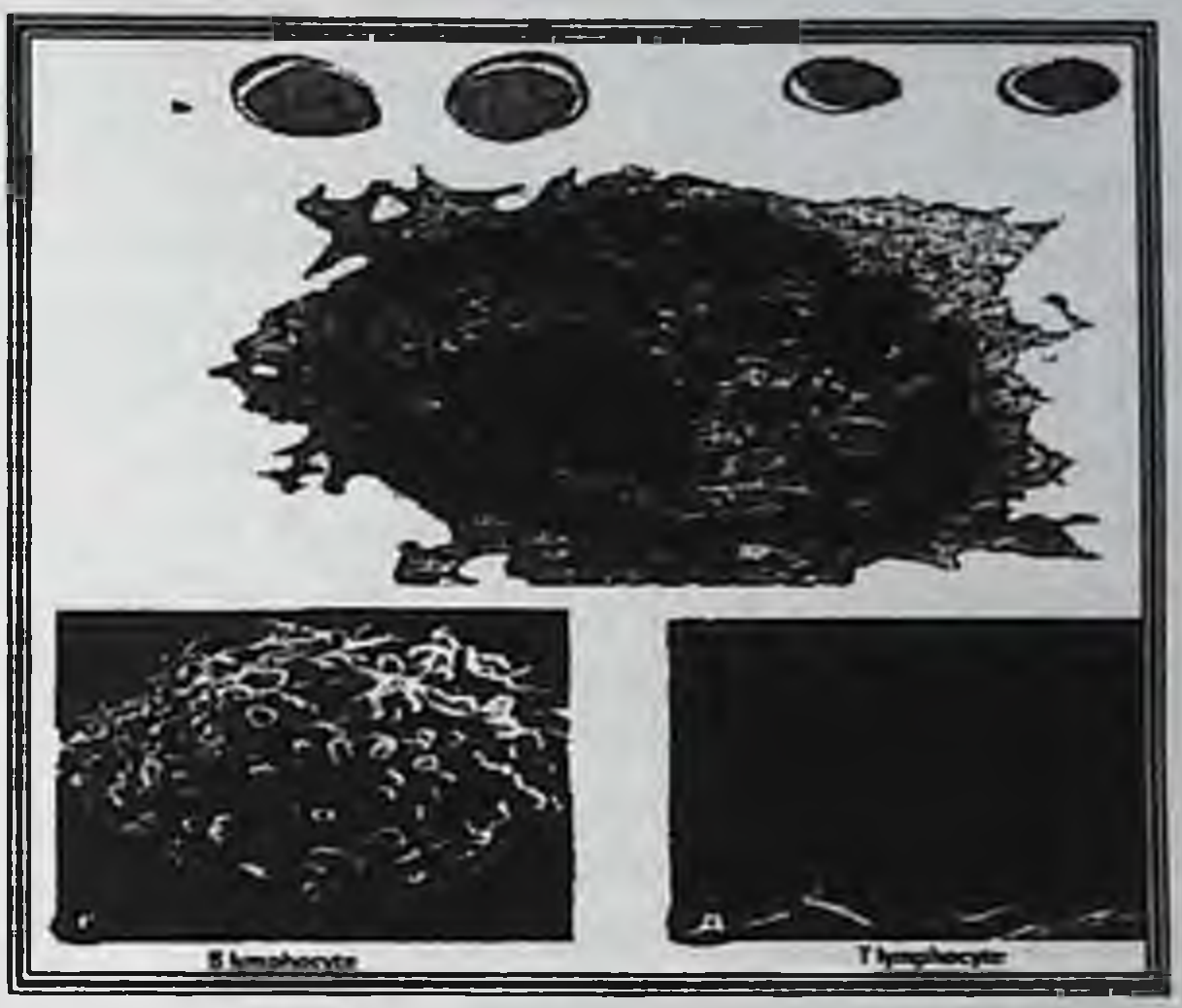
*** T memory, retain memory of the antigen.**



Picture-30. **Plasma cell.** A - circuit structure. 1 cytoplasm. 2-core. B-cell ultra scheme. 1-core. 2-perinuclear space. 3-granular reticulum. 4-KG. 5-Yard. 6-Mytochondria

T cells produce cytokines that have a stimulating and inhibitory effect on cells involved in immune response. T cells are involved in the regulation of humeral immunity and have receptors on the surface.

B-lymphocytes are responsible for humeral immunity. They are formed from the cells of the bone marrow.



Picture-31. **B-monocots, B-macrophage young, GD Lymphocytes**

They are characterized by the presence of large amounts of immunoglobulin receptors for antigen on the cell surface. Immunoglobulin receptors are IgM, IgA, IgD, IgG, IgE.

Antigen-specific immunoglobulins are on Turn the single cell of their income up to 150 000sht. B cells by the action of theantigen in peripheral organs proliferate and differentiate into effector cells active plasma cells that actively synthesize antibodies immunoglobulins of different classes.

The features are lymphocytes that cytoplasm of T-killer cells contain lysosomes more than the rest, the B cell-rich granular reticulum.

Plasma cells (plasma cells, a 42-fig.) Ensure the development of antibodies - gamma globulins with the appearance of antigen in the body. They are formed in the lymphoid organs of B-lymphocytes, are commonly found in loose fibrous connective tissue layer of mucous membranes own hollow organs, glands, interstitial connective tissue of various glands, lymph nodes, spleen, bone marrow. The value of 7 to 10 microns, the cell shape is round or oval. The nuclei are eccentric. Strongly basophilic cytoplasm contains a well-developed concentric granular endoplasmic reticulum, where proteins are synthesized antibody (img.30). Basophilia is not only in a small area of light cytoplasma round the nucleus, forming a so-called field or court. Here are found the centrioles and the Golgi apparatus.For plasma cells characterized by a high rate of synthesis and secretion of antibodies, which distinguishes them from their predecessors. A well-developed secretory apparatus allows to synthesize and secrete several thousand molecules

of immunoglobulins per second. The number of plasma cells is increased by various infectious and allergic and inflammatory diseases.

Macrophages

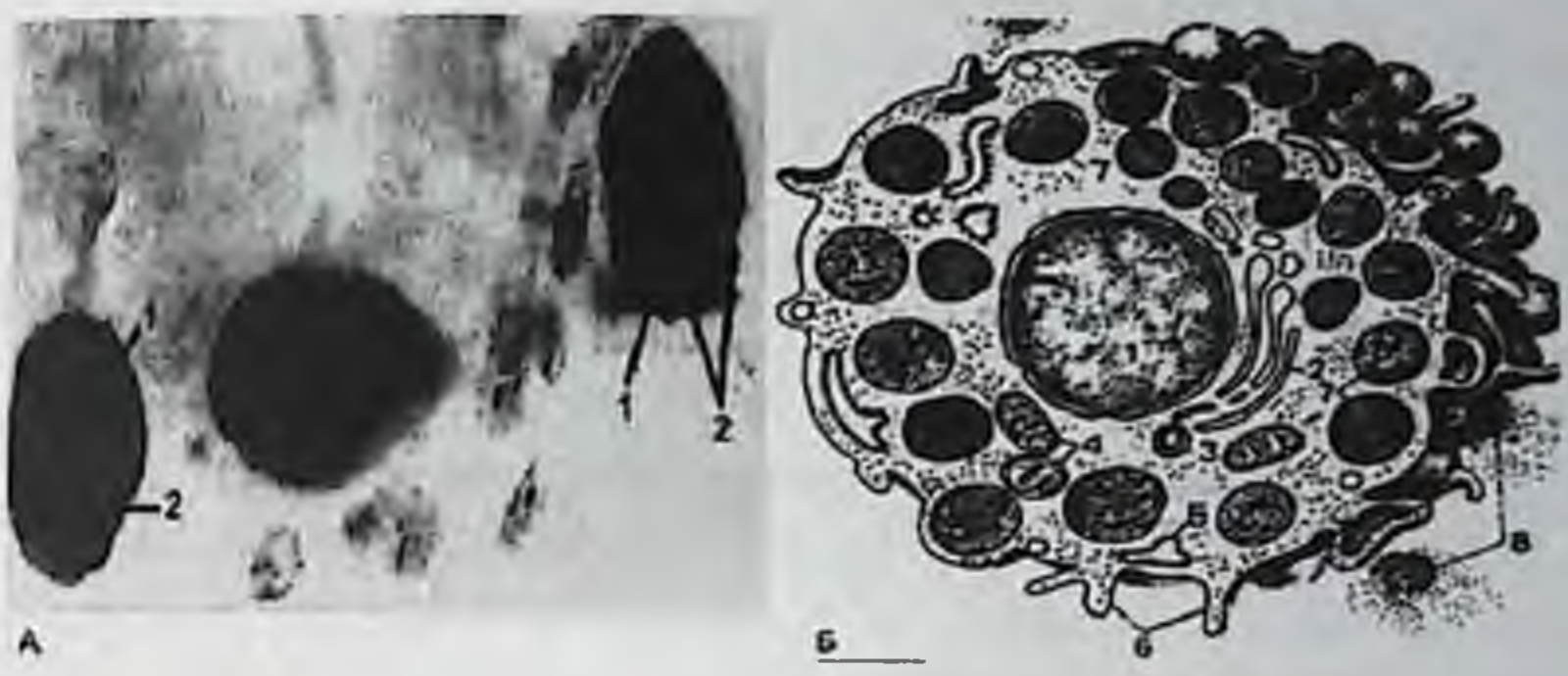
They are involved in the natural and acquired immunity, are formed from the cells of the blood-monocytes in the tissues of the body and there are various forms. Macrophages are capable of their membrane receptors recognize antigens and provide information on their own lymphocytes and phagocytose them. Makofages have multiple processes by which constitute false legs to capture antigen. Lyse the captured antigens in the cytoplasm. Basophilic cytoplasm, rich with lysosomes,phagosomes (that is their hallmark) and pinocytic vesicles (pic-31). Located directly under plasmolemm network of actin filament with a diameter of 5-6 nm.Through this network, the microtubules are 20 nm in diameter, which are attached to plasmolemma and play an important role in intracellular movements of lysosomes mikropinotsitoznyh vesicles and other structures Macrophages can phagocytose both soluble and particulate antigen. Macrophages are divided into free and fixed. Free mobile macrophages, are in the blood, in the loose connective tissue are called histiocytes. Fixed organ-called macrophages. Differ in the following fixed macrophages:

1.Pechenochnye macrophages, Kupffer cells, Vysokovicha
2.Legochnye macrophages, alveolar macrophages
3.Makrofagi nervous tissue - mikrogliotsity
4. Macrophages bone-osteocytes,
5.Makrofagi cartilage-hondroklasty
6. Peritoneal - macrophages abdomen.
7. Thymic macrophages and T and B zones of lymphoid organs, lymph node and spleen-inter digitiruyuschie and dendritic cells.

8-epidermal skin macrophages, Langerhans cells

Is the source of all monocyte macrophages. At present, all together in mononuclear macrophages Makrofagicheskuyu System - MMC.

Picture- 32. **TEM. active fragment macrophage. In the cytoplasm of many phagosomes, pinocytosis Bubbles**



*Picture-33.***Tuchnye cells** - A light microscopic and TEM 1-kernel; 2 receptors; B 1-kernel; 2-ketoglutarate; 3 matures granule; 4- mitochondria; 5- granullyarny reticulum; 6 cytoplasmic outgrowths; 7- mature granules; 8- degranulated granules.

The practical part

Compilation of logical structures, the study of drugs elektronogrammm, multimedia on secretory, suction, transport and immunnyi cells and a sketch of the principles of the structure of the secretory, suction, transport and immune cells in the albums.

Studied drugs: 1. secretory cells of the pancreas. 2. Suction cell of the`small intestine. 3. Blood smear. 4. The`electron atsinotsita pancreas and small intestine suction cells, T- and B-lymphocytes and macrophages.

Sample tests

1. What type of secretion called merokrinovym?

a) secret stands out without destroying glandulotsitov;
b) secret stands out with complete destruction glandulotsitov;
c) secret stands out with the destruction of microvilli glandulotsitov;
d) secret stands out with the destruction of the tops glandulotsitov.

2. What type of apocrine secretion called?

a) secret stands out without destroying glandulotsitov;
b) secret stands out with complete destruction glandulotsitov;
c) secret stands out with the destruction of microvilli glandulotsitov;
d) secret stands out with the destruction of the tops glandulotsitov.

3. What type of secretion called holocrine?

a) secret stands out without destroying glandulotsitov;
b) secret stands out with complete destruction glandulotsitov;
c) secret stands out with the destruction of microvilli glandulotsitov;
d) secret stands out with the destruction of the tops glandulotsitov.

4. Determine the function of tissue basophils (mast cells):

a) production of biogenic amines.
b) synthesis of antibodies;
c) involvement in inflammatory and allergic reactions;
d) phagocytosis;
e) participation in the production of the basic substance.

5. Determine the function of plasma cells:

a) in the production of antibodies;
b) formation of intercellular substance;
c) participation in inflammation;
d) phagocytosis;
e) Production of biogenic amines.

6. Mast cells. All true, except:

a) heparin-containing granules and histamine;
b) migration capability;
c) number increases in allergic reactions;
d) comes from precursors in the bone marrow;
e) synthesizing antibodies.

7. What term is called the increase in the number of red blood cells?

a) eritropeniya;
b) poikilocytosis;
c) anisocytosis;
d) erythrocytosis.

8. What term refers to a decrease in the number of red blood cells?

a) eritropeniya;
b) poikilocytosis;
c) anisocytosis;
d) erythrocytosis.

Approximate refereed paper on "The structure of the sarcomere

TOPIC-5: the contractile, and impulsobrazuyuschie impul-sprovodyaschie, ciliated and germ cells.

I. Aims and objectives:

1. To study the function and structure of the contractile. Impulse generators and impulse conducting cells;
2. To study the function and structure of ciliated and germ cells.

II. Sample questions for self-training.

1. Types of neurons;
2. The structure of neurons;
3. Impulsobrazovanie
4. Smooth myocyte.
5. The mechanism of muscle contraction.
6. cardiomyocyte.
7. The male reproductive cells;
8. The female germ cells;
9. The clinical significance of the topic.

The theoretical part

3.5. Contractile cells

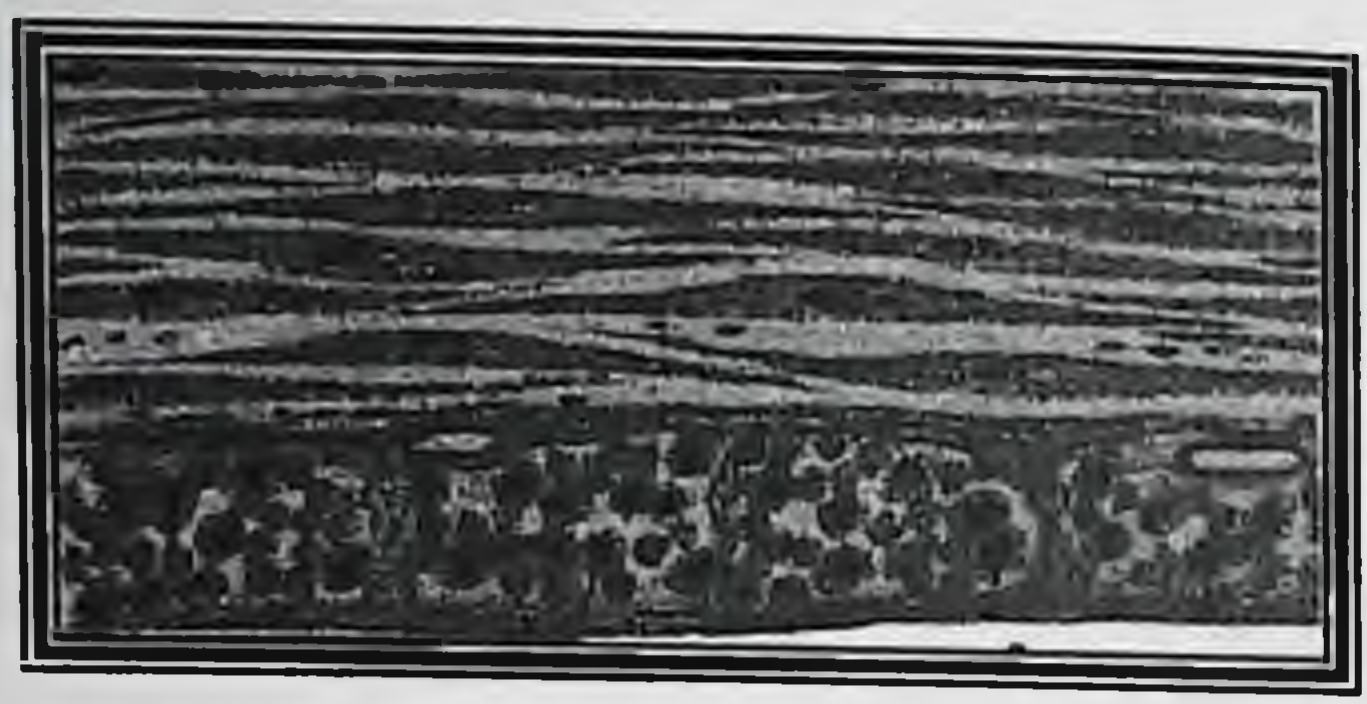
Contracting muscular cells form a muscular fabric. In cytoplasm of these cells there is a considerable quantity contracting fibers which form **Contracting fibrilly-miofibrilly. Miofibrills provide reduction of muscles and consist from aktin-thin and thick-miozin microfibrills.**

Actin microfibrills consists of actin fiber, and represents a thin thread, miozinly thick microfibrills consists of fiber miozin and it represents bunch.

In miofibrills is available disks, a strip and lines. It is accurately visible in cardiomiocytes and in cross-section striped skeletal muscular fabric.

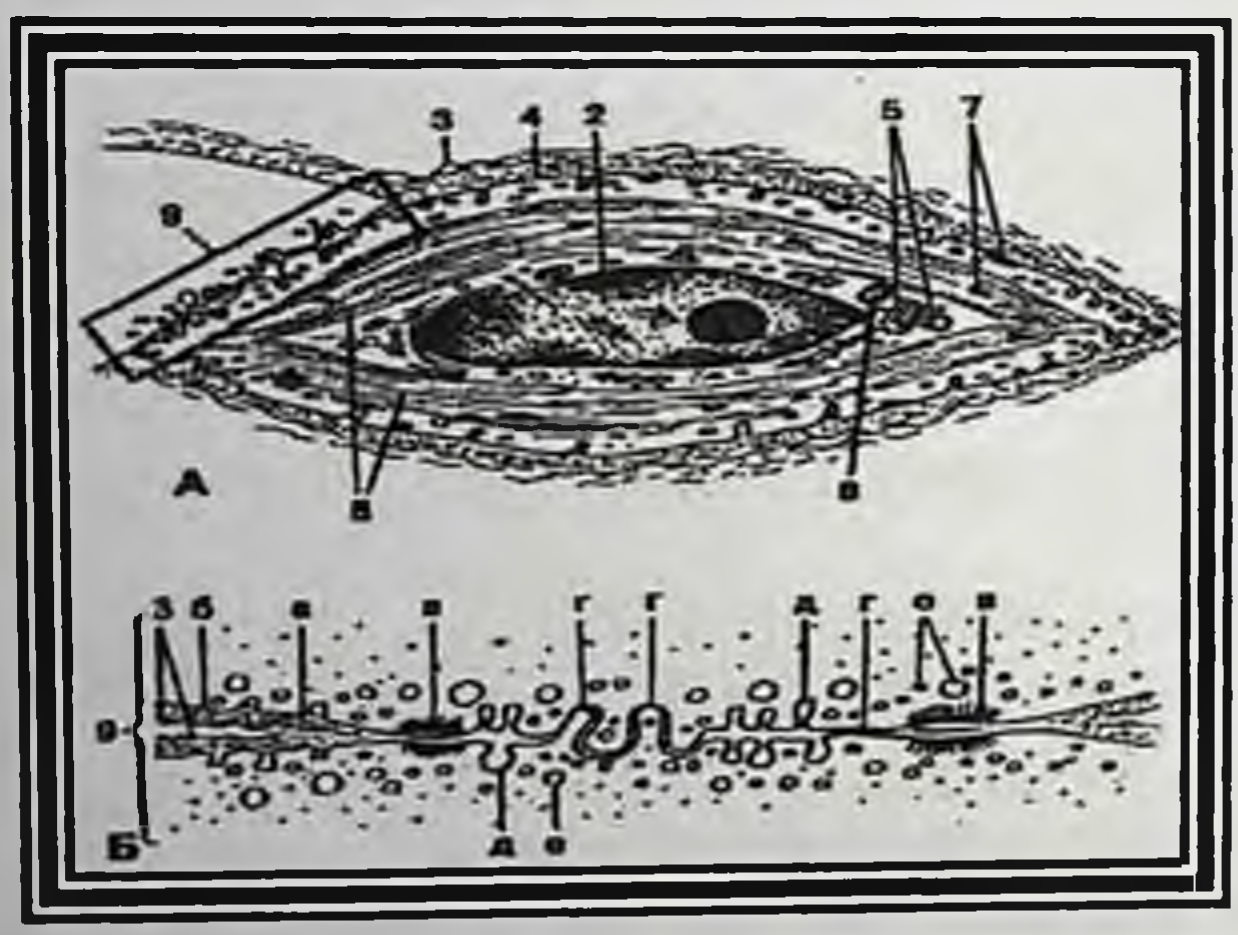
The I-isotropic disk-light a disk is presented only actinly

Threads. **A**-disk an anisotropic dark disk in which area are available actinly and miozinly threads. Because of alternation actinly and miozinly microfibrills it is formed cross-section in cross-section striped cells.



Picture-33. **Smoothmiocytes in longitudinal and cross section cuts**

The H-strip, light strip, settles down in the middle And a disk,Here are available only miozinly microfibrills.**The M-line** (mezofragma)-is in middle H of a strip, to this line are attached miozinly threads.**The Z-line** (somafragma) is in the middle of 1 disk, at to this line are attached actinly threads.**Sarkomer** - It is a site of a muscular fibre between two зетLines, structurally functional unit miofibrills a cross-section-striped muscular cell.**Smooth miocyte** has the form (34,35-rice), length 20 500mkm, the cytolemma-sarkolemma forms numerous embolies - pinocytozly phials and kaveols and in them there are calcium ions.



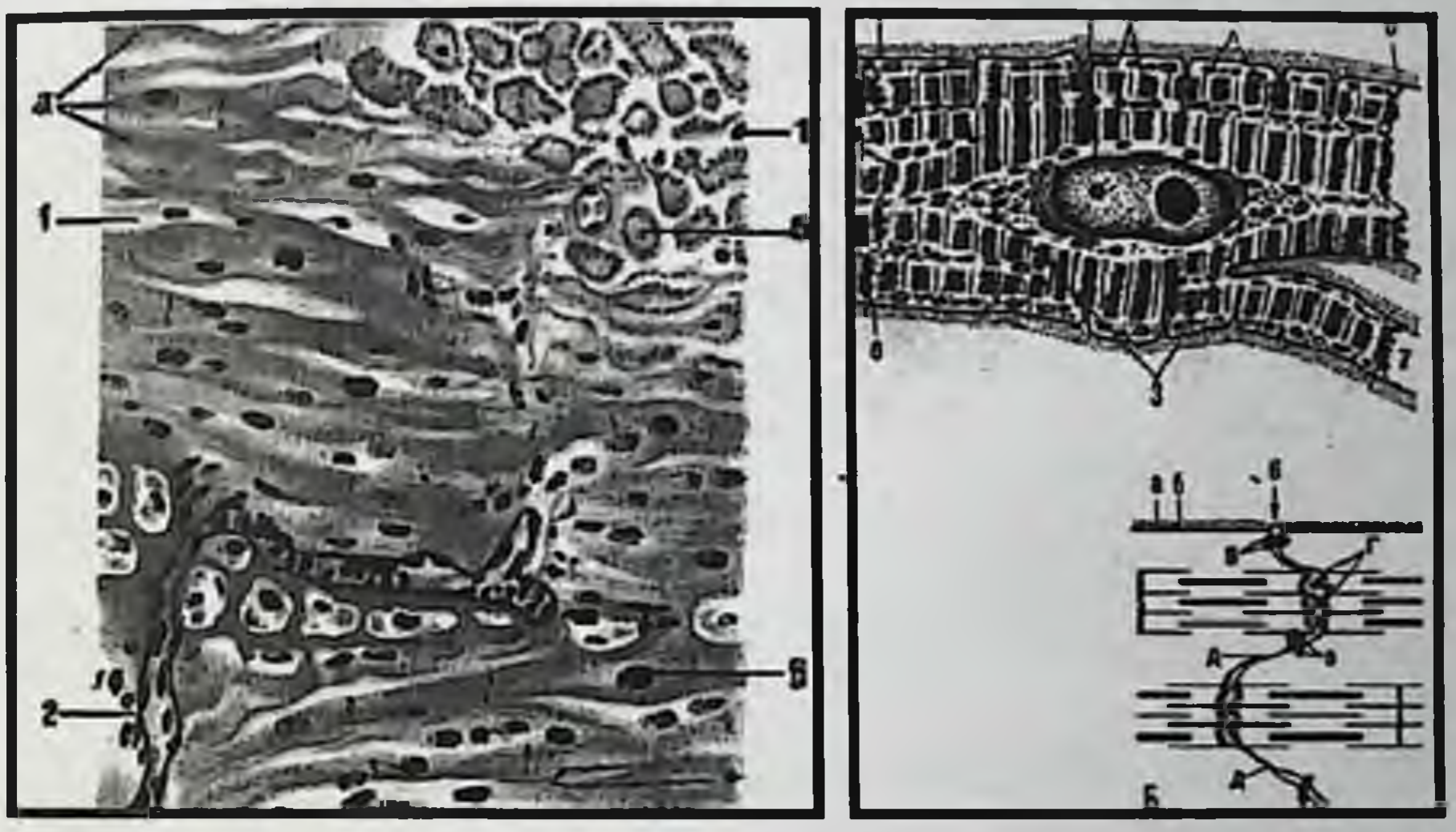
Picture-34. **A-smooth miocyte. Contact B-places Smooth Miocytes**

Actinly miofillaments go in cytoplasm it is mainly longitudinal or under a corner to a long axis of a cell. Places of their attachment to a cytolemma or each other on electronogram as electron-thick little organs.

Miozinly miofillaments settle down it is longitudinal. At reduction redistribution actinly and miozinly threads rather each other is observed and actinly threads are displaced on a meeting each other, energy of draught is transferred to a cytolemma and the cell is reduced

Miocytes are surrounded basaling by a membrane which consists from thin elasticly and reticuling fibres. In cells distinguish **the basic device** (dense little organs, sarcolemma, basaling a membrane), **the trophic device** (inclusions, organellas, a kernel) and **the contracting device** (miofibrills).

Cross-section-striped the contracting cardiomiocyt has the extended cylindrical form, their ends are connected by inserted disks. Disks consist from desmosoms, interdigitation and nexus. The cell has lateral anostomozes. Sarcoplasma it is rich agranular with a network, mitochondries, a glikogen. Agranular the network forms tanks (component T of system) in which there are calcium ions. The kernel has the oval form.



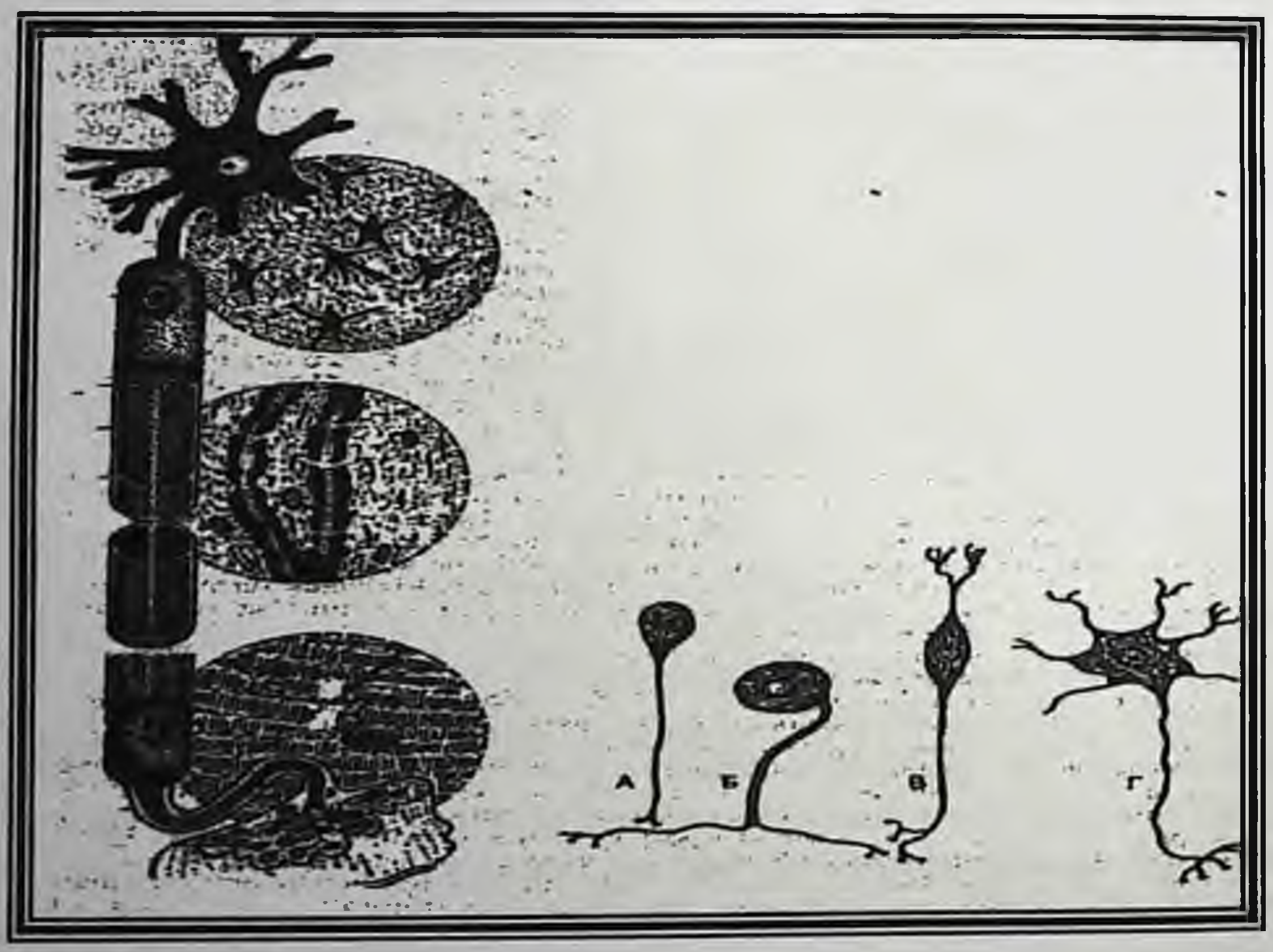
In cells special organellas - miofibrills, having cross-section are well developed. Miofibrills consists from actinly and miozinly contracting fibrilling fibers. And

Places of their fastening form somafragma (a line attached to a cytolemma) and mesofragma. A site between two somafragmами name саркомером. The cytolemma at level somafragma forms embolies-t-tubules (37-rice), round them there are tanks and is formed T - system, having great value in impulse carrying out to miofibrills. At the moment of reduction the impulse is transferred to T to systems, ions of calcium are released and they cause reductions miofibrills. Thus threads of an actin by sliding come nearer to H to a strip and so there is a cell reduction (The sliding theory).

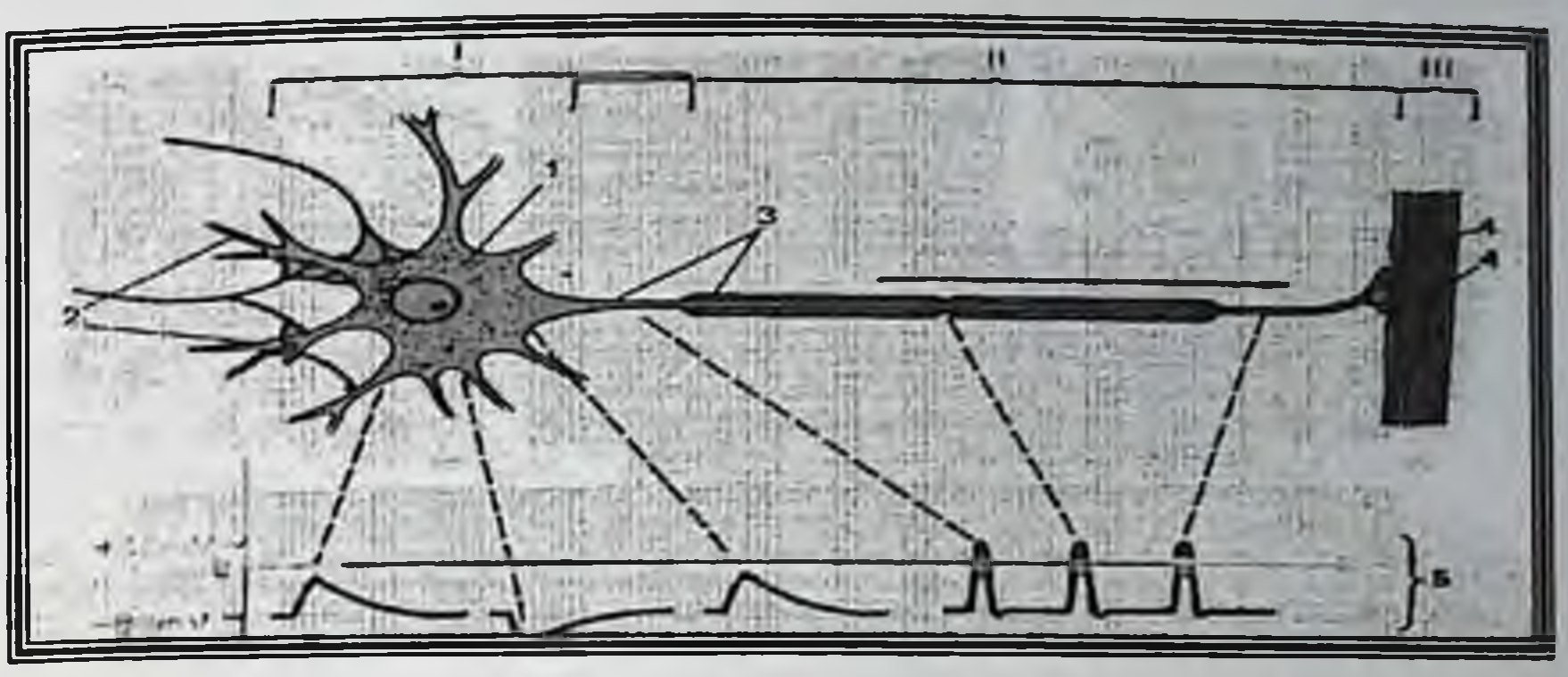
Typical neurocytes

They incude neyrones and neurocytes. Neurones-it cells of the wrong form, have 2 kinds offshoots-one long **akson or neyrit**, the second short, branching shoots-dendrites . By quantity of shoots neurocytes happen: **unipolar, bipolar and multipolar** Depending on function share: on ***receptorly** (sensitive or afferent), they generate impulses; on ***associative** (inserted)-carry out various communications between neurocytes;**effector**transmit the exiciment on the tissue As a whole, neuron consists of three parts: **a cell body, shoots and nervous the termination-sinapsy**

The plazmolemma of neurons specialised, it spends impulses. Under influence irrotant in a cell ions of sodium and go out ions kalii enter, that leads to formation of a wave of a depoljarzatsii-impulse. Waves depolarization are very quickly translated in other sites of a plazmolemma, further from dendrits to a cell body, and aksons. Actually aksons are transmitters of a working impulse to organs.



Cheme of the neurone **II** type of neurons
A- unipolar **B**-psevdounipolar **C**- bipolar **D**-multipolar



36-fig. **I-body neuron. II. A nervous shoot. The III-nervous termination.**
1-nejron. 2-dendrit. 3-akson. 4-5-the nerviously termination with sinaps.

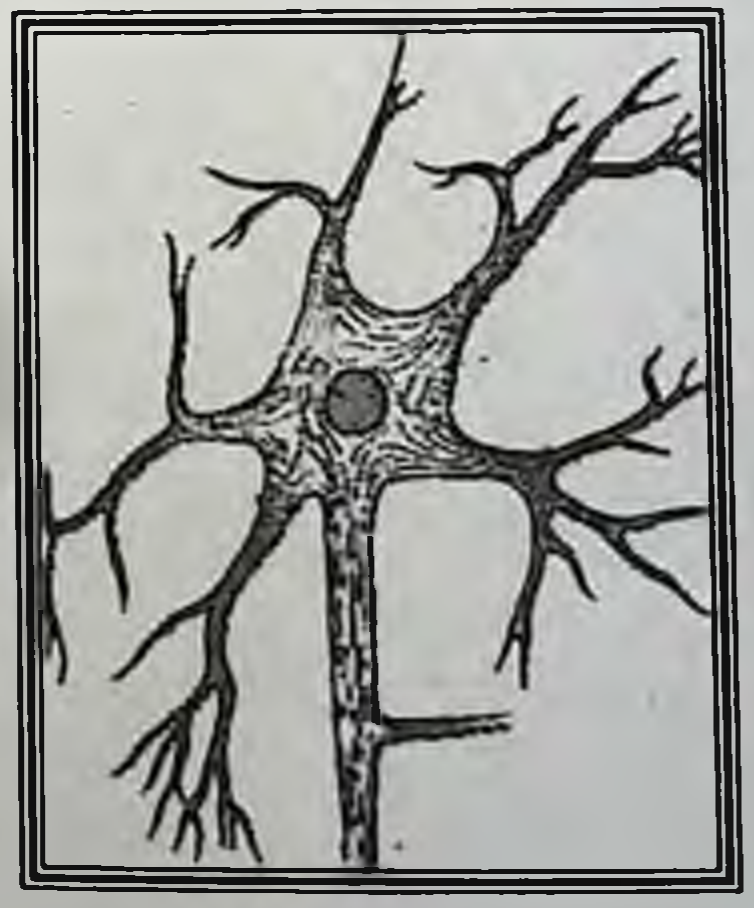
Cytoplasm-nejroplazma is rich with organellas, there is a special organella-**nejrofibrills, as chromatophilous substance of Nissl** which consists also packings granular an endoplazma network. Here special substances - mediators, transfers of an impulse participating in process are synthesised. In neuronax KG are well developed,mitohondries, neurofibrills.

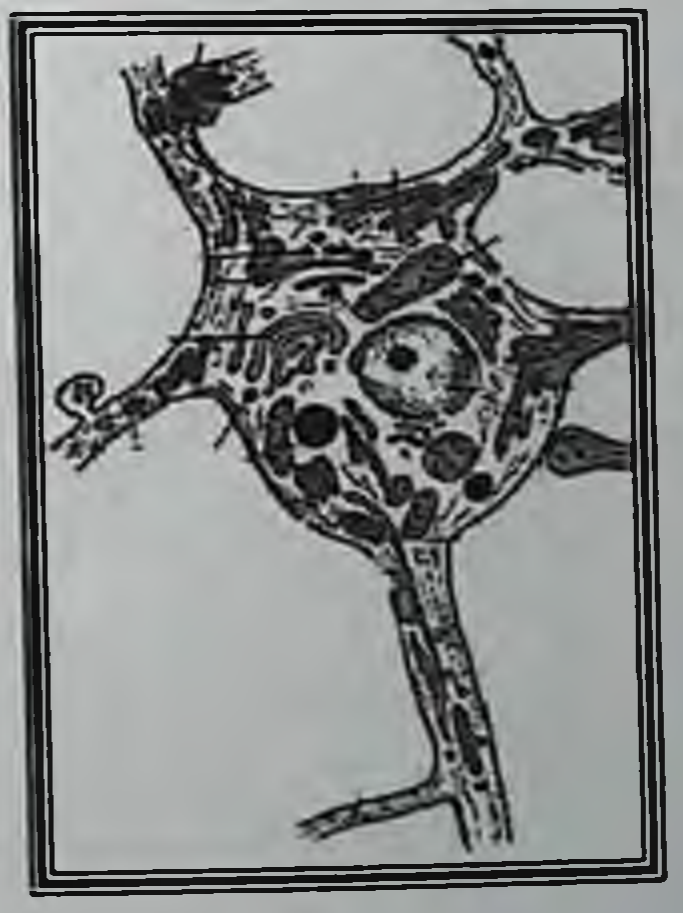
Picture-37. **Neurons of the spinal cord**

Neurofibrills consist of bunches neurofilaments (diam. 6-10 nanometers)

Ultra neuron circuit

Oligodendrogliotsity on the surface of the cylinder axis - process neuron.





3.6. Sex cells

Sex cells - sperm and oocyte are also highly specialized cells and have their own specific features cytophysiological (see. The same 3-chapter "Human Embryology").

Sperm - male germ cells, up to 75 microns, has a head and a tail. The head part has a nucleus, acrosome, akroblast and receptors. Core has 23 pairs of chromosomes. Of these, one chromosome and sex called the Y chromosome. Caudal section also has four parts: the neck (proximal centriole), intermediate, primary and terminal. The intermediate part contains a large number of mitochondria, and the axial filament is the biggest part of it - comes to 45-55 microns. And then the end-terminal part.

Oocyte - female sex cell, has a rounded shape, surrounded by three membranes: a) follicular layer - consists of follicular cells; b) brilliant cover - is composed of glycoproteins; c) ovolemma - tsitolemmy the cell. The cytoplasm contains all kinds of organelles, except for the cell center, and the inclusion of rich - yolk.

3.7. Ciliated cells

To ciliated cells include cells of the fallopian tubes, uterus, airways, respiratory cells of the alveoli. Cilium - a thin cytoplasmic outgrowth of cells up to 5.10 m, a width of 300 nm. Covered with the plasma membrane. Cilia - this organelle movement. Ciliary dynein protein promotes the movement of cilia.

Ciliated cells the respiratory tract their movements helps release dust particles, microorganisms, mucus from the cavities resperatornyh bodies.

Congenital immobility of the cilia - Kartagener syndrome, defects of cilia in smokers lead to diseases of the respiratory tract and lungs. Flicker frequency of cilia is important to purify the inhaled air.

45 Fig. Lining the oviduct. Note the numerous cilia. In the center is part of the apical secretory cells covered with short microvilli.Ciliated cells. To ciliated cells include cells of the fallopian tubes, uterus, airways, respiratory cells of the alveoli. Cilium - a thin cytoplasmic outgrowth of cells up to 5.10 m, a width of 300 nm. Covered with the plasma membrane. Cilia - this organelle movement. Ciliary dynein protein promotes the movement of cilia. Ciliated cells the respiratory tract their movements helps release dust particles, microorganisms, mucus from the cavities resperatornyh bodies. Congenital immobility of the cilia - Kartagener syndrome, defects of cilia in smokers lead to diseases of the respiratory tract and lungs. Flicker frequency of cilia is important to purify the inhaled air.

Ciliated cells of the fallopian tubes, uterus contribute to the movement of fertilized and not fertilized egg. Pathology of the cilia of the fallopian tube and uterus may result in

The practical part

Compilation of logical structures, the study of drugs for impulsobrazuyuschim, contractile, sex, ciliated cells and sketch the principles of their structure to albums

The objects under study. 1. Spinal Cord, 2 small intestines. 3. Smear sperm 4. Trachea.

Sample tests

1. What organelles formed hromatofilnaya substance in the cytoplasm of neurons?

a) in the mitochondria;
b) lysosomes;
c) dictyosome golgi complex;
d) smooth cytoplasmic network,
e) granular endoplasmic reticulum.

2. What structures are formed neurofibrils?

a) in the mitochondria;
b) lysosomes;

c) microtubule;
d) endoplasmic reticulum;
e) neurofilament.

3. What are the morphological types of neurons are most common in mammals?

a) unipolar;
b) multipolar;
c) psevdounipolyarnye;
d) bipolar;
e) apolar.

4. What are the organelles involved in the active transport of substances spikes of neurons?

a) microtubules;
b) neurofilament;
c) mitochondria;
d) ribosomes;
e) golgi complex.

5. A nerve cell has 5 processes. Specify the possible number it axons anddendrites?

a) 4-one axon and dendrite;
b) 3 dendrite and the axon 2;
c) 2 and 3 axon dendrites;
d) 1 and 4 dendrite axon.

6. With the introduction of colchicine is the destruction of the cytoskeleton. What will happen at the same time in the cytoplasm of neurons?

a) disappearance of golgi complex;
b) the disappearance of neurofibrillary;
c) violation axo- flow;
d) mitochondrial damage;
e) inhibition of protein biosynthesis.

7. Axon transported all EXCEPT:

a) vesicles;
b) neurotransmitter;
c) mitochondria;
d) ribosomes;
e) protein molecules.

Approximate refereed report on "Age characteristics of red blood cells"

CHAPTER IV. THE EMBRYOLOGY OF PERSON

TOPIC: Sex cells. Fertilization.

I. Goals and Objectives:

1. I met concept of human embryology;

2. To study the formation, the structure of gametes and fertilization stages.

II. Questions for self-preparation of students

1. The concept of embryology;
2. Progenies;
3. Spermatogenesis;
4. Stages of spermatogenesis;
5. Agenesis stage;
6. Fertilization;
7. Functional differences of male and female sex cells;
8. The clinical significance of the topic.

The theoretical part

The embryology is the science studying laws of development of a germ. Embryology the person studies laws of development of a germ of the person, structural, metabolic and functional features of a placentary barrier (system mother-placenta-fruit), the reasons of occurrence of uglinesses and other deviations from norm, and also regulation mechanisms embryogenesis.

Embryology studies following periods:

- pre-embrionalnyj (progenez-formation of sexual cages
- embrionalnyj (from the moment of fertilisation and till a birth);
- Early postnatal.
- Embryogenesis is a part of individual development, that is ontogenesis. It is closely connected with progenesis which shares on:

-ovogenesis; spermatogenesis

4.1. Sexual of cella

Mature sexual cages, unlike somatic, contain single (gaploid) a set of chromosomes. All chromosomes of a gamete, except for one sexual,

are called autosoms. In man's sexual cages at mammals sexual chromosomes or X, or Y, in female sexual cages - only chromosome X contain, the Differentiated gametes possess low level of a metabolism and are incapable of reproduction.

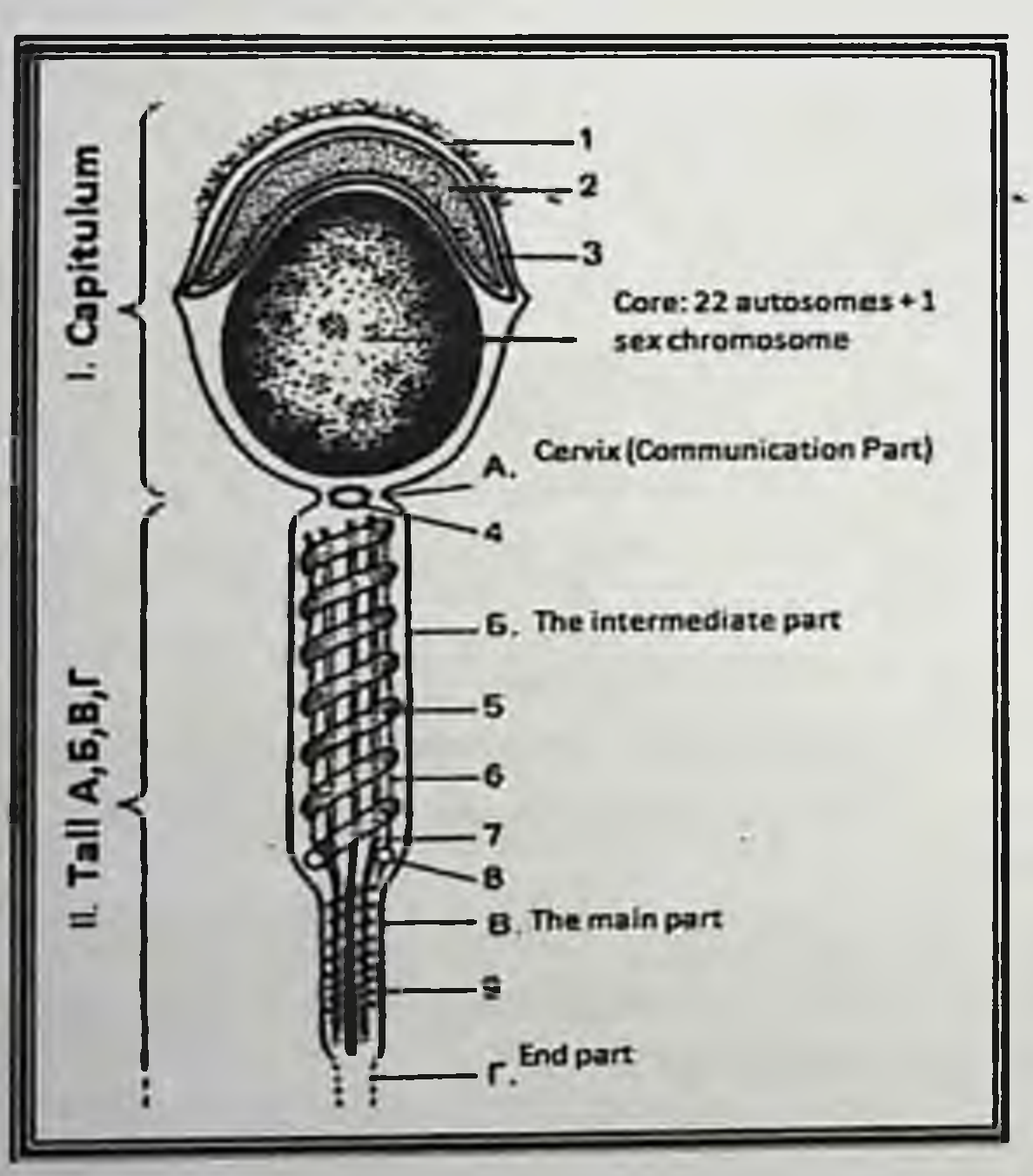
Progenesis includes spermatogenesis and ovogenesis (18-rice).

Spermatogenesis

Spermatogenesis is a development and formation of man's sexual cages. Spermatogenesis its average duration from 68 till 75 days proceeds in canals seed plants, and. Spermatogenesis at the person begins with the moment of puberty and proceeds during all active sexual period in considerable quantities.

Stages spermatogenesisa: reproduction; growth; maturing-division; formation.

Initial phase spermatogenesisa is reproduction spermatogon by a mitosis, the most part of cages continues shares, and the smaller part enters a growth stage. During this period of a cage grow, accumulate nutrients, and then turn in spermatocytes 1st order.



Picture-40. **Structure of men sexual system.** A 1-head 2-akrosom granul 3 "cover" 4-proksimal centriol 5-mitohondries 6-layer elastic fibrills 7-aksonema 8-distal centriol 9-circular fibrils.

The following phase maturing-division, is characterised by two reduction divisions, without interfaze. As a result of 1st division 1 spermatocyte 1st order 2nd gives rise spermatocyteам 2nd order, and 2nd division-maturing leads to occurrence 4 spermatid. The formation phase occurs at presence testosteron and androgen there is a transformation spermatid in spermatozoides. The kernel spermatidы gets the species-specific form, chromatin is condensed. The complex Goldjis migrates to a head top spermii and forms cover and acrosoma. Centriols go to an opposite pole, proximal the centriol forms a ringlet in the field of a neck, and distal the centriol gives rise aksonema - an axial thread spermii. Mithohondries keep within in an intermediate part of a tail. Microfilamentses surround aksonema in the main department of a tail, the terminal department of a tail represents a lash. Akrosoma contains spermatolysins (tripsin, gialorunidaz).

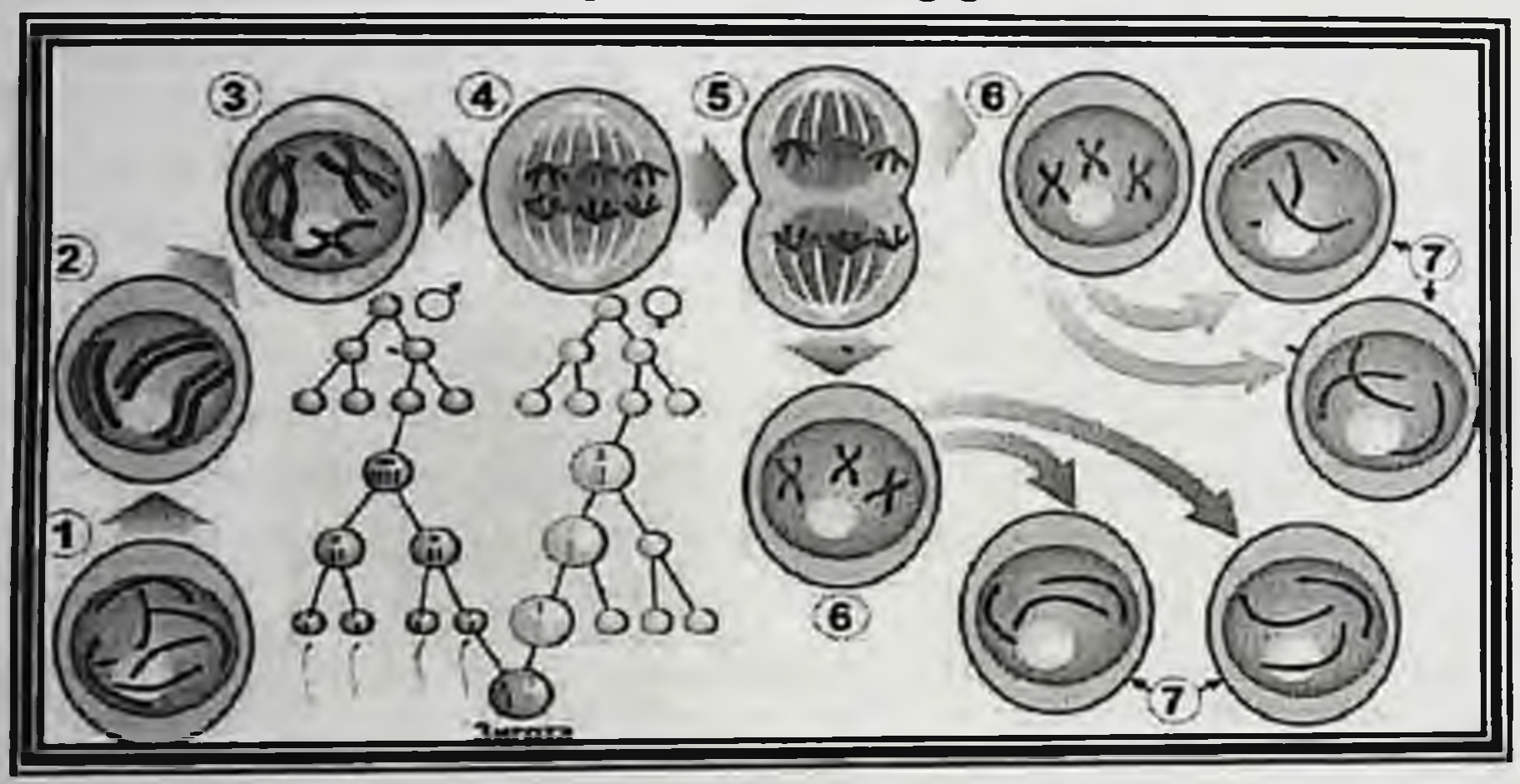
Spermatozoides are small, mobile cages, the size 30-60 microns. In spermatozoide distinguish a head and a tail. (18-rice). The head spermii has ovoid the form and includes the small dense kernel surrounded with a thin layer of cytoplasm. Kernels spermies are characterised by the high maintenance nucleoprotamins and nucleogistions. The forward half of kernel is covered by the flat sack making "cover"-akroblast spermii. In it at a forward pole settles down akrosoma. Cover and akrosoma Goldjis are derivatives of a complex. Akrosoma contains a set of enzymes among which the important place belongs gialorunidaze and proteaz, capable to dissolve the covers covering eggcytes. Behind a head is available annular narrowing. The head the same as also tail department, is covered by a cellular membrane. In a head membrane there are receptors.

The tail department spermii consists of binding, intermediate, main and terminal parts.

In a binding part or a neck centriols - proximal and distal from which the axial thread (aksonema) begins settle down. The intermediate part contains 2 central and 9 steams of the peripheral microtubules surrounded located on spiral mithohondries. mithohondries provide with energy impellent activity spermies which infringement is quite often connected with process defeat energy in mithohondries. The organ on a structure reminds a lash. It is surrounded thin fibrills by a vagina. Terminal, or the final part contains individual contracting filamentses (19-rice).

Ovogenesis

Ovogenesis is a process of formation and development of female sexual cages. It includes 3 phases: reproduction; growth; maturing.The reproduction phase begins in embrion the period and proceeds within 1st year of a life of the girl. By the moment of a birth for the girl is available about 2 million cages. By the puberty period remains about 40 thousand sexual cages and in subsequent 1 time in 28-32 days there is amaturing and an exit of one eggcytes in uterus a pipe - ovulation. Ovulation stops at approach of pregnancy or menopause. Essence of a phase of reproduction is mitoz division ovogonies.**The growth phase**, in the end of 1st year of a life of the girl reproduction ovogonies stops also cages яичника enter a phase of small growth, turning in ovogonies 1st order. There comes 1 block of growth which acts in film with puberty approach, that is occurrence of female sexual hormones.Further ovogonies 1st order enter a phase of the big growth.



Picture 41. **Formation of sexual cages Meyoz.** 1-Profazal a 2-metaphase I 3-anafaza. I 4-telofaza I 5-prophase II 6-metaphase II 7-anafaza II 8-telofaza II

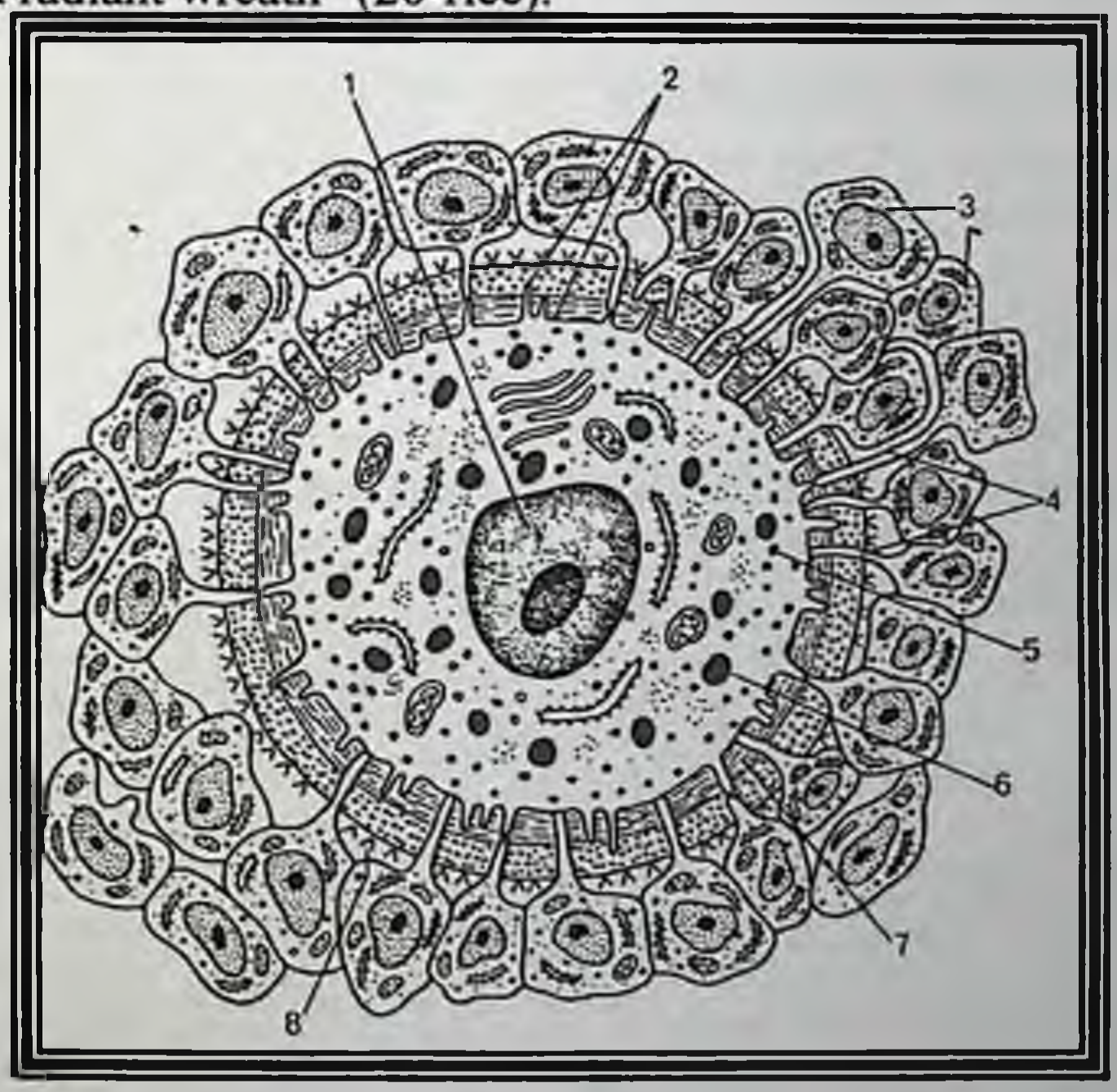
The maturing phase, as well as during time spermatogenesis, includes two divisions, and the second follows the first without interkinez, that leads to reduction (reduction) of number of chromosomes twice, and the set from becomes gaploid. At the first division of maturing ovocytes 1st order shares, therefore are formed ovocytes 2nd order and small reduction a little organ (19-rice).

Ovocytes 2nd order receives almost all weight of the saved up yolk and consequently remains so large on volume, as well as ovocytes 1st order. Reduction the little organ represents a small cage with a cy-

toplasm small amount. At the second division of maturing as a result of division ovocytesa 2nd order are formed one eggcytes and the second reduction a little organ. The first reduction the-little organ sometimes too shares on two identical small cages. As a result of these transformations ovocytes 1st order are formed one eggcytes and three reduction little organs. Eggcytes -it the largest cages in a human organ, their size makes about 130-160 microns. In cytoplasm eggcytes all organellas (except for the cellular centre) and inclusions, basic of them - a yolk (lecithin) contain. In eggcytes distinguish a vegetative pole in which the yolk collects, and animal the pole where is displaced a kernel.

The yolk is an inclusion which is used in eggcytes as nutrient; besides under ovolemme contain cortical granules which Goldjis are derivatives of a complex and form a fertilisation cover. In a kernel eggcytes is available gaploid a set of chromosomes, 22 are somatic and 1 () sexual.

Outside eggcytes it is covered 3-mja by covers, the person has following: ovolemma; a brilliant cover; a cover, образуемая follicular cages - "a radiant wreath" (20-rice).



Picture-42. **Structure of a female sexual cage.** A 1-kernel a 2-cytolemma 3-follicul 4-radiant wreath 5-kortikaln granules 6-yolk inclusions 7-bright zone a 8-receptor in fraction Zp3-N-acetilglikozami

The brilliant cover represents in the chemical relation glikozaminoglicans and proteoglicans which are an ability to live product eggcytes and follicular cages.

Classification eggcytes:.On quantity of a yolk in cytoplasm:

alecytal - anyolk; oligolecytal - inyolk;

polilecytal -multiyolk.

On character of an arrangement of a yolk in cytoplasm:

izolecytal - with uniform distribution of a yolk;

centolecytal - the yolk settles down in the centre eggcytes; somalecytal – yolk grains accumulate at one pole eggcytes (20-rice). Eggcytes the person concerns to oligolecytal and izolecytal.

4.2. Embryogenesis. Phase of the embryonic period

In embrion the period of development of the person distinguish 3 stages:

*beginner - 1 week;

*embrion-2-8 weeks;

*The perfect period-s8 of week.

Embryogenesis. Phases embriology the period

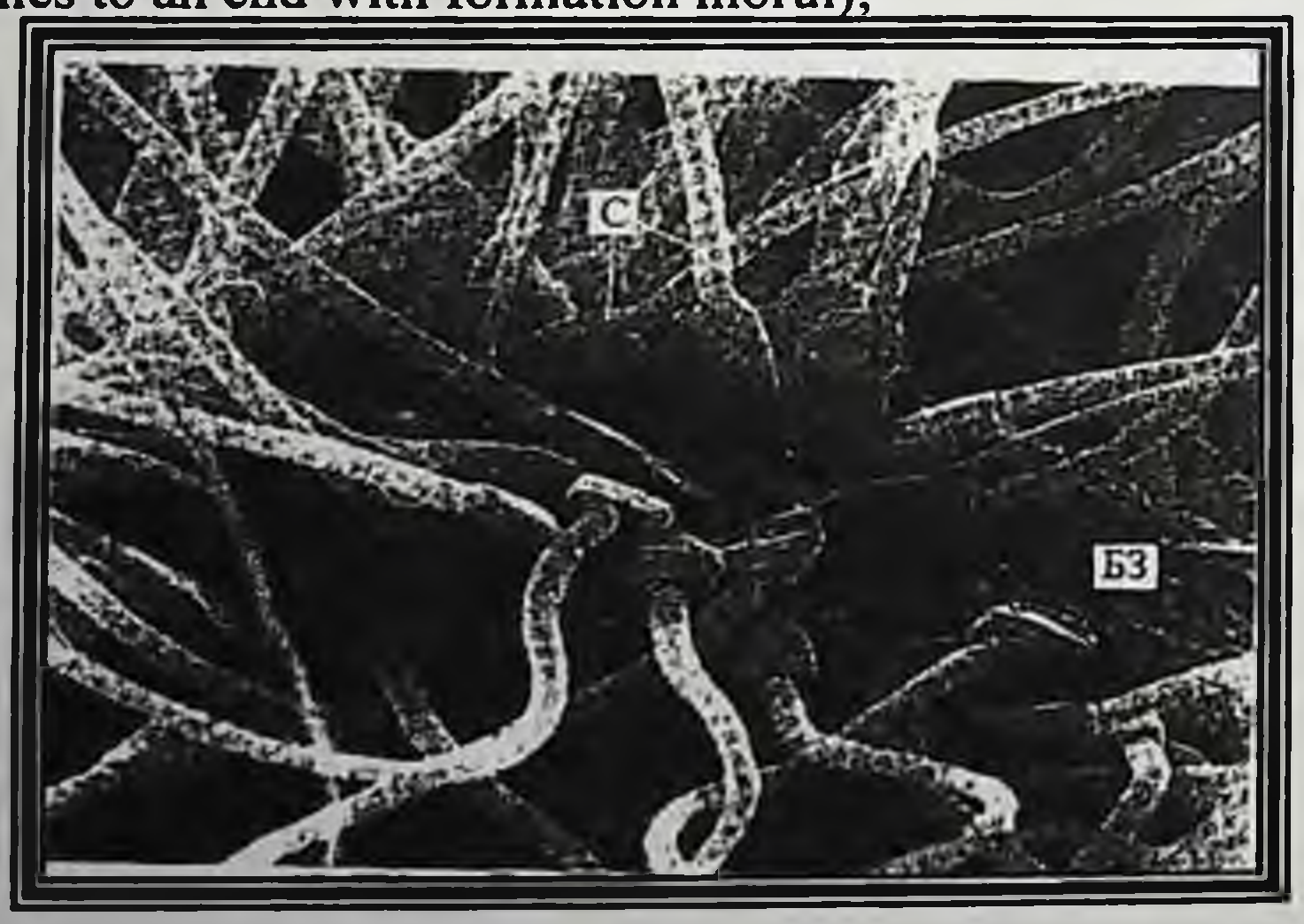
Embriology the period includes following phases:

- Fertilization

(Process comes to an end Zygote formation);

-Crushing (process

Comes to an end with formation morul);



- gastruljatsija (process comes to an end
Formation of 3 germinal leaves and axial rudiment of organs);
-gistogenez and organogenesis, sistemogenesis or formation of systems of organs.

Contact stage. S-spermatozoidy, the Bz-shining zone-cover.

4.2.1. Fertilisation

Fertilisation - process of merge of the man's and female gametes, leading to zygote formation. At fertilisation co-operate man's and female gaploid gametes, thus merge their kernels (pronucleus), chromosomes unite, and there is the first diploid a cage of a new organism - a zygote. The fertilisation beginning - the moment of merge of membranes spermii and eggcytes, the fertilisation termination - the moment of association of a material man's and female pronucleusов.

Fertilisation occurs in distal department uterus pipes and there pass 3 stages.

I stage - distant interaction, includes 3 mechanisms:

- hemotaksis - the directed movement spermatozides towards to eggcytes (ginigamones 1,2);

- reotaksis – movement spermies in sexual ways against a liquid current;

- kapatsitacia strengthening of impellent activity spermies, under
Influence of factors of a female organism (pH, slime and others).

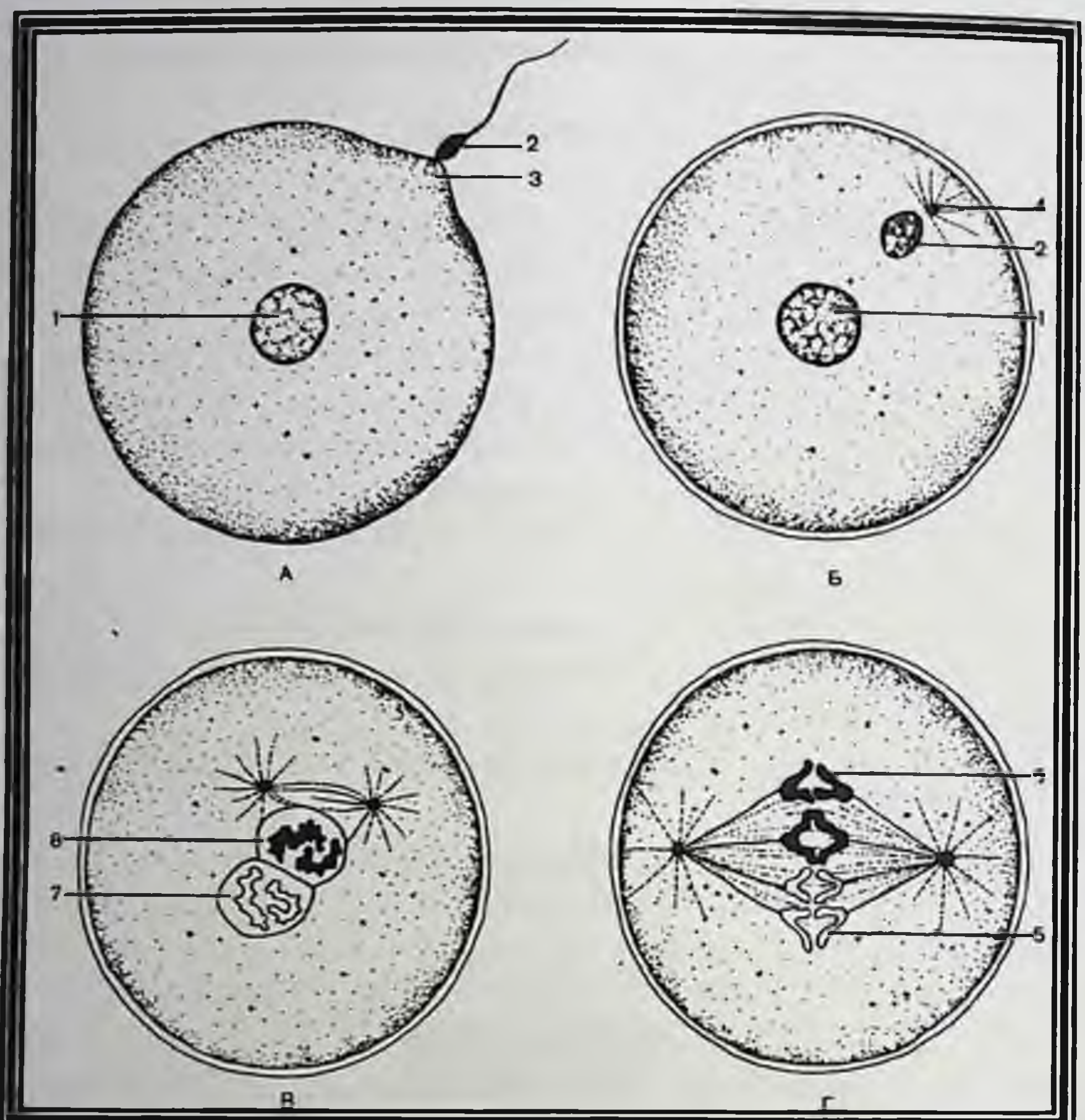
II stage - contact interaction (21-rice), for 1,5-2 ч spermatozoides come nearer to eggcytes, surround it and 4 turns in a minute lead to rotary movements, with a speed. Simultaneously from acrosoms spermies are allocated spermatozilines which loosen covers eggcytes. In that place where a cover eggcytesthins it is maximum, there is a fertilisation, ovolemma the head spermii is stuck out also gets into cytoplasm eggcytes, bringing with itself of a centriol, but leaving outside a tail.

III stage - penetration, the most active spermatozoid gets a head in eggcytes, right after it in cytoplasm eggcytes the cover of fertilisation which interferes полиспермии is formed. Then there is a merge man's and female pronucleus, this process carries the name sinkarion. This process (singam) also is actually fertilisation, there is diploid a zygote (a new organism, while monocelled) (22-rice).

The conditions necessary for fertization:

*concentration spermies is not less than 20-60 million in 1 ml;

* passability female sexual ways;
*normal organ temperature of the woman;
*alkaline environment in female sexual ways.



Picture-44. **Stages of fertilization:** a 1-kernel eggcytes; 2-kernel spermii; 3-fertization tuberculum; 4 centrosoma; 5chromosome eggcytes; 6-chromosomes spermi; 7 female pronucleus; 8-man's pronucleus

The practical part

Compilation of logical structures, the study of drugs and electron diffraction germ cell stages of fertilization schemes, viewing multimedia and Principal sketch of the structure of cells in the albums.

The objects under study:

1. Spermatozoid person.

2. Ovotsit person.
3. Stages of fertilization schemes

Sample tests

1. What is the initial period of development of the individual:
a) phylogeny;
b) embryogenesis;
c) the ontogeny;
d) gametogenesis.
2. What are the initial stage of embryogenesis:
a) crushing;
b) gastrulation;
c) fertilization;
d) organogenesis.
3. What are the main characteristics of mature germ cells:
a) differentiated;
b) diploid;
c) haploid;
d) undifferentiated;
e) not able to divide.
4. Name the final stages of embryogenesis:
a) crushing;
b) gastrulation;
c) histo-and organogenesis;
d) neurulation.

Approximate refereed report on "Comparative analysis of the process offertilization in humans and animals

TOPIC: Crushing, gastrulation.

I Aims and objectives: 1. to study the fragmentation of the zygote and blastocyst;

2. To study the significance and stages of gastrulation.

II. Sample questions for self-training.

1. The concept of fragmentation;
2. The blastocyst;
3. Types of crushing;
4. Fragmentation of the person;
5. Implatatsiya value;

6. Gastrulation;
7. Stages of gastrulation in humans;
8. Education of provisional bodies and zarodyschevyh sheets;
9. The clinical significance of the topic.

The theoretical part

4.2.2. Crushing

Crushing is consistently proceeding mitosis, without growth of the formed cages till the sizes initial. At crushing there is rather fast increase in quantity of cages (blastomer).Crushing goes until the parity of volume of a kernel to cytoplasm volume, characteristic for the given kind will be restored. The quantity blastomers increases from 2 to approximately 12-16 by third days after fertilisation when the zygote reaches stages morul and enters into a cavity of a uterus from uterus pipes.

Distinguish crushing: full, incomplete; uniform, non-uniform; synchronous, asynchronous.

At the person crushing full, asynchronous, non-uniform. As a result of the first division are formed 2 blastomer, dark and light, light share quickly and envelop a zygote outside - trophoblast, and dark are inside and share slowly: embrioblast. Crushing of a zygote at the person stops at a stage 107 blastomers.

Implantation

Implantation consists of 2 stages: * sticking;* immersing.

For 4th days after fertilisation in a uterus cavity drops out morul - group of the cages which have arisen during several divisions of crushing and prisoners in a transparent cover. About 2 days morul is in a uterus cavity in not attached condition, thus cages trophoblasta absorb nutrients and water from environment, the liquid collects in морулe and it turns in blastocysta. Blastocysta arises with occurrence blastocysta (the filled liquid of a cavity), the volume blastocysta increases also a germ gets the vial form. The transparent cover also disappears (23-rice).Adhesion is carried out by means of enzymes trophoblasta, these enzymes destroy the prepared mucous membrane of a uterus in the field of sticking, forming implantation a pole into which plunges blastocysta - immersing which occurs for 6-7 days after fertilisation.

4.2.3. Gastrulation

Simultaneously with implantation process in a germ begins gastrulating. Essence of process is.

The finished moving blastomers with formation of 3 germinal leaves (24 rice).

At mammals in gastrulation distinguish following processes:

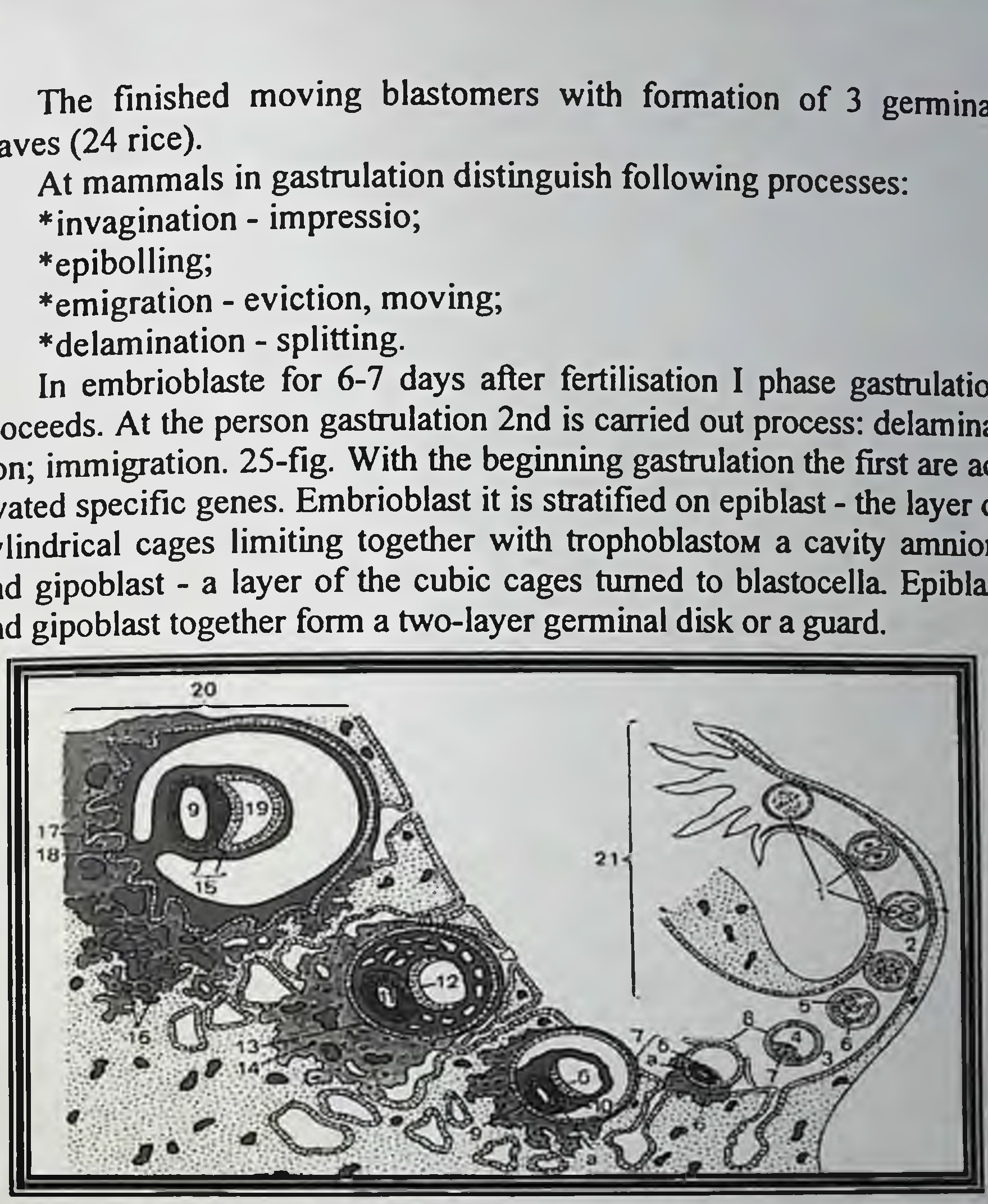
*invagination - impressio;

*epibolling;

*emigration - eviction, moving;

*delamination - splitting.

In embrioblaste for 6-7 days after fertilisation I phase gastrulation proceeds. At the person gastrulation 2nd is carried out process: delamination; immigration. 25-fig. With the beginning gastrulation the first are activated specific genes. Embrioblast it is stratified on epiblast - the layer of cylindrical cages limiting together with trophoblastom a cavity amnion, and gipoblast - a layer of the cubic cages turned to blastocella. Epiblast and gipoblast together form a two-layer germinal disk or a guard.



Picture-45. **Implantation, crushing, gastrulation.** 1 crushing. 2-morula. 3-blastocysta. A 4-cavity blastocysta. 5-embrioblast 6-trofoblast. A 7-germinal small knot epiblast gipoblast a fertilisation 8-cover. 9-amniot (ekzodermal) vial. 10 embryonic mezoderma. 11-ektoderma. 12-entoderma. 13-cytotrofoblast. 14-simplastotrofoblast. A 15-germinal disk. 16-lacunas with parent blood. 17-horion. 18-amniot leg. 19-y. vial. A uterus 20-mucous membrane. 21-tuba ovo.

From a germinal guard in a cavity blastocysta cages parenhim are moved, the part from these cages is pushed aside to cytotrophoblasty, thus formed horion.IIphase gastrulation begins for 14-15 days and proceeds about 17 days embryogenesis. In epiblaste owing to reproduction

and moving of cages the primary strip and a small knot is formed. Cages epiblasta located forward from a primary small knot, migrate through a primary pole under epiblast where it is formed of cages - a chord. The chord is between epiblastom and gipoblastom. Then throughout a primary strip it is formed impressio - a primary groove. Cages of a primary strip migrate through a primary groove and keep within between epiblast and gipoblast in a kind mezoderm wings so 3rd germinal leaf - mezoderma is formed.

From 17 to 21 days there is a differentiation of germinal leaves - presomit the period. By the very first it is differentiated ektoderma, its central part from head to kaudal the germ end is pressed through and formed a nervous tube. This process is called neurulation - process of a bookmark of nervous system and axial structures.

Stages neurulation:

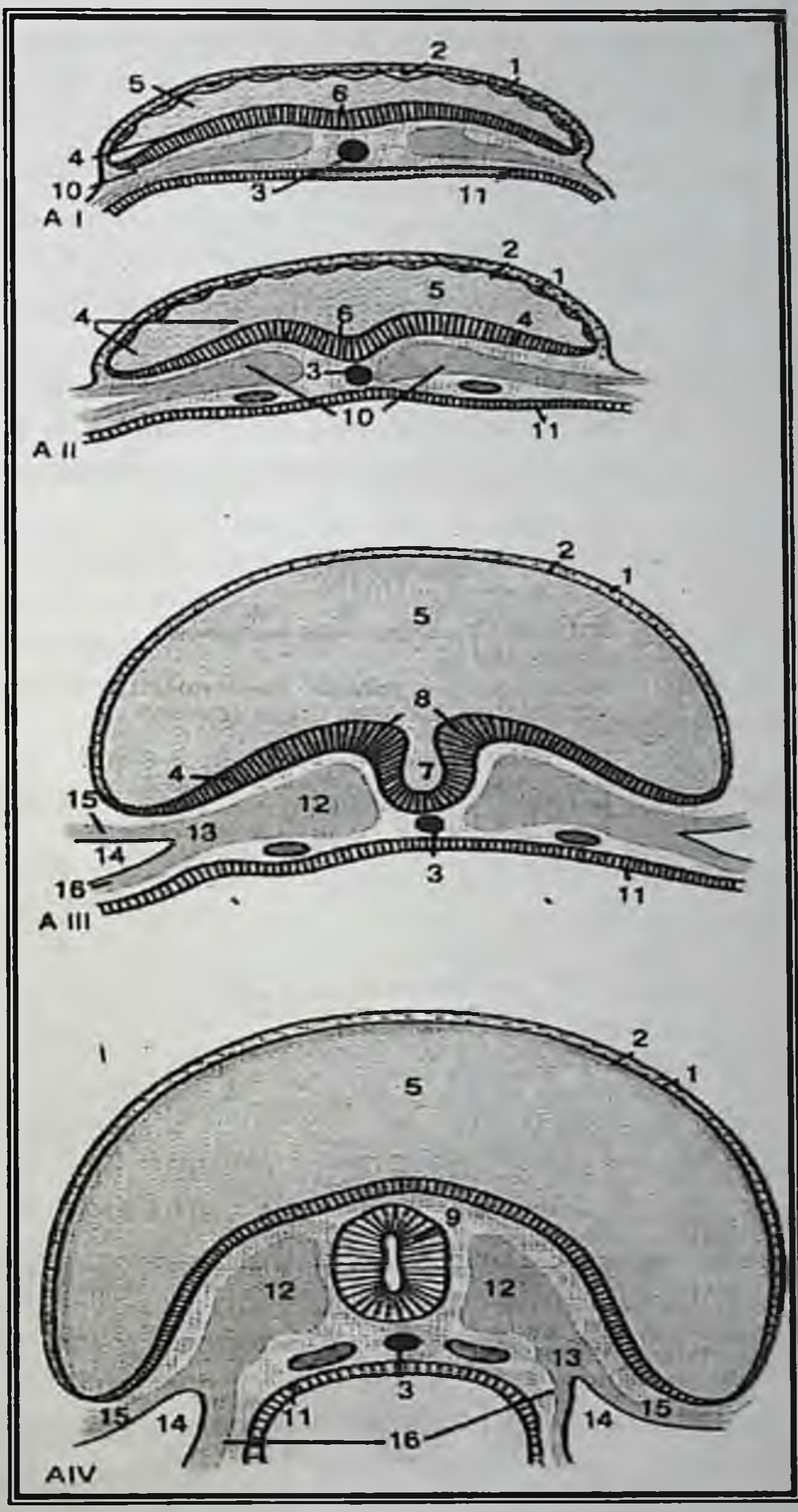
* induction a nervous plate;
* levator edges of a nervous plate and formation of a nervous fillet;
* levator nervous platens;
* shaping a nervous crest and the beginning of eviction from it cages;
* connecting nervous platens and formation of a nervous tube;
* connecting ektoderma over a nervous tube.

The congestion of cages between ektoderma and a nervous tube is called ganglios as a plate. With 21 till 35th day it is differentiated mezoderma - somit the period. Approach somit the period is marked by formation corpus folds which separates a germ from embryonic organs and promotes short circuit of an intestinal tube. In the beginning mezoderma it is differentiated on 3 parts :

dorsal; the intermediate; lateral- dorsal and ventral.Formation of a fruit and provizor organs.

Cages germinal mezoderma are moved from epiblasta, is formed presomit mezoderma, from which arise somits (44 steams) - symmetric pair structures on each side from a chord and a nervous tube.

As a result proliferation cages, their migration and the subsequent aggregation from somitomers it is formed dorsal mezoderma. Formation somits occurs from a head germ by the tail end. New pair somits is formed back from last already generated pair through a certain time interval. This interval averages 6,5 hours. In everyone somit distinguish sclerovolume, dermatom and miotom, their cages have the ways of migration and are a source for various structures.



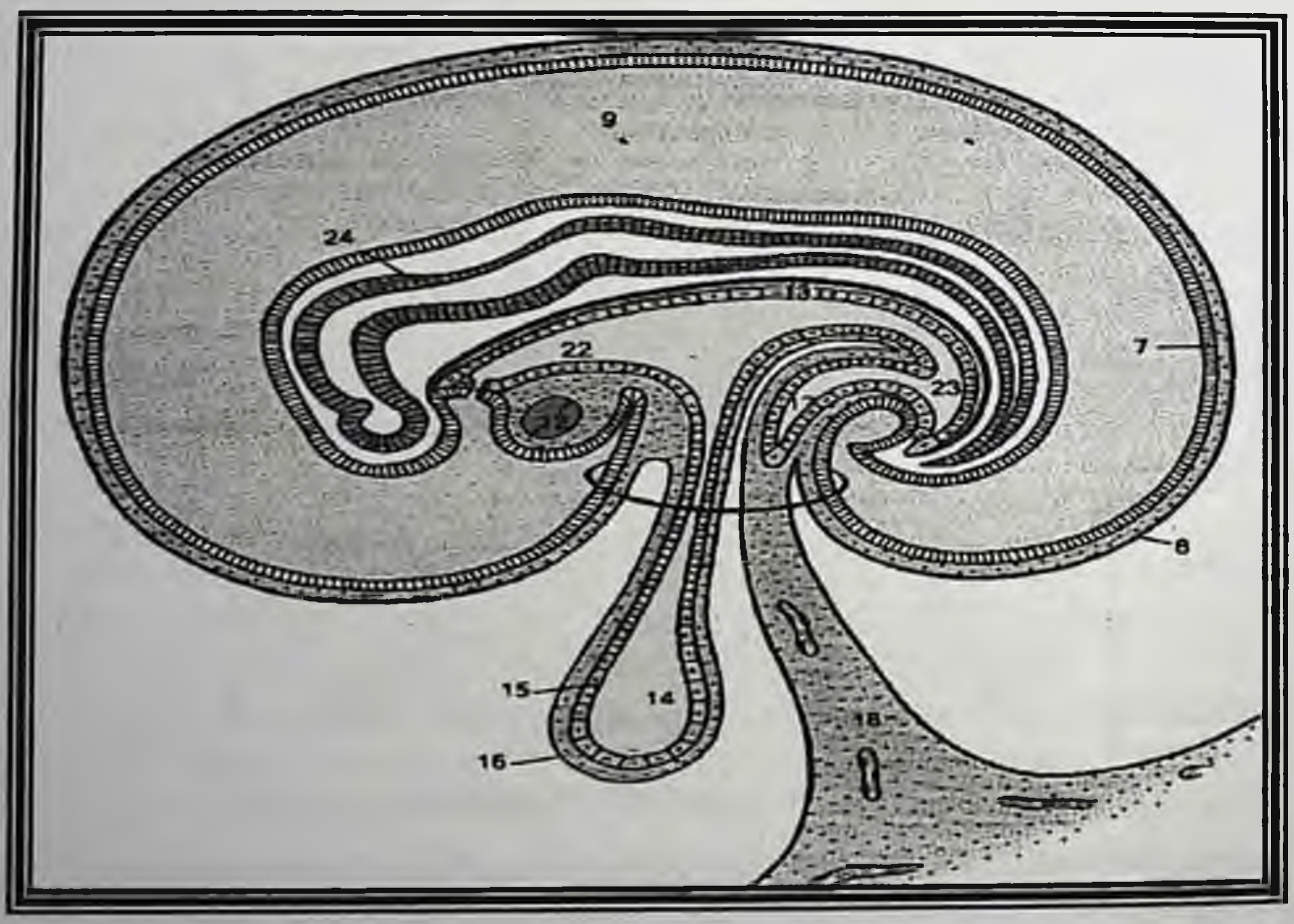
Picture-46. **Differentiation embrion leaves: formation primary rudiments. provizor organs:** amnion, allantois, yolkly bag. 7-ektoderma amnion. 8-mezoderma amnion 9-amnion cavity. A heart 12-rudiment. 13-entoderma.

Under the influence of a chord and a nervous tube of a cage ventromedial areas somits breed intensively and moved from somits, surrounding a chord and ventral part of a nervous tube - sclerovolume. The moved cages are differentiated in cartilago and form vertebras, edges, shovels.

In remained dorsolateral parts somit allocate somit (the inside layer of cages forming subsequently skeletal muscles) and derma (an external layer - a rudiment skin parts).

In caudal germ department dorsal mezoderma is not segmented and called nephrogen as a fabric. Intermediate mezoderma it is segmented with formation of segmentary legs -nephrotoms, a rudiment urinus and sexual systems.

Located lateral nephrotom mezoderma, it is split on two leaves – dorsal and ventral. Dorsal leaf - somatic mezoderma, from it serous covers are formed. The ventral leaf, or splanch mezoderma, from it is formed heart, a bark of adrenal glands, stroma gonad, connecting and muscul fabrics of internal organs and blood vessels.



Picture-47. **Process formation**

Embrion leaves and rudiments of organs. AI-AIV. 7-21-s' days of development, a cross-section cut. 1-mezoderma amnion 2 epitely amnion. A 3-chord.

4-ektoderma. A 5-cavity amnion. A 6-nervous plate a 7-nervous fillet the 8-nervous platen. A 9-nervous tube. 10-mezoderma. 11-entoderma. 12-somity. 13-somitnye legs. 14-embrionalnyj whole 15-somatoplevra. 16-splahnoplevra.

cavity yolk bag. 15-entoderma yolk bag 16-mezoderma yolk bag 17-allantois 18-connecting leg 22-forward gut 23-back gut 24-nervous tube.

Compilation of logical structures, the study of types and stages of crushing and gastrulation, viewing multimedia and sketch diagrams crushing and gastrulation in albums.

The object being studied: the preparation chicken (embryonic sheets), multimedia, circuit crushing and gastrulation.

Sample test items

1. Give the period of transition from a single-celled stage (zygote) to multicellular development (blastocyst):

a) fertilization;
b) gastrulation;
c) histogenesis;
d) chipping.

2. What are the final stages of embryogenesis:

a) crushing;
b) gastrulation;
c) histo- and organogenesis;
d) neurulation;
e) systemogenesis; f-fertilization.

3. What type of cell division is characteristic of the human zygote?

a) full uniform;
b) full uneven (asynchronous);
c) partial.

4. Specify the components of the blastocyst:

a) trophoblast;
b) ectoderm;
c) embryoblast;

d) endoderm;
e) ekzotselom (cavity).

5. Name the process by which the embryo establishes a connection with the body of the mother.

a) gastrulation;
b) implantation;
c) histogenesis;
d) fertilization;
e) placentation.

6. What are the usual time of implantation in humans after fertilization?

a) 1-3 hours;
b) 3-5 hours;
c) 5-6 hours;
d) 7-8 hours;
e) 10-12 hours.

4.2.4. Hysto-organogenesis

I. Goals and Objectives: To study the stages of organogenesis histo, differentiation of tissues and organs.

II. Sample questions for self-training:

1 The concept of histogenesis;
2. The concept of organogenesis;
3. The ectoderm; formed therefrom tissues and organs;
4. Entoderma; formed therefrom tissues and organs;
5. Mesoderm;
6. Emerging from the mesoderm tissues and organs;
7. Critical periods of ontogenesis;
8. The clinical significance.

The theoretical part

Every cell in the developing embryo contains a specific set of genes - the genome, the set of genes of an organism - genotype. At the heart of histogenesis based on the following processes: proliferation - reproduction; growth; migration; induction; determination; differenttiation.

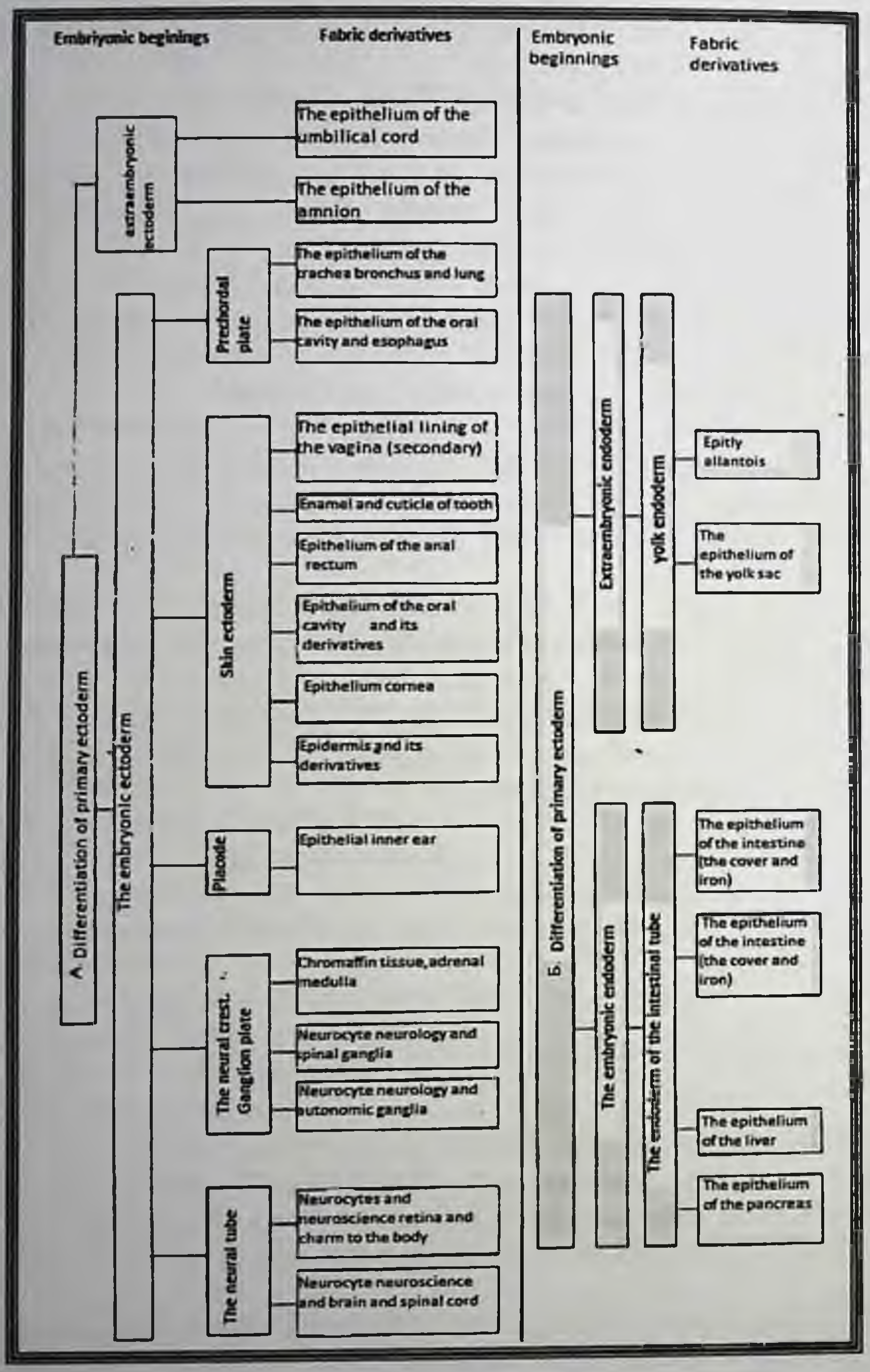
Distinguish intestinal endoderm and yolk sac. From the endoderm develops intestinal epithelium of the gastrointestinal tract and the major

digestive glands, liver, pancreas. The yolk endoderm gives rise to the primary blood cells and germ cells.

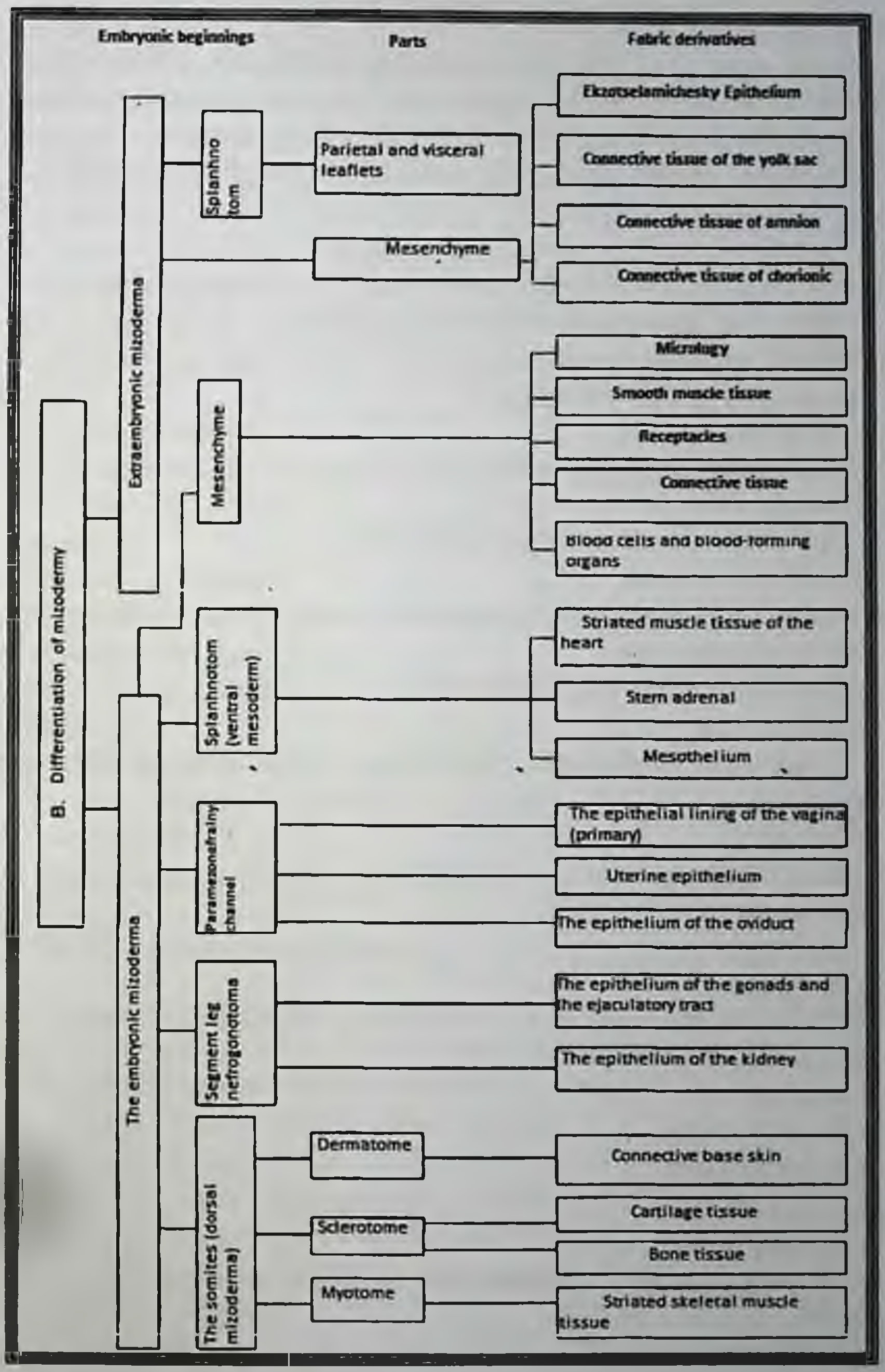
Distinguish cutaneous ectoderm, extraembryonic ectoderm and neuroectoderm. Of cutaneous ectoderm develop the epidermis, hair, nails and skin cancer. Of neuroectodermal developing neural tube and plate ganglion. Extraembryonic ectoderm of developing connective tissue. From the mesoderm - dermatomes-somites formed dermis of the skin, from the myotome-somites striated muscle tissue from sclerotome-somites - bone and cartilage. Of the parietal layer develops splanchnotome serosa peritoneum, pleura, pericardium, from the visceral leaf splanchnotome - endocardium, myocardium.

Future pediatricians, family physicians should be aware of the anomalies that occur in infants and the timing of their occurrence in the embryonic period. At the bottom are some anomalies in terms of occurrence of embryonic and fetal development (Yu.I.Afanasev and N.A.Yurina 2013)

Just encouraged not to have an idea about the sources of tissues and organs. Any tissue or organ in the beginning has its predecessor - the germinal temporary agencies. They are given in schemes V.V.Yaglova where three germinal zarodyschevyh sheets formed bodies and, more tissues and organs, respectively. These schemes are given in the form of drawings 48 and 49.


Embriyonic beginings
Fabric derivatives
Embryonic beginnings
Fabric derivatives
A. Differentiation of primary ectoderm
The embryonic ectoderm
extraembryonic ectoderm
The epithelium of the umbilical cord
The epithelium of the amnion
Prechordal plate
The epithelium of the trachea bronchus and lung
The epithelium of the oral cavity and esophagus
Skin ectoderm
The epithelial lining of the vagina (secondary)
Enamel and cuticle of tooth
Epithelium of the anal rectum
Epithelium of the oral cavity and its derivatives
Epithelium cornea
Epidermis and its derivatives
Placode
Epithelial inner ear
The neural crest. Ganglion plate
Chromaffin tissue, adrenal medulla
Neurocyte neurology and spinal ganglia
Neurocyte neurology and autonomic ganglia
The neural tube
Neurocytes and neuroscience retina and charm to the body
Neurocyte neuroscience and brain and spinal cord
B. Differentiation of primary ectoderm
The embryonic endoderm
Extraembryonic endoderm
yolk endoderm
Epitly allantois
The epithelium of the yolk sac
The endoderm of the intestinal tube
The epithelium of the intestine (the cover and iron)
The epithelium of the intestine (the cover and iron)
The epithelium of the liver
The epithelium of the pancreas

Picture-48.


Embryonic beginnings
Parts
Fabric derivatives
B. Differentiation of mizodermy
Extraembryonic mizoderma
Splanhnotom
Parietal and visceral leaflets
Mesenchyme
Ekzotselamichesky Epithelium
Connective tissue of the yolk sac
Connective tissue of amnion
Connective tissue of chorionic
Mesenchyme
Micrology
Smooth muscle tissue
Receptacles
Connective tissue
blood cells and blood-forming organs
The embryonic mizoderma
Splanhnotom (ventral mesoderm)
Striated muscle tissue of the heart
Stern adrenal
Mesothelium
Paramezonafrainy channel
The epithelial lining of the vagina (primary)
Uterine epithelium
The epithelium of the oviduct
Segment leg nefrogonotoma
The epithelium of the gonads and the ejaculatory tract
The epithelium of the kidney
The somites (dorsal mizoderma)
Dermatome
Connective base skin
Sclerotome
Cartilage tissue
Bone tissue
Myotome
Striated skeletal muscle tissue

Picture-49.

The practical part

Compilation of logical structures, the study in the schemes, multi-media slide gistoroganogeneza processes, viewing multimedia, sketch entities germinal bodies and their derivatives in the albums.

The objects under study: drug - education trunk folds in birds.

Sample test items

1. What are the derivatives of the epiblast?

a) germ ectoderm;
b) extraembryonic ectoderm;
c) germ endoderm;
d) hordomezodermalny rudiment;
e) neural tube.

2. What are the derivatives hypoblast?

a) In the ectoderm;
b) extraembryonic endoderm;
c) Germ endoderm;
d) Hordomezodermalny rudiment;
e) neural tube.

3. Name the embryonic beginnings of developing from the ectoderm.

a) somites;
b) neural tube;
c) nephrotomy;
d) myotomy;
e) ganglionic plate;

4 What are the embryonic beginnings of developing from the mesoderm.

a) somites;
b) intestinal tube;
c) mesenchyme;
d) nephrotomy;
e) Splanhnotom.

5. Indicate which tissues and organs develop from gut endoderm:

a. cerebrum;
b. epithelium of the liver;
c. pancreatic epithelium;

d. kidneys;

b) C-epithelium of the gastrointestinal tract.

6 Specify which tissues and organs develop from cutaneous ectoderm:

a) In the epidermis;

b) spleen;

c) sweat and sebaceous glands;

d) epithelium of the vestibule of the oral cavity;

e) tooth enamel.

7. What are the tissues and organs develop from neuroectodermal?

a) nervous tissue;

b) neurocytes and neuroglia of the brain and spinal cord;

c) neurohypophysis;

d) retina;

e) olfactory organ.

8. Specify which tissues and organs develop from mesoderm dermatomes somites:

a) In the epidermis;

b) Kidney;

c) mesothelium;

d) connective tissue of the skin (dermis);

e) stomach.

Approximate refereed report "histogenesis in humans"

The Theme. Provisory organs

I. Aims and objectives: 1. Understand what the role of provisional bodies; 2. The study of the formation and structure of provisory

II. Sample questions for self-study:

1. Structure and function of the chorion;
2. Structure and function of the amnion
3. Structure and function of the yolk sac;
4. Structure and function of the allantois;
5. The first foci of hematopoiesis;
6. Umbilical cord;
7. The mother-fetus;
8. The clinical significance.

4.2.5. Provisory organs

Inner-uterus character of development of an embryo demands a fast establishment of communication between it and mother. Therefore appear and the fabrics intended for performance of these functions are quickly differentiated.

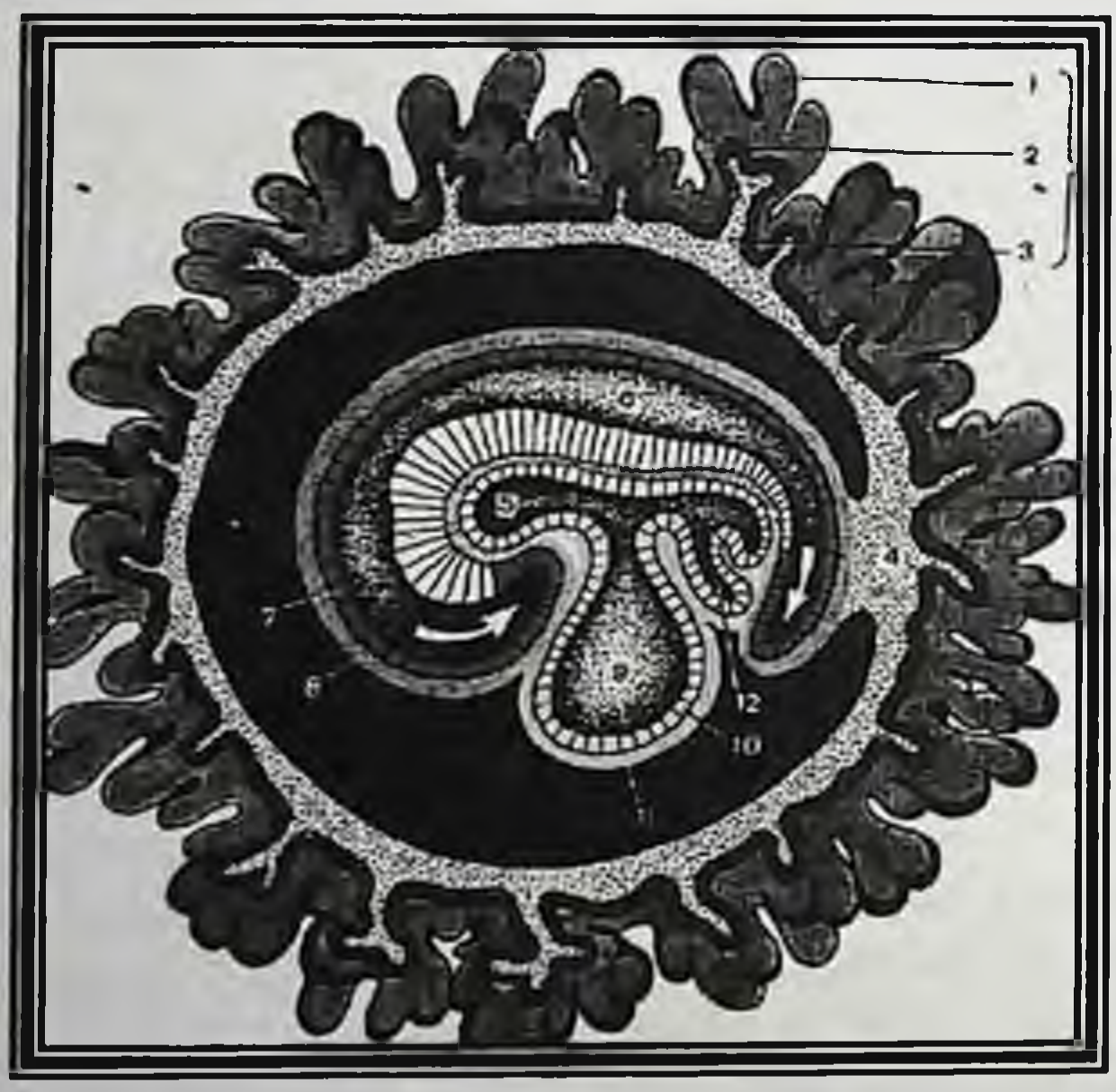
These organs carry the name provizor organs, them concern:

horion; amnion; yolkly a bag; allantois (50-pic).

They form germ covers, connect it with an organism of mother and carry out some special functions. By the first of provizor organs it is formed horion.Uterus mucous membrane by the implantation moment mucous glands reach maximum activity. At immersing blastocysta in a uterus mucous membrane, enzymes trophoblasta destroy vessels and glands. It is thus formed blood which surrounds blastocysta.

Arrows designate a direction formation corpus folds.

Blood contains all necessary nutrients, thus trophoblast provides a germ hystotrophical with food type.



Picture-50. **Germ of the person at a formation stage corpus folds and embryonic organs (the scheme on P.Petkovu):** 1-simplastotrofoblast. 2-cytotrofoblast. 3-embryonic mezoderma. A 4-place amnion legs. A 5-primary gut. A 6-cavity amnion. 7-ektoderma amnion. 8-embryonic mezoderma amnion. A 9-cavity yolk bag. 10-entoderma yolk meshka. 11-embryonic mezoderma yolk a bag. 12-allantois.

At immersing in implantation a pole a food of cages trophoblasta as much as possible improves, that leads them mitoz to division. As a result of it the new structure - simplastotrophoblast is formed, are thus formed numerous offshoots - primary offshoots (27-rice).

Trophoblast it is differentiated on cytotrophoblast which consists of intensively breeding cages. Simplastotrophoblast it is formed by cell fusion cytotrophoblasta

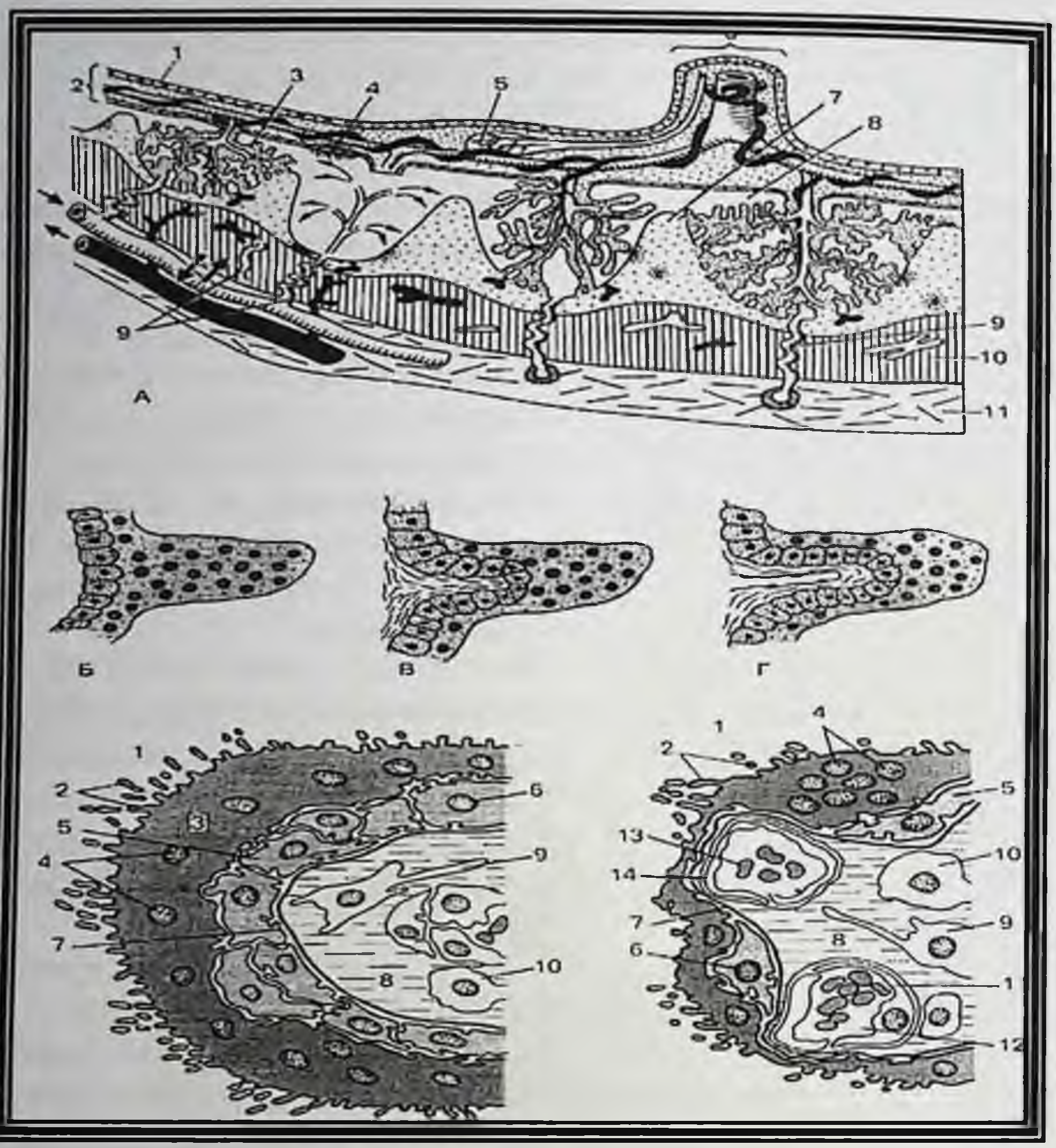
Structure horiona: embryonic mezenhima; cytotrophoblast;

simplastotrophoblast. In a consequence from horiona it will be formed a placenta part. Other part offshoots cages stratifies blastocysta dividing it on sectors, as a result of such stratification to gipoblasty connect a vial filled with a liquid and the same to epiblasty. From edges gipoblasta cages embrionic entoderms are moved and grow up at earlier formed mezenhim bookmarks - yolk a bag. From edges epiblasta cages embrionic ektoderma are moved, is formed amnion.

Amnion - the voluminous bag forming fold filled amnion with a liquid. On the belly party amnion it is attached to a germ organ. Generated amnion the bag is filled with a liquid protecting a germ at concussion, allowing a fruit to make movements and preventing connecting a fruit with surrounding fabrics. The fruit swallows amnion a liquid which thus gets to intestines. In amnion a liquid the fruit allocates urine.

Amnion consists from: epiblasta - future ektoderma; embryonic mezenhima; embryonic ektoderma.**Vitellicle**- taken out for limits of a germ a part of a primary gut. The wall yolk a bag consists of two layers. The inside layer is formed embrionic entoderms, and external - embrionic mezoderms. Folds amnion squeeze yolkly a bag, forming the narrow crosspiece connecting it with a cavity of a primary gut - yolkly a small stalk. This structure is extended and comes into contact the leg of a organ containing allantois. Yolkly the bag usually completely grows by the end of 3rd month of development of a fruit.

The back wall yolk a bag by 14-16 day of development forms **small offshoot - allantois,** formed embrionic entoderms and mezoderms. Distal the part allantoisa in process of growth quickly extends and turns to a bag connected to a gut by means of a leg. At the person allantois rudimentary participates in formation of a vascular network of a placenta. It proximal the department concerns bladder formation that it is necessary to consider at anomalies of development of this organ.



Picture-51. **The Placenta haemohorial type. Dynamics of development vorsin horiona is shown.** A placenta A-structure (arrows specify blood circulation in vessels and in one of lacunas where the fiber is removed): 1-epitely amnion 2-horial a plate a 3-fiber 4-fibrinoid 5-yolkly a bag 6-umbilical cable a 7-partition of a placenta a 8-lacuna a 9-spiral artery 10-bazal layer endometry 11-miometry. The B-structure primary offshoots trophoblasta (1st week). A V-structure secondary epitelial-mezenhimalnoj offshoots horiona the G-structure tertiary offshoots horiona - epitelial-mezenhimalnoj with blood vessels (3rd week) D - a structure offshoots horiona (3rd month) the E-structure vorsin horiona (9th month): 1-interfleecy space of a 2-microfiber 3-simplastotrofoblast 4-kernels simplastotrophoblasta 5-cytotrofoblast 6-kernels cytotrophoblasta 7-bazal a membrane 8-intercellular space 9-fibroblast 10-macrofags (Kaschenko-Goffbauera cage) 11-endoteliotsit a blood vessel 12-gleam 13-erithrocytes 14-bazal a haemocapillary membrane (on E.M.Shvirtsu).

Functions provizor organs

*horion carries out protective, trophicendocrine, exretory functions; 28-fig.

*yolkly the bag participates in formation of primary blood vessels and primary sexual cages;

*amnion - development waters, protection of a fruit against mechanical damages, maintenance of certain concentration of salts in waters; *allantoisy sprout primary blood vessels from a germ to horiony, forming a placentary circle of bloodcirculation.

The practical part

Compilation of logical structures, the study of drugs, viewing multimedia, and a sketch of the principle structure of the amniotic, yolk sac, chorion and allantois to albums

The objects under study. The drug chorionic villi. 2. The preparation of the umbilical cord

Sample tests

1. What are the sources of human amnion develops wall?

a) extraembryonic ectoderm;
b) ectoderm germ;
c) germ-mesoderm;
d) extraembryonic mesoderm.

2. Identify sources of the yolk sac man?

a) germ ectoderm;
b) extraembryonic endoderm;
c) germ mesenchyme;
d) extraembryonic mesoderm.

3. What type of human placenta?

a) multiple desmohorialnaya placenta;
b) epiteliohorialnaya diffuse placenta;
c) banded gemohorialnaya placenta;
d) belt endoteliohorialnaya placenta.

4. Specify the function of human placenta:

a) trophic;
b) excretory;
c) endocrine;
d) Protection;

e) link provides the fetus with the mother.

5. What structures form the wall of the yolk sac?

a) germ endoderm;
b) extraembryonic endodermal epithelium;
c) germ ectoderm;
d) extraembryonic mesoderm;
e) extraembryonic ectodermal epithelium.

6. What structures form the wall of the amniotic sac?

a) nucleation ectodermal epithelium;
b) extraembryonic ectodermal epithelium;
c) ventral mesoderm Visceral layer;
d) extraembryonic mesoderm (connective basis);
e) nucleation endodermal epithelium.

7. What does the amniotic membrane in mammals?

a) trophic;
b) respiratory;
c) excretion;
d) hematopoietic;
e) creating the aquatic environment for the fetus.

8. What does the allantois in mammals?

a) conducting blood vessels of the body of the fetus to the placenta;
b) gas exchange;
c) excretion;
d) hematopoietic;
e) creating the aquatic environment for the fetus.

Approximate refereed report "Features of provisional organs in animals and humans"

4.2.6. Placenta

I. Goals and objectives:

1. Know the function of the placenta.
2. To study the structure of the placenta.
3. The value of the placental barrier.

II. Questions for self-control students:

1. The concept of the placenta.
2. The development of the placenta.
3. The functions of the placenta.

4. Gematohorialny barrier;
5. Factors that stimulate the activity of the placenta;
6. The system of mother-fetus;
7. Violations in the activities of the placenta;
8. The clinical significance.

The theoretical part

The placenta (afterbirth) is a type of human Banded gemohorialnyh villous placenta. Placenta is composed of two parts: the embryonic or fetal and maternal. Fetal part is branched and chorion adherent to him from within the amniotic sac and maternal - modified the mucous membrane of the uterus, are rejected at birth. The development of the placenta begins on the third week, when the secondary villi begin to grow blood vessels and form tertiary villi, and ends at the end of the third month of pregnancy. Chorionic villi are washed by the blood of the mother, streamed from broken blood vessels in the endometrium gaps. However, maternal and fetal blood in normal conditions never mixed. Gematohorialny barrier separating the two flow consists of fetal vascular endothelium, connective tissue surrounding the vessels, the epithelium of chorionic villi (simplastotrofoblast and cytotrophoblast), and moreover, fibrinoid of which covers-Nap places outside.-

Fetal part of the placenta by the end of the third month is represented by branching chorionic plate consisting of a fibrous (collagenous) connective tissue covered by cyto- and simplastotrofoblastom (multi-core structure, covering reduces the cytotrophoblast. Structural and functional unit of the placenta is formed cotyledon formed stem ("anchor") nap and its secondary and tertiary (final) ramifications. The total number of cotyledons in the placenta reaches 200.

Maternal part of the placenta is presented basal lamina and connective tissue septa separating cotyledons from each other, as well as the gaps filled with maternal blood. The basal layer of the endometrium (lamina basalis) - connective tissue lining of the uterus contains decidual cells. These large, glycogen rich cells of the connective tissue are located in the deep layers of the mucous membrane of the uterus. They have clear boundaries, round nuclei and cytoplasm oxyphilous. During the 2nd month of pregnancy decidual cells significantly upsize. In their cytoplasm but glycogen detected lipids, glucose, vitamin C, iron, nonspecific esterase, dehydrogenase, succinic acid and lactic acid.

Formation of the placenta ends at the end of the 3rd month pregnancy. Placental function: 1) breathing, 2) transport nutrients, water, and electrolytes immunoglobulins 3) secretory 4) endocrine, 5) involved in the regulation of myometrial contraction.

Fetal breathing provided by the oxygen attached to the hemoglobin maternal blood that enters by diffusion into the blood stream through the placenta to the fetus, where it connects with fetal hemoglobin.

Transport of nutrients required for fetal development comes from the mother's blood through the placenta into the fetal blood, and vice versa, from the blood of the fetus in the mother's blood in the transport of immunoglobulins (Ig) are involved pinocytic vesicles simplastotrofoblasta. Placental amniotic fluid penetrate in Ig class G and A (IgG, IgA).

Endocrine function. Spot production of placental hormones are particularly simplastotrofoblast cytotrophoblast and decidual cells.

One of the first placenta synthesizes chorionic gonado-

tropin, B chorion, and decidua synthesized in progesterone. Progesterone (first produced by the corpus luteum in the ovary, and with 5-6 weeks of the placenta) inhibits contractions of the uterus, stimulates its growth, has immunosuppressive effect by inhibiting the reaction of rejection of the fetus.

Moreover, melanocyte synthesized in the placenta and adrenocorticotropic hormone, somatostatin, etc.

Critical periods

It has been established that in the embryonic and post-embryonic period have the following stages (critical periods) of which are the most sensitive to the fetus to various (especially negative) factors. Significant factors in the negative impact of these periods results in defects of the organism. On this issue, the Russian scientist Světlov did a great job. At present there are 13 such periods:

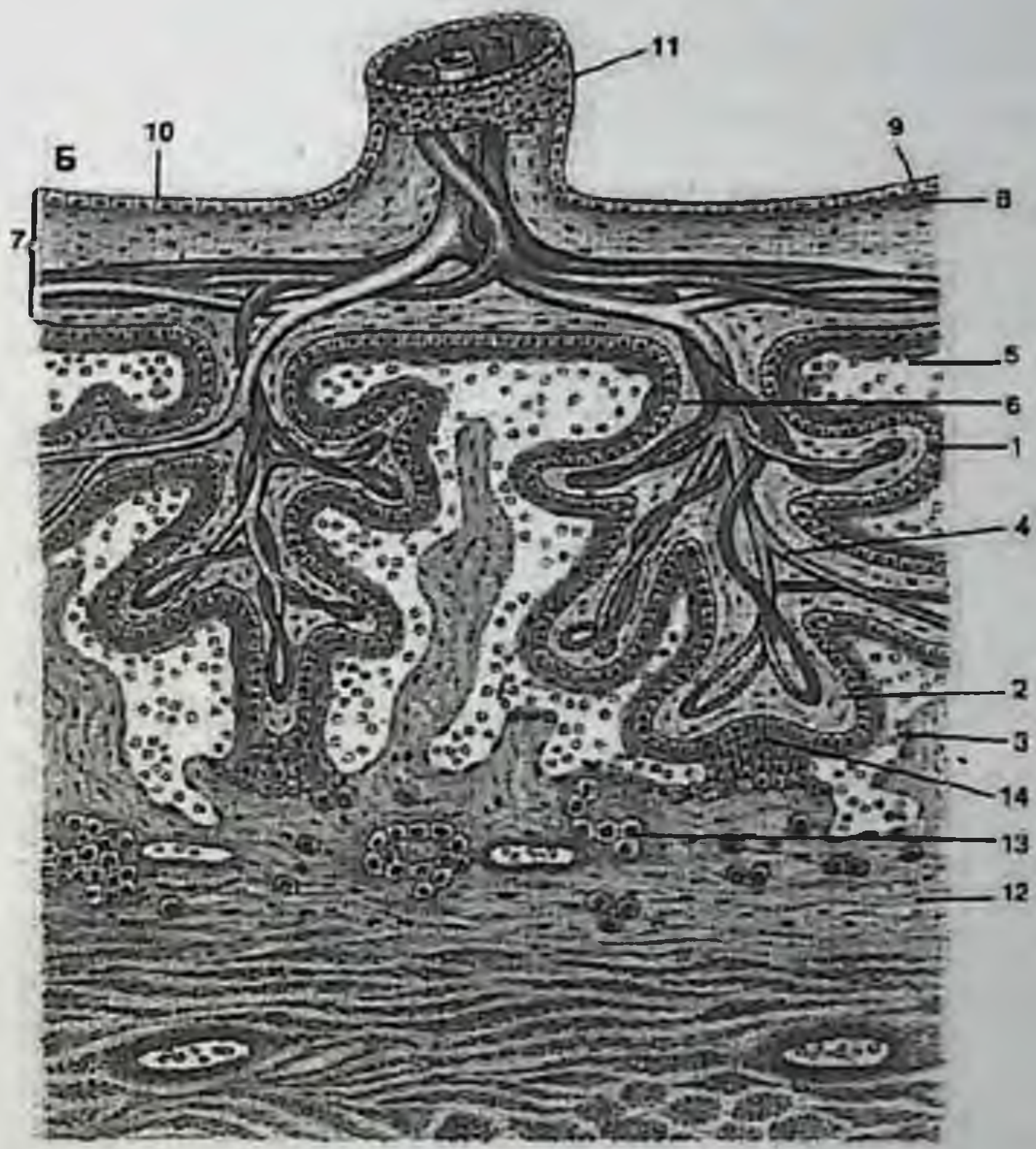
1) Gametogenesis (oogenesis and spermatogenesis);
2) fertilization;
3) Crushing;
4) Implantation;
5) Gastrulation;
6) Histo-organogenesis
7) neurulation;
8) placentation;
9) Steps enhanced growth of the brain (15-20 weeks);

10) System genesis and differentiation of the genital apparatus (20-24 weeks);

11) Birth;

12) the neonatal period (one year);

13) during puberty.



Picture-52. **the Scheme of a structure of a placenta.** 1 terminal fiber horiona. 2-connecting fabric of a fiber. 3-sintsititrofoblast. 4-capillaries. 5-interfleecy space. 6-7-horial a plate. 8-connecting fabric amnion. 9-epitely amnion. 10-amnion. 11-umbilical cable. 12-connecting fabric endometry. 13-detsidualnye cages. 14-cytotrofoblast

The practical part

Compilation of logical structures, the study drug placenta, charts, and view multimedia sketch of the principle of the structure of the placenta in the albums.

Learning object - preparation of the placenta.

Sample test items

1. Indicate which structures (tissue) are part of the placenta (gematohorialnogo) barrier:

a) chorionic (trophoblastic) epithelium;
b) Connective tissue villi;
c) basement membrane;
d) capillary endothelial villi.

2. What, what structures are part of the fetal part of the placenta:

a) vessels of the fetus;
b) chorionic plate;
c) chorionic villi;
d) amniotic membrane, adherent to the chorion.

3. Name, which tissues and structures are part of the maternal part of the placenta:

a) amniotic epithelium;
b) decidua caduca;
c) Blood gaps;
d) chorionic connective plate;
e) connective septum;
f) decidual cells.

4. What are the fabric layers is the amniotic sac?

a) amniotic epithelium;
b) Connective tissue layer;
c) smooth muscle;
d) trophoblastic chorionic epithelium;
e) cytotrophoblast.

5. Specify the basic functions of human placenta:

a) barrier;
b) Trophic;
c) Breathing (gas exchange);
d) endocrine (hormonal);
e) Alimentary;
f) Development of amniotic fluid.

6. Specify the structures that make up the primary chorionic villi?

a) cytotrophoblast;
b) extraembryonic connective tissue;
c) Plazmodiotrofoblast.

V CHAPTER. GENERAL HISTOLOGY

5.1. General principles of the organization of tissues. Epithelial tissue

Fabric - historically (phylogenetically) the existing system of cells and non-cellular structures with community structure, and sometimes origin, and specialized to perform specific functions. Fabric - a new (after cells) level of organization of living matter.

Tissue components

Cells are the basic functional components of the leading tissue. All other structural components of the tissue (intercellular substance) are derived cells. Virtually all tissues are composed of several cell types. Besides cells of each type in the tissues may be at different stages of maturity - differentiation. Therefore, in tissues distinguish concepts such as cell population and cell differons.

Cell population - a collection of cells of a given type. For example, in the loose connective tissue (the most common in the body) contains: a population of fibroblasts, macrophages, population, population tissue basophils and others.

Cellular differons or histogenetic series - a collection of cells of this type (this population), at different stages of differentiation. Stem cells are stem cells differons, followed by several transition - semi stem cells, young (blasts) and maturing cells, and finally, mature or differentiated cells. Distinguish full differons - when the tissue contains cells of all stages of development (eg, erythrocyte differons in the bone marrow or epidermal differons in the epidermis of the skin) and incomplete differons - when the tissues are only transitional and mature, or even only the mature forms of cells (eg, netrotsit central nervous system).

However, the fabric - it is not just the accumulation of various cells. Cells in tissues are in a specific relationship, and the function of each of them focused on the function of tissue. For example, macrophages, connective tissue and having high phagocytic ability to serve as "cleaners" fabrics from foreign substances, or from decaying own tissue components. When the redundancy of such substances, macrophages

can phagocytosis in an amount such that they are unable to digest and therefore die. Cells in tissues affected by each other, or directly through the slit-like contacts (Nexus), through the synapses, or at a distance (distance) - through the provision of various biologically active substances (for example, lymphokinesis, monokinesis, chalones and others). On the function of the cells are also affected substances from the blood (hormones), or of the nerve endings (mediators).

Derivative cells - is symplast and syncytia.

Symplast - education (the structure), which contains a large amount of cytoplasm of a single nucleus and organelles (general or special). Symplast formed through a merger of the individual cells. Biodisposition: simplastotrofoblast chorionic symplast of striated muscle fibers.

Syncytia - education, consisting of cells connected by spikes through which the cytoplasm of one cell into another cell continues. Syncytia formed by incomplete cytokinesis of dividing cells. Biodisposition - spermatogenic epithelium of the convoluted tubules of the testis, and the pulp of enamel (dental) organ.

Post cells education - red cells, platelets, horny scales of the epidermis of the skin. Are cells lacking nuclei and organelles of most erythrocytes, or fragments of the cytoplasm of cells (megakaryocytes) - platelets or platelets, or the cells (epidermotsits) transformed in the horny scales of the epidermis of the skin.

Intercellular substance - is also a product of the activity of certain cells. Intercellular substance consists of an amorphous material, fibers - collagen, reticular, elastic.

Intercellular substance is expressed differently in different tissues. The detailed structure and development of the structural components of the intercellular substance will be considered in the "connective tissue."

Tissue development in ontogeny and phylogeny.

In ontogenesis are following stages of tissue:

Stage I topical differentiation - presumptive (presumably) are the beginnings of tissue in certain areas of the cytoplasm of the egg, and then the zygote;

Stage II blastomer differentiation - as a result of crushing presumptive zygotes beginnings tissues are localized in different blastomers of the embryo;

Stage III rudimentalis differentiation - as a result of gastrulation presumptive rudiments tissue localized in different parts of the germ layers;

Histogenesis stage IV - the process of converting the rudiments of tissues in the tissue as a result of the proliferation, growth, induction, determination, migration and differentiation of cells.

There are several theories of development of tissues in the phylogeny. The most significant of these are:

* Law of parallel rows (A.A. Zavarzin) - tissue of animals of different classes and types that perform the same function, have a similar structure, as they develop in parallel in different animals of the phylogenetic tree;

* Law of divergent evolution of tissues (N.G. Khlopin) - divergence in the phylogeny is evidence of tissue and the appearance of new types of tissue within the tissue groups, which leads to a complication of living organisms and increase the diversity of tissues.

There are several approaches to the classification of tissues.

The major ones are: morphofunctional, genetic.

It is generally accepted morphofunctional classification, according to which there are four tissue groups:

* Epithelial tissue;

* Connective tissue (the tissue of the internal environment, support-trophic tissue);

* Muscle tissue;

* Nerve tissue.

Some writers-(A. Afanasiev and others) from the group of connective tissues secrete the blood and lymph, as an independent type of tissue. In each tissue group (with the exception of nervous tissue) identify several types or subtypes of fabric that will be considered in the study of the corresponding tissues.

Condition of the structural components of tissues and their functional activity is constantly changing under the influence of external factors. First of all, the rhythmic oscillations observed structural and functional state of the tissue - biological rhythms: daily, weekly, seasonal, yearly.

External factors can cause adaptive (adaptive) changes and maladaptive, leading to the disintegration of tissue components.

There are regulatory mechanisms (interstitial, interstitial, organism), which maintain the structural homeostasis.

Interstitial regulatory mechanisms are provided, in particular, the ability of mature cells secrete biologically active substances - chalones that inhibit proliferation of young (and blast stem) cells of the same population. The death of a large part of the selection chalones mature cells decreases, which stimulates the proliferative processes and leads to restoration of the number of cells of a given population. Interstitial regulatory mechanisms provides magnetic interaction, notably with the lymphoid tissue (immune system) to maintain the structural homeostasis. Organismic regulatory factors having an impact the endocrine and nervous systems.

Under certain external influences can disrupt the natural determination of young cells, which can lead to the transformation of one tissue type to another. This phenomenon is called metaplasia, and is carried out only within a given tissue group. For example, the replacement of a single-layer prismatic gastric epithelial monolayer flat.

Regeneration

Regeneration - cell regeneration, aimed at maintaining the functional activity of the system. In regeneration distinguish concepts such as shape recovery, the level of regeneration, regeneration method.

Forms of regeneration:

* **Physiological regeneration** - the restoration of tissue cells after their natural death (eg, hematopoiesis);

* **Reparative regeneration** - the restoration of tissues and organs after injury (trauma, inflammation, surgical exposure and so on).

The levels correspond to the levels of regeneration organization of living matter):

* **Cell** (intracellular)

* **Tissue;**

* **Authority**.

Methods of regeneration: cellular process (reproduction (proliferation) of cells) intracellular process (recovery intracellular organelles, hypertrophy, polyploidy) substitutive method (replacing the defect of connective tissue or organ tissue, usually with the formation of the scar, such as scarring of the myocardium after myocardial infarction).

Factors that regulate the regeneration:

* Hormones - the biologically active substances;

* Picks - indicators of metabolic processes;

* Chalones - substances glycoprotein nature, which are synthesized by somatic cells, the main function - inhibition of cell maturation;

* Antagonists chalones - growth factors;
* Any cell microenvironment.

The integration of tissue

Tissue, which is one of the levels of organization of life are part of the structures of a higher level of organization of life - the structural and functional units of the agencies and bodies, which is the integration (merging) of several tissues.

Integration mechanisms: interstitial fluid (usually inductive) interaction; endocrine effects; nervous influences.

For example, in the heart include cardiac muscle, connective tissue, epithelial tissue. In diseases of the first one is usually affected tissue, which can then affect the status of other tissues, interstitial fluid through inductive interactions.

5.2. Epithelial tissue

I. Aims and objectives: 1. to have the concept of the epithelial tissue.

2. To study the structure of epithelial tissue

II. Sample questions for self-training;

1. The concept of epithelial tissue.
2.Function of epithelial tissue
3. The classification of epithelial tissue
4. Structure of the surface epithelium
5. Glandular epithelium.
6. The regeneration of the epithelium
7. Age features epithelium.
8. The clinical significance of the theme

The theoretical part.

Epithelial tissues

Epithelial tissue or epithelium, external and internal covers the body, and most of the glands.

Function of epithelial tissue:

* **Protective** (barrier);
* **Secretory** (secretes a number of substances);
* **Excretory** (identifies a number of substances);
* **Suction** (epithelium of the gastrointestinal tract)

Structural and functional characteristics of epithelial tissues:

* **Epithelial** cells are always layers;

* **Epithelial** cells are always located on the basement membrane;

* **Epithelial** tissues do not contain blood and lymph vessels, except, vascular strip of the inner ear (the organ of Corti)

* **Strictly** differentiated epithelial cells in the apical and basal pole;

* **Epithelial** tissues have a high regenerative capacity;

* **In a predominance of epithelial cells** over the intercellular substance or lack of it.

Structural components of epithelial tissue:

Epithelial cells - are the main structural elements of the epithelial tissue. Located in the epithelial layer, and closely related to each other by different types of cell-cell contacts:

simple, desmosomes, tight, slit-shaped (Nexus).

Basement membrane cells are attached by semidesmosoms. In various epithelia, and often one type of epithelium contains different types of cells (several cell populations). In most epithelial cells localized basal nucleus, and in the apical part of the present secret, which is produced by cells, located in the middle of all the other cell organelles. Such a characteristic of each cell type will be given in the description of the particular epithelium.

Basement membrane - the thickness of about 1 mm, consisting of: thin collagen fibrils (protein collagen of type 4) amorphous substance (matrix), consisting of a carbohydrate-protein-lipid complex.

Types of epithelial tissue

Classification of epithelial tissues:

surface epithelium - forms the outer and inner covers;

glandular epithelium - comprising the majority of iron.

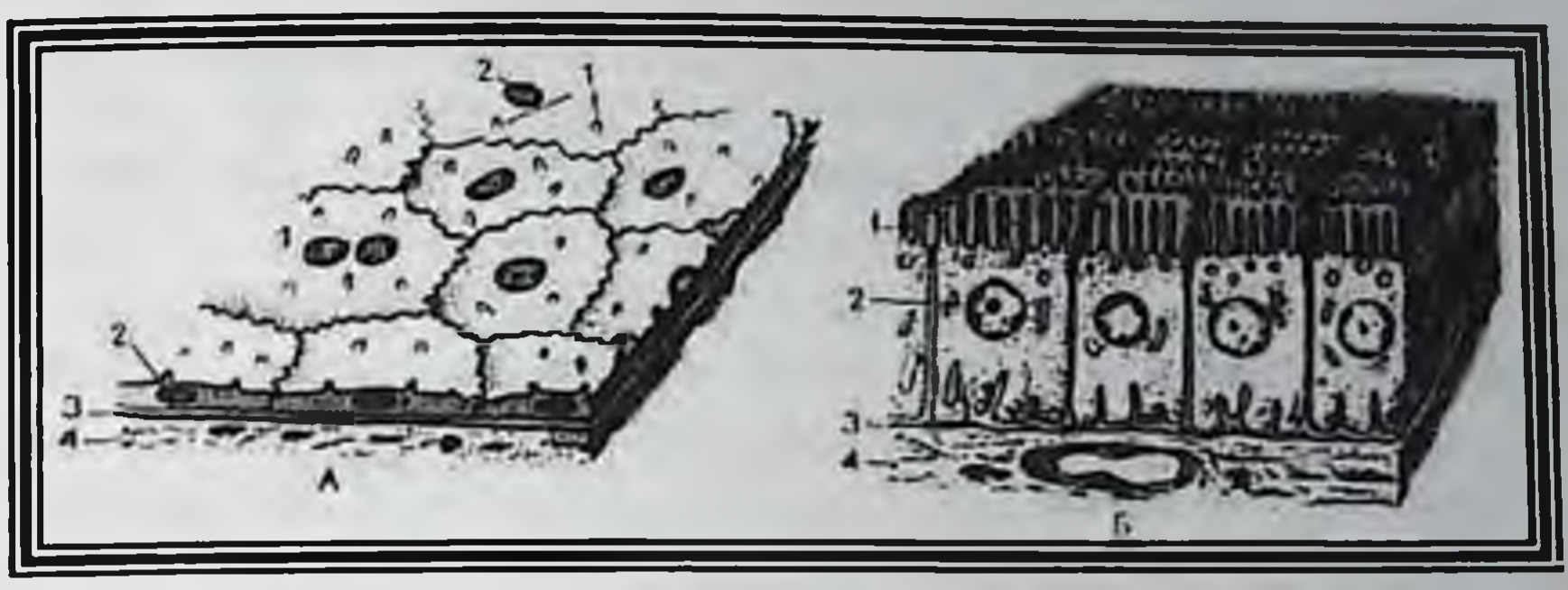
Morphological classification of the surface epithelium:

- **Mono-layer epithelium** (endothelium - lined with all the vessels; mesotelium - lines the cavity of the natural man: pleural, peritoneal, pericardial) (pic-53).

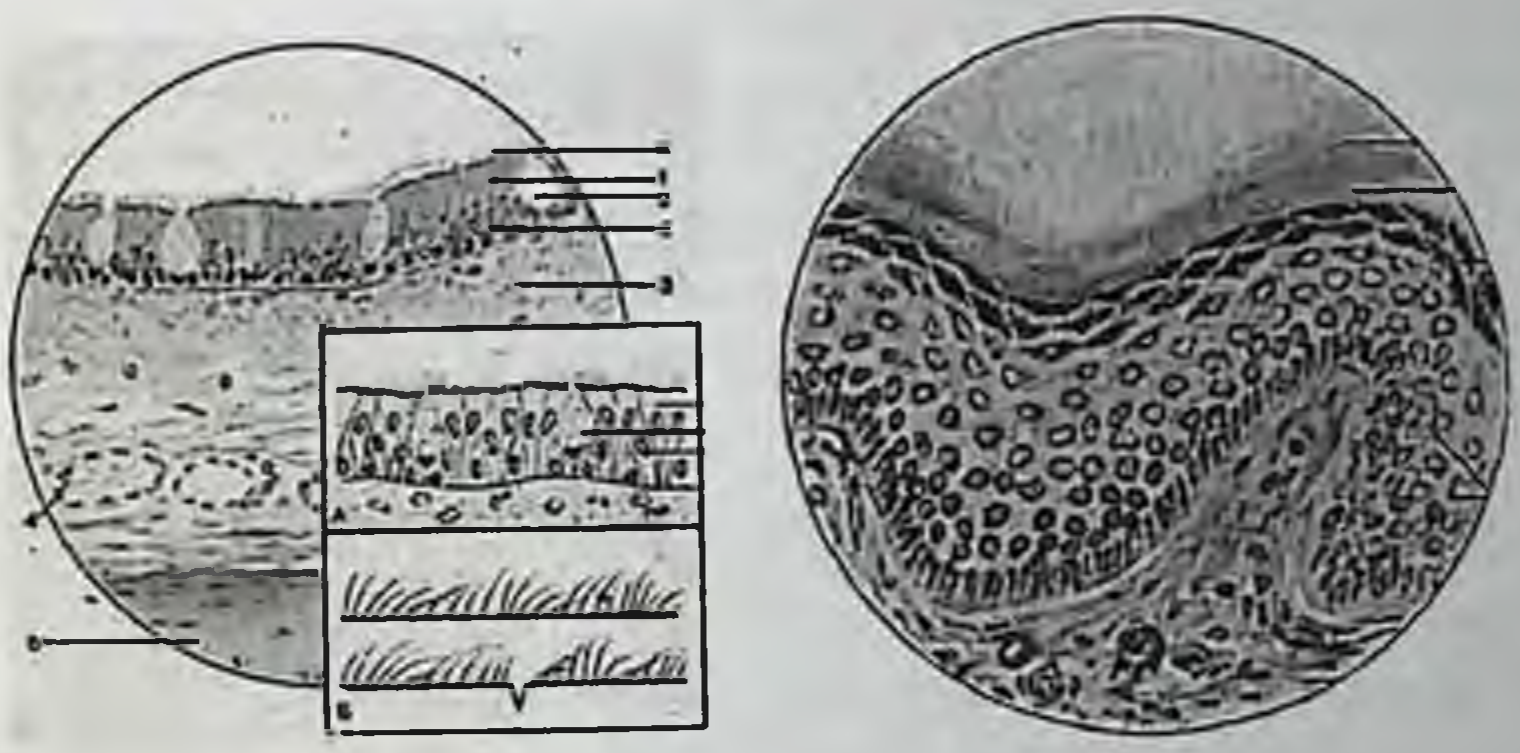
* Single Layer cubic epithelium - renal tubular epithelium.

* single-layer single-row cylindrical epithelium - nuclei are on the same level (img.47). They come in the limbic (45B,49-img/), secretory, ciliated.

* Single Layer multirowed columnar epithelium - nuclei are at different levels (pulmonary epithelium 54-PIC.)



Picture-53. **Scheme. The structure of the single-layer epithelia.** A flat epithelium (mesotelium) B-prismatic epithelium limbic 1 microvilli (band) 2-3-core epithelial cells basement membrane 4-connective tissue



Picture-54. **Simple pseudostratified Multilayer flat keratinizing epithelium ciliated epithelium**

Picture-55. **Stratified squamous multilayer transitional epithelium neorogovevayuschy epithelium**

* stratified squamous epithelium - oral cavity, esophagus, vagina (pic.55);

* keratinizing stratified squamous epithelium - the skin, the columnar epithelium (pic.56)

* transitional epithelium - a form of epithelial cells depends on the functional state of the body, such as the bladder (pic. 57).

Genetic Classification of epithelia (by N.G. Khlopin)

* Epidermal type develops from ectoderm - layered and pseudostratified epithelium, a protective function;

* Enterodermality type, developed from the endoderm - single-layer columnar epithelium, in the process of absorption of substances;

* Tselonefrodermality type - develops from the mesoderm - single-layer flat epithelium, a barrier and excretory functions;

* Pendimogliality type develops from neuroectoderm lines the cavities of the brain and spinal cord;

* Angiodermality type - the vascular endothelium, develops from the mesenchyme.

Clinical significance

Fast-growing tissues (eg, epithelial cancer) often contain mitotically dividing cells, which is not observed in the slow-growing tissues. The increased number of mitotic figures and abnormal mitosis in tumors are important characteristics that distinguish malignant from benign tumors. The body has a complex regulatory systems that control the reproduction of cells, either stimulating or inhibiting mitosis. Normal proliferation and differentiation of cells is controlled by a group of genes - protoon-kogens, disturbing the structure or expression of these genes lead to the development of tumors. Changed protooncogenes contained in viruses that cause tumors, they are likely to have a cellular origin. Change in the activity of oncogenes can be caused by disorders of the sequence in DNA (mutations), increasing the number of genes (gene amplification), or gene rearrangements, in which genes are moved to the area near the active promoter. Was linked to changes in ¬ oncogenes and development of certain tumors and hematologic neoplasms. Proteins that stimulate mitotic activity in various cell types, including nerve growth factor, epidermal growth factor, fibroblast growth factor and growth factor precursors of red blood cells (erythropoietin), a list of these proteins is expanding and growing rapidly (see Chapter 13).

Cell proliferation is normally regulated GOVERNMENTAL exact mechanisms that, when necessary, can stimulate or retard mitosis de-

pending on the needs of the body. A number of factors (eg, chemicals, not ¬ which types of radiation, viral infection) can cause DNA damage, mutation and abnormal cell proliferation, which bypass the normal regulatory mechanisms of controlled growth and lead to the formation of tumors NIJ. The term "tumor" was originally used to refer ¬ Year ended any limited swelling in the body caused by inflammation or abnormal cell proliferation, is now commonly used as a synonym for "neoplasm, neoplasia" (Greek neoz - new + plazta - education). New growth can be defined as a pathological mass of tissue, formed as a result of irregular -cell proliferation of neoplasms can be either benign or malignant depending on their existing signs - slow and invasive growth (benign) or rapid growth and marked ability to grow into other tissues and organs (malignant). Cancer is a common term that refers to all malignant tumors. Most cells are able to activate its program of apoptosis, when significant changes occur in their DNA, for example, just before the appearance of tumors, when DNA has accumulated a large number of mutations. In this way, apoptosis prevents proliferation of malignant cells, which are due to accumulated mutations in DNA. To create a clone and develop into a tumor, cancerous cells need to inactivate the genes that control the process of apoptosis.

Cell death as a result of an "accident" - the disease process, which is known as necrosis. Necrosis can be caused by the action of micro-organisms, viruses, chemicals and other harmful factors. Necrotic cells swell and their organelles increase in volume, and in the end they burst, releasing their contents into the extracellular space. Makrofags absorb detritus necrotic cells by phagocytosis and then secrete molecules that activate other cells of the immune system, causing inflammation.

Metaplasia

In some pathological conditions, one type of epithelial tissue can be converted to another. This reversible process known as metaplasia (Greek conversion). It can be illustrated by the following examples. People who smoked a lot of cigarettes, pseudostratified ciliated epithelium lining the bronchial tubes, can be transformed into stratified squamous epithelium. In patients with chronic vitamin A deficiency of those types of epithelial tissues that normally found in the bronchi and in the bladder, gradually replaced stratified squamous epithelium. Metaplasia is not limited to the epithelial tissues, it also occurs in the connector tissue. Apudomy is a tumor that develops from cells DNES secreting polypeptides. Their clinical symptoms depend on the nature of a particular chemical messenger pro-

duced. The diagnosis is usually confirmed using immunocytochemical staining sections of biopsies of the tumor.

5.3. The endocrine system

Glandular epithelium forms the vast majority of iron. It consists of: gland cells - glandulotsits; basement membrane.

Classification of glands

1. According to the number of cells: unicellular (cup-shaped iron); multicellular - the vast majority of the glands.

2. By way of removing secretions from the prostate and in the structure:

*** Exocrine glands - have duct;**

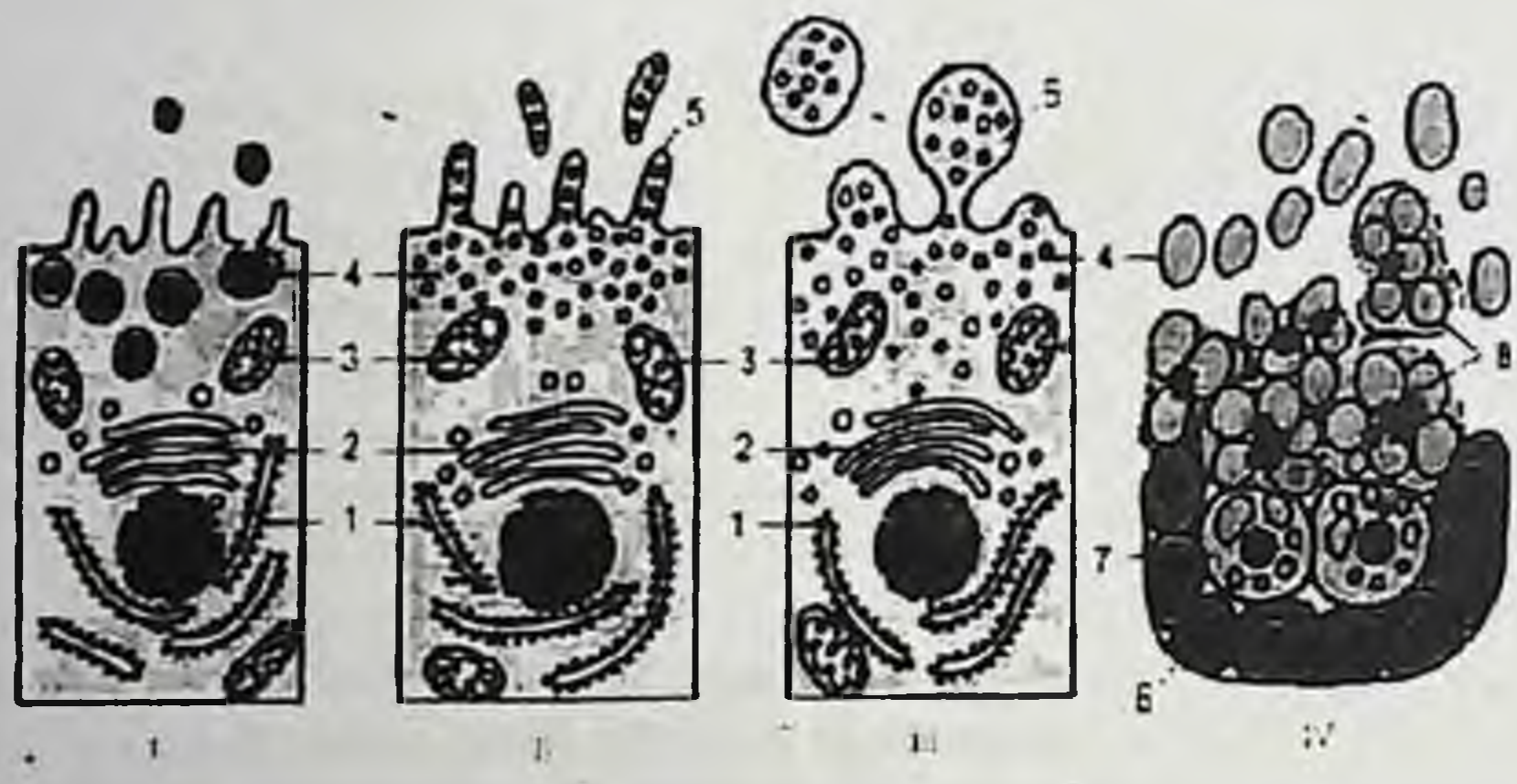
*** Endocrine glands** - have ductless and secrete hormones (hormones) into the blood and lymph systems.

3. By way of secretion of glandular cells:

merokrine - sweat and salivary glands;

apocrine - breast, underarm sweat glands;

holocrine - sebaceous glands of the skin (img.56).

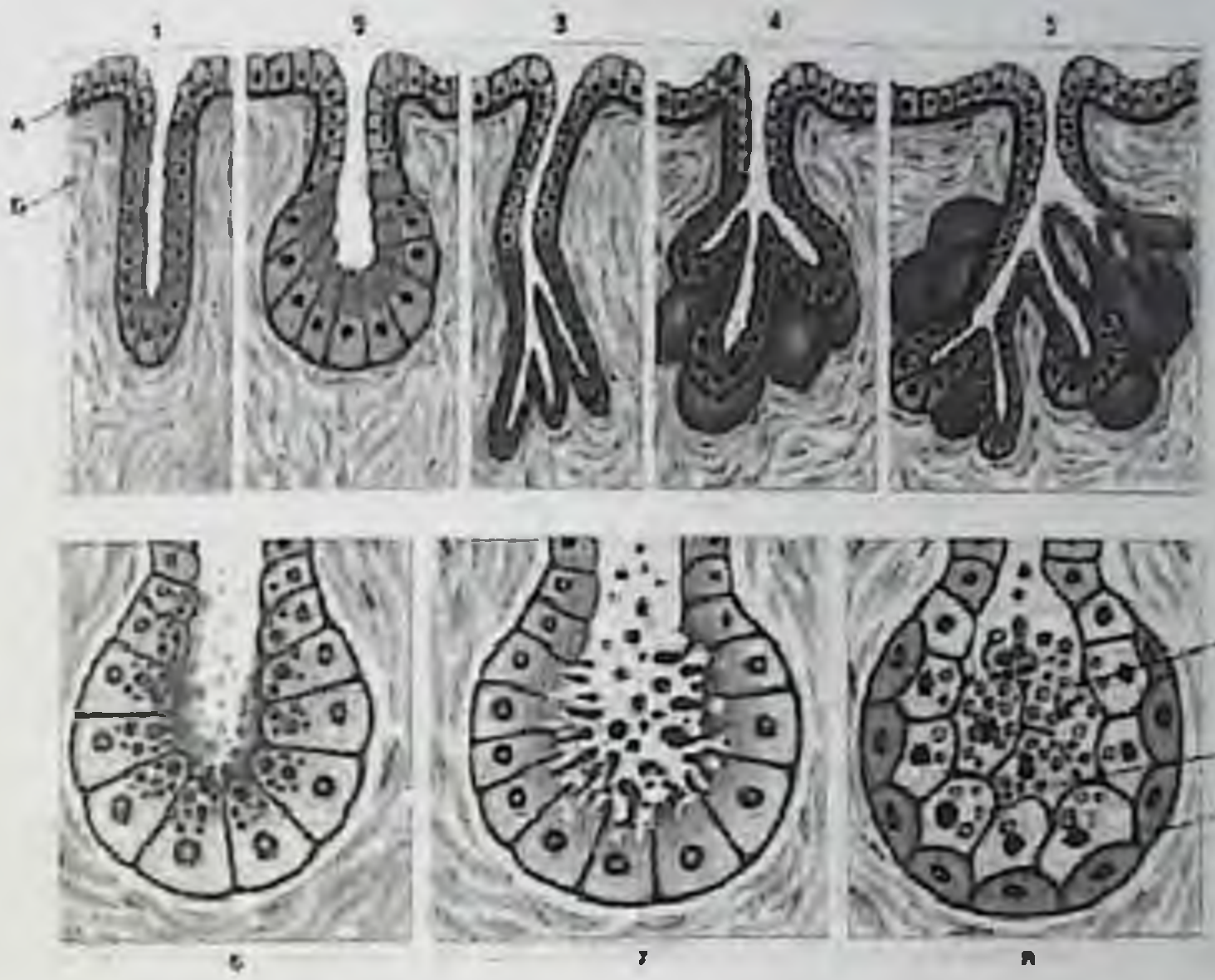


Picture-56. **1-granular reticulum; 2- Golgi complex; 3-mitochondria; 4 secretory granules; 5-secret exit; 6- cambial cells; 7-start.**

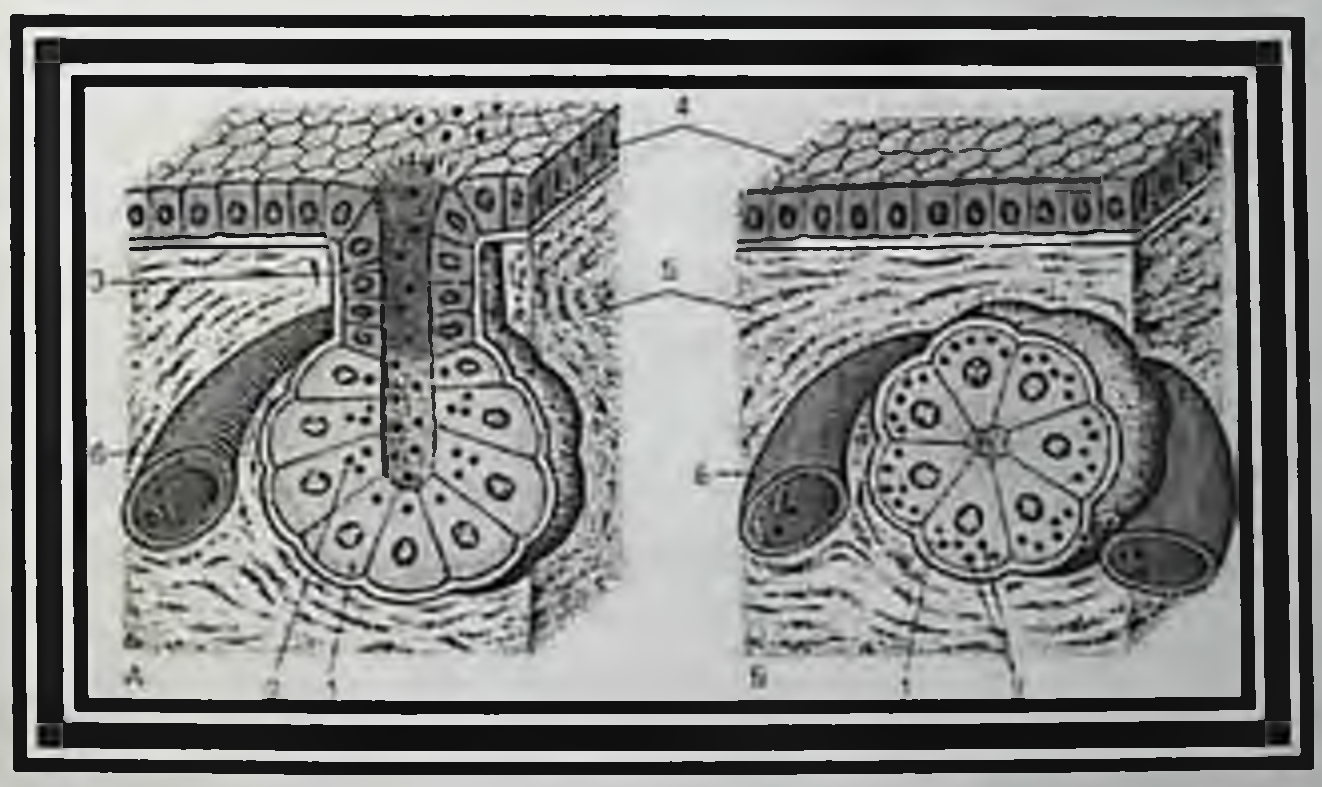
Holocrine secretion secretion Holocrine. Exocrine glands consist of the end or the secretory units and ducts (57,58-rice). Terminal units may take the form of alveoli or tubules. If the duct is opened one end department - iron simple unbranched (alveolar or tubular).

If the duct open multiple terminal units - simple branched gland (alveolar, tubular or alveolar-tubular).

If the main duct branches - iron complex, it also is an extensive (alveolar, tubular or alveolar-tubular (57, 58-picure)).



Picure-57. **Structure and types of exocrine secretion glands.** A epithelium. B-fibrous connective tissue. 1 simple branched tubular gland. 2-simple branched alveolar glands. 3-iron with simple tubular branched end department. 4-iron with simple alveolar branched end department. 5-complex alvellary-tubular iron. 6 merokrinalytype of secretion. 7-type apocrine glands. 8 golokrinnaly type of secretion. and cell growth layer, b-cells in the process of death, in the cell-splitting



Picture-58. **The structure of the exocrine and endocrine glands (scheme for E.F. Kotovsky).** An exocrine gland. B-endocrine gland: 1-end department, 2-secretory granules, 3-duct exocrine glands, 4 surface epithelium, 5-connective tissue, 6-a blood vessel.

Secretory phase of the cycle, the glandular cells:

Absorption of the initial products, formation Secretary, synthesis and accumulation of secretions, secretions (for merokrines or apokrines or type), restoration of the glandular cells.

Note: cells secreting on Holocrine type (sebaceous glands), are completely destroyed, and from cambium (germ) cells form new sebaceous gland cells.

Clinical significance of Topics

Most types of epithelial cells can develop both benign and malignant tumors. In medicine, the most widely used term "cancer". - A malignant tumor, which has developed from epithelial cells. Malignant tumors that arise from glandular epithelial tissue, commonly referred to as adenocarcinomas. These tumors generally are the most common tumors in adults. Children up to 10 years, most of the tumors developed (in descending order frequencies) from hematopoietic, neural, soedinitelnyh and epithelial tissues. These relations are gradually changing, and after 45 years, more than 90 % of all tumors are developing epitelialnoe origin

The practical part

Compilation of logical structures, the study of drugs, electron diffraction, multimedia and a sketch of the structure of the coating and pintsipe zhelezitogo epithelium into albums.

The objects under study: 1.Preparaty intestinal epithelium, bladder, trachea, skin epithelium.

Sample test items

1. What listed histomorphological features are characteristic of epithelial tissues?

a) pogranichnoe position;
b) plast cells;
c) polyarnaya differentiation;
d) otsutstvie hemocapillars.

2. What components are part of the basement membrane?

a) kollagenovye fiber;
b) elasticheskie fiber;
c) glikoproteiny;
d) glikozaminoglikany.

3. What epithelium belong to the group of single-layer, according to themorphological and functional classification? (2 answers)

a) single row;
b) orogovevayuschy;
c) multirowed;
d) transition.

4. What epithelium are at multi-layer, according to the morphological andfunctional classification?

a) single row;
b) orogovevayuschy;
c) multirowed;
d) transition;
e) neorogovevayuschy.

5. What is called a single layer of epithelium?

Amantaj Usenov all cells which are connected to the basement membrane.

a) which all cells are connected to the basement membrane;
b) cells which are not associated with a basement membrane;
c) orogovevayuschy.

Approximate refereed report on "Age characteristics of epithelial tissue"

5.4. Blood and blood forming organs

I. Goals and objectives:

1. To study the function and cellular composition of the blood;
2. To study the function and composition of the lymph

II. Questions for self-control students.

1. The functions of the blood.
2. Composition of the blood.
3. The concept of hemogram and hematocrit.
4. Red blood cells function.
5. Types and shape of erythrocytes.
6. Eozinophiles.
7. Bazofiles.
8. Neytrophiles.
9. Limphotsites and macrophages.

10. Trombotsity.
11. Hematopoiesis and lymph formation.
12. The clinical significance of the theme.

The theoretical part

Hemolymph

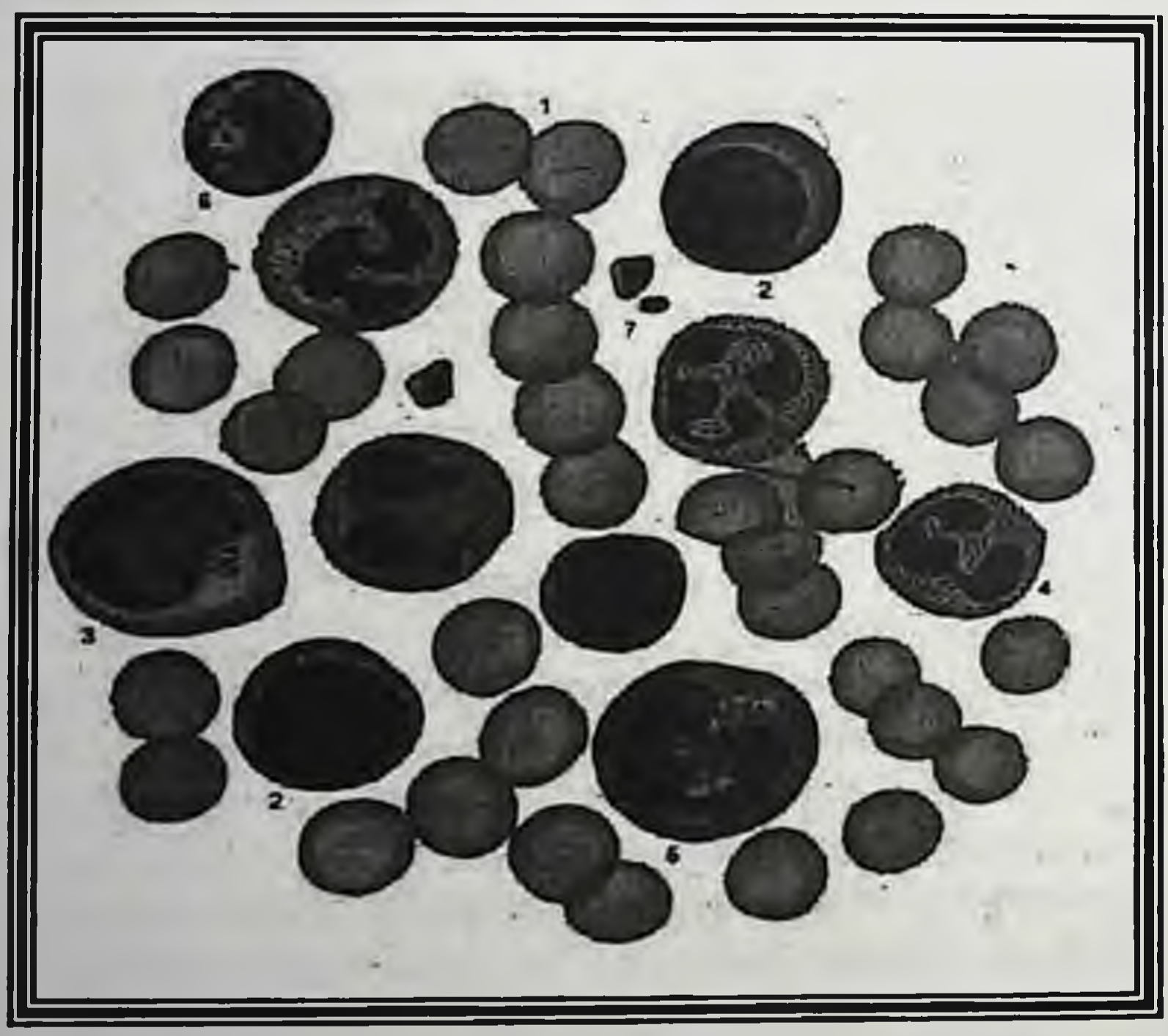
Hemolymph - the fabrics of the internal environment of the body, they are a type of connective tissue.

In these types of fabrics have the following features: mesenchymal origin, a large proportion of interstitial substance, a wide variety of structural components.

Blood function: transport, trophic, respiratory, protective, excretory, regulation of homeostasis.

Components of blood:

- Cells - forming elements;
- Liquid intercellular substance - blood plasma.



Picture-59. **3- segmented neutrophilic; 4-monocyte granulocyte; 5-eosinophilic (acidophilic) granulocyte; 6-basophilic granulocyte platelets**

Mass of blood is 5% of body weight, blood volume of about 5.5 liters. Depot - liver, spleen, skin, and intestine, the intestine can be de-

posited up to 1 liter of blood. The loss of a man 1/3 of the blood leads to death. The ratio of units of blood: plasma - 55-60%, forming elements - 40-45%. Blood plasma consists of water at 90-93% and it contains substances - 7-10%.

The plasma contains proteins, amino acids, nucleotides, glucose, minerals, products of metabolism. Plasma proteins: albumin, globulins (including immunoglobulins), fibrinogen, proteins, enzymes and other. Functions of plasma - transport of soluble substances.

Due to the fact that the blood contains as true cells (leukocytes) and post cell formation - red blood cells and platelets, usually called them together formed elements.

Classification formed elements: red cells, platelets;

white blood cells (img-56).

The qualitative composition of the blood (blood) is defined concepts such as blood count and WBC. Blood count - the quantitative content of blood cells in a liter or milliliter.

Hemogram adult:

red blood cells: a woman - 3,7-4,9 million liters in men - 3,9-5,5 million liters 200-400 thousand platelets per liter;

leukocytes 3,8-9,0 thousand per liter.

Structural and functional characteristics of erythrocytes

Red blood cells - the dominant population of blood cells. Morphological features: contains no nucleus, does not contain most of the organelles, the cytoplasm is filled with pigmented nodules - hemoglobin: gems - iron, globin - protein.

The size of red blood cells: normocytes 7,1-7,9 m (75%); macrocytes more than 8 m (12.5%) less than 6 microns microcytes (12.5%).

The shape of red blood cells:

biconcave disk - diskotsites (80%) and the remaining 20% are spherocytes, planotsites, echinocytes, stomatotsity.

By saturation of hemoglobin erythrocytes are different:

normochromic, hypochromic, hyperchromic.

There are two forms of hemoglobin:

hemoglobin A, hemoglobin F - Fetal.

In the adult human hemoglobin and 98%, hemoglobin F 2%. A newborn child and 20% hemoglobin, hemoglobin F 80%. The life span of red blood cells - 120 days. Old red blood cells are destroyed by macrophages, mainly in the spleen, which is released from the iron used maturing erythrocytes. In peripheral blood from 1% to 5% of red blood

cells are immature and are called reticulocytes. Their content reflects the intensity of the red cell and blood is of great diagnostic and prognostic value. **Poykilocytosis** - the presence in the peripheral blood of a large number of red blood cells in different shapes. **Anisocytosis** - the presence in the peripheral blood of a large number of red blood cells of different sizes (pic-60).

The functions of red blood cells:

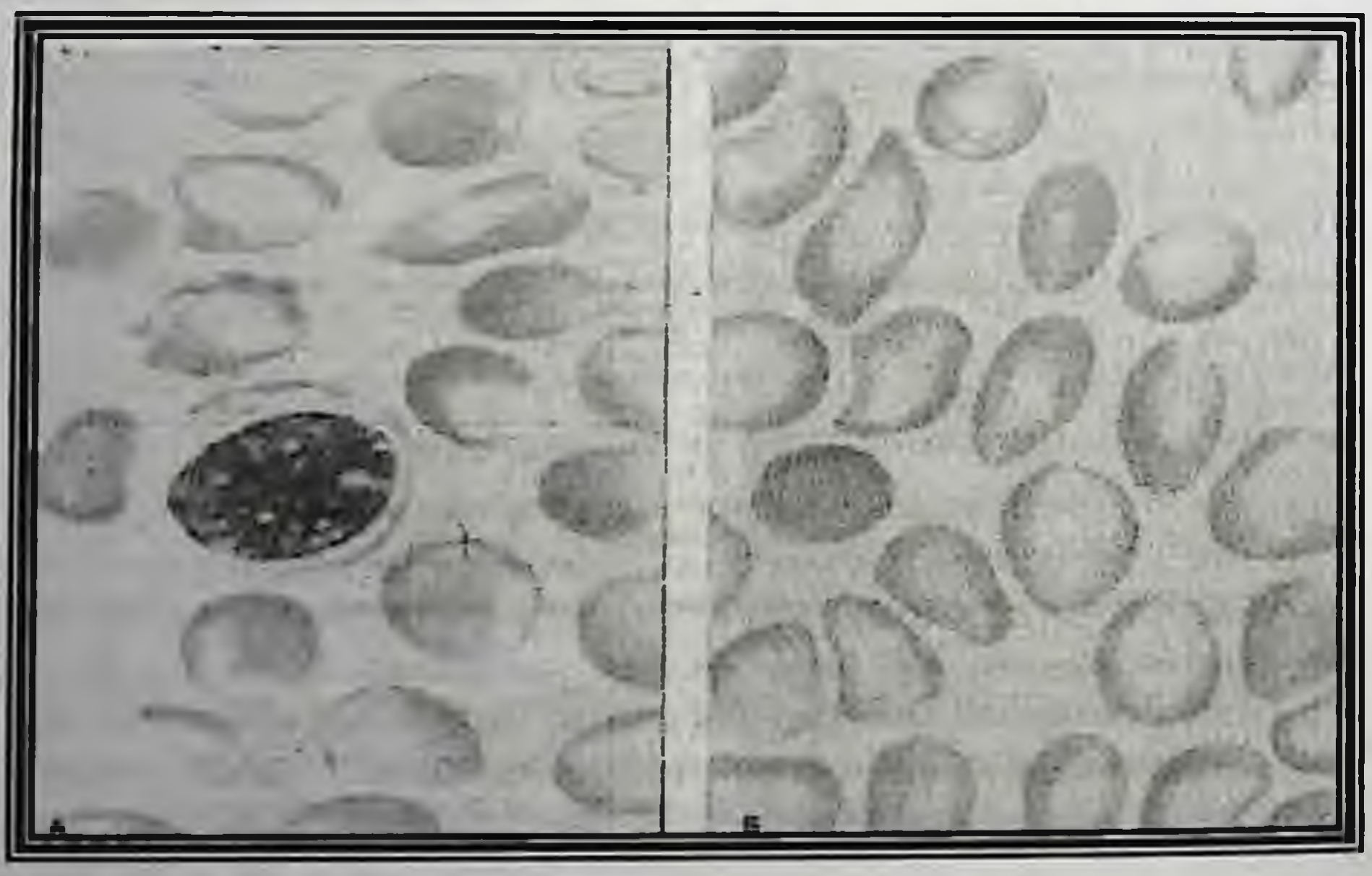
And respiratory - transport of gases (O2 and CO2);

-Transport other substances adsorbed on the surface tsitolemm (hormones, antibodies, drugs, toxins, and others).

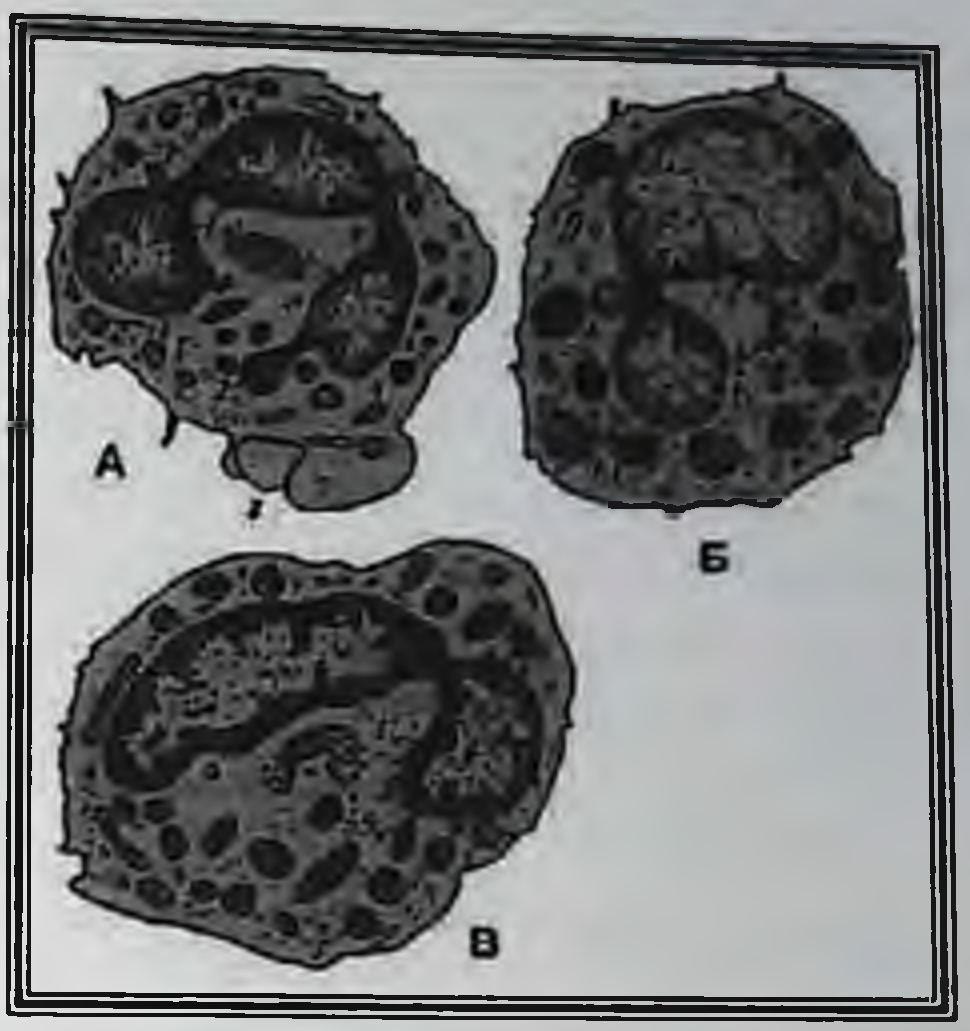
Structural and functional characteristics of leukocytes

Leukocytes, or white blood cells, the nuclear blood cells, is protective. Found in blood from several hours to several days, and then leave the bloodstream and exert their functions mainly in the tissues. White blood cells are a heterogeneous group and subdivided into different populations. Leukocyte classification is based on:

* The content of granules in the cytoplasm;
* Related to dyes for tinctorial properties;
* The degree of maturity of cells of this type;
* Morphology and function of cells;
* The size of the cells.



Picture-60. **Smear of peripheral blood of the newborn (general view)**



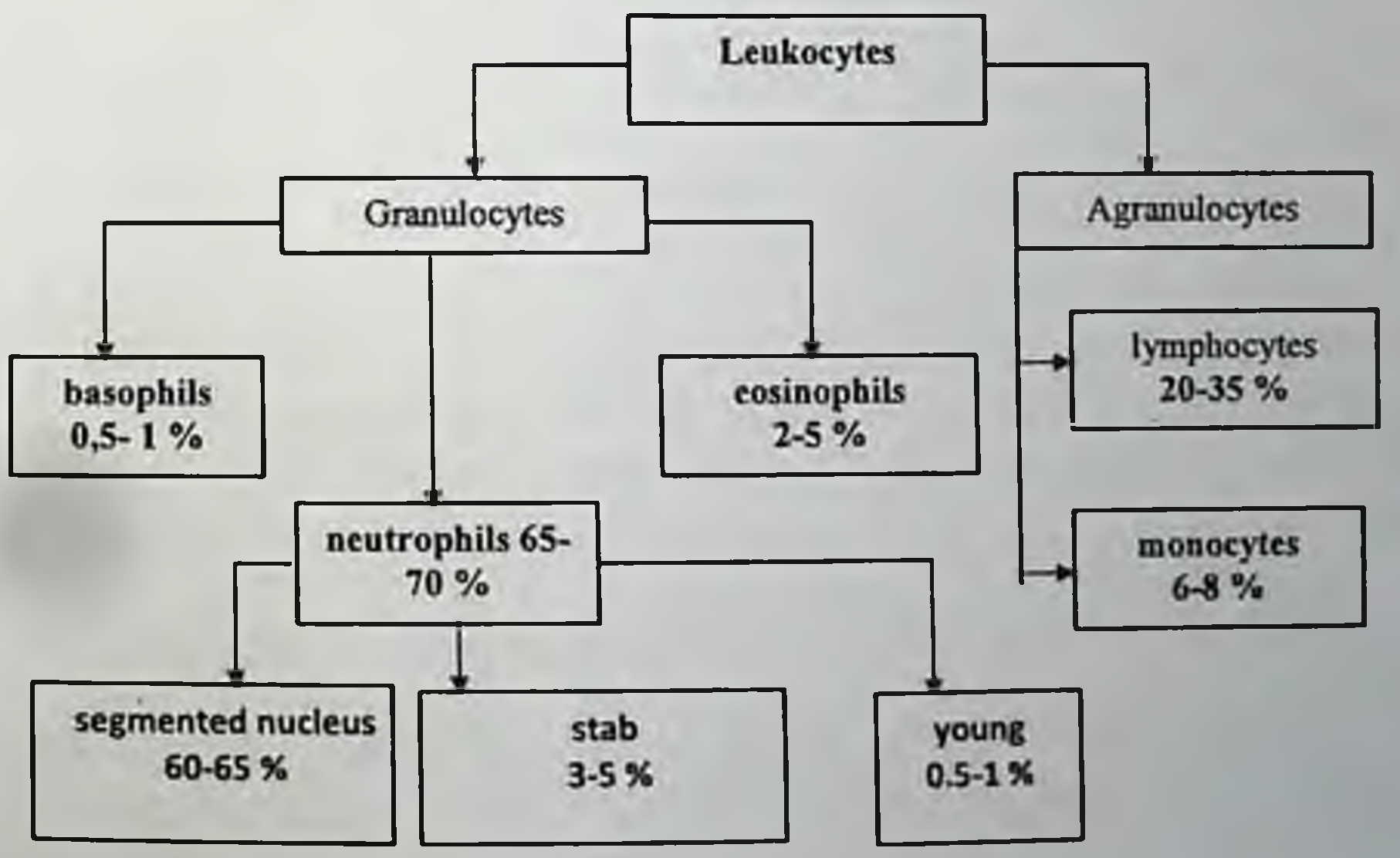
Picture-61. **Granulotsity.**
A-B-neutrophil leukocyte
eosinophilic leukocyte B-basophil
1. two core segments. 3.Azurofilnye
chromatin-lysosomal) granules
granules 4.spetsialnye
5. Eozinofilnye pellets 6. false
sektiseveropody

Classification of leukocytes:

- Granular (granulocytes) - neutrophils (65-75%):
- Young (0-0.5%);
- Stab (3-5%);
- Segmented (60-65%);
- Eosinophils (1-5%);
- Basophils (0.5-1.0%) (Figure 59).
- Not grainy (agranulocytes)
- Lymphocytes (20-35%);

T-lymphocytes;
- B-lymphocytes;

Monocytes (6-8%) (img-90).



Wbc - is the percentage of the various forms of leukocytes (white blood cells to the total number - 100%). The following table shows the classification of white blood cells WBC healthy body. Morphological feature sofneutrophils:

- Segmented nucleus;
- In the cytoplasm contains small granules stained in slightly oxyphilic (pink) color, which distinguishes among non-specific azurophilic granules - a variety of lysosomes, specific granules, and other organelles are poorly developed. Dimensions in smear 10.12 microns. Neutrophils in maturity are classified as:
- Young (metamyelocytes) 0 - 5%;
- Stab 3-5%;
-Segmented (mature) 60-65%.

The increase in the percentage of young and stab forms of neutrophils is called leukocyte shift to the left and is an important diagnostic indicator. By neutrophils determine the sex of the blood - by the presence of one of the segment near-nuclear satellite (epididymis) as a drumstick (in women). The life span of neutrophils 8 days are 8-12 hours they are in the blood, and then leave the connective and epithelial tissue, where and perform basic functions.

-Neutrophil function:

-Phagocytosis of bacteria;

-Phagocytosis of immune complexes (antigen-antibody)

-Bacteriostatic and bacteriolytic;

Chalones-selection and regulation of reproduction of white blood cells.

Morphological features of eosinophils:

- The size of 12-14 microns in smears.

Two-segment-core;

in the cytoplasm of large oxyphilic (red) grit, consisting of two types of granules: azurophilic specific - a kind of lysosomes containing peroxidase, nonspecific granules containing acid phosphatase, other organelles are poorly developed.

Eosinophil function:

- Participate in the immunological (allergic and anaphylactic) reactions;
- Suppress (inhibit) allergic reactions by neutralization of histamine and serotonin in several ways:

- Phagocytosis histamine and serotonin, secreted by mast cells and basophils, and adsorb these biologically active substances on cytolems;

- Secrete enzymes that cleave extracellular histamine and serotonin;

- Allocate obstacles release of histamine and serotonin basophils and mast cells;

- Are able to phagocytosis bacteria, but not much.

Participation of eosinophils in allergic reactions due to their high content (up to 20-40% or more) in the blood in a variety of allergic diseases (parasitic infestations, bronchial asthma, and other malignancies). The life span of eosinophils 6-8 days of them being in the bloodstream is 8.3 hours

Basophilic leukocytes, or basophils

This is the smallest population of white blood cells (0.5-1%), but the total mass in the body of a huge number. Dimensions in smear 11.12 microns.

Morphological features of basophils:

- A large poorly segmented nucleus;

- In the cytoplasm contains large granules stained with basic dyes, metahromatins, due to their content of glikozoaminoglikanolity - heparin and histamine, serotonin, and other biologically active substances;

- Other organelles are poorly developed.

Basophil function is to participate in immune (allergic) reactions by placing granules (degranulation) and they contain the above biologically active substances that cause allergic reactions (swelling of the tissue perfusion, itching, spasm of smooth muscle tissue, etc.). When meeting with the antigens (allergens), some B cells and plasma cells produce immunoglobulin E, which are adsorbed on cytolemm basophils and mast cells. At the second meeting of basophils with the same antigen on the surface formed antigen-antibody complexes, which cause sharp degranulation and release to the environment of histamine, serotonin, heparin. Basophils also have the ability of phagocytosis, but this is not their main function.

Structural and functional characteristics agranulocytes

Agranulocytes not contain granules in the cytoplasm and are divided into two distinct cell populations - lymphocytes and monocytes.

Lymphocytes are cells of the immune system, and therefore in recent times called immunocytes. Lymphocytes (immune cells), with the participation of accessory cells (macrophages), provide immune system

- the body's defense against foreign substances genetically. Lymphocytes are the only blood cells, capable, under certain conditions mitotically divided. All other white blood cells are the final differentiated cells. Lymphocytes are very heterogeneous (non-uniform) cell population.

Classification of lymphocytes:

By size: small 4.5-6 microns, 7-10 microns;

large - more than 10 microns.

In the peripheral blood of about 90% are small lymphocytes and 10-12% average lymphocytes. Large cells in normal peripheral blood do not occur. Electron-microscopically small lymphocytes are divided into light (70-75%) and dark (12-13%).

The morphology of small lymphocytes:

- Relatively large circular core consisting mainly of heterochromatin (especially in small dark lymphocytes);
- A narrow rim of basophilic cytoplasm, which contains free ribosomes and the smaller organelles - the endoplasmic reticulum, isolated mitochondria and lysosomes.

The morphology of medium lymphocytes:

- Larger and looser core of euchromatinum and heterochromatin in the center to the periphery;
- In the cytoplasm of the more developed granular and smooth endoplasmic reticulum, plate complex, more mitochondria.

The blood also contains 1-2% of plasma cells formed from B-lymphocytes.

<u>By source of lymphocytes are divided into:</u>

- T-lymphocyte formation and further development is associated with the thymus gland (thymus gland);
- B cells, and their development in birds is associated with a particular body - bursa of Fabricius, in mammals and humans while it is not set by its counterpart.

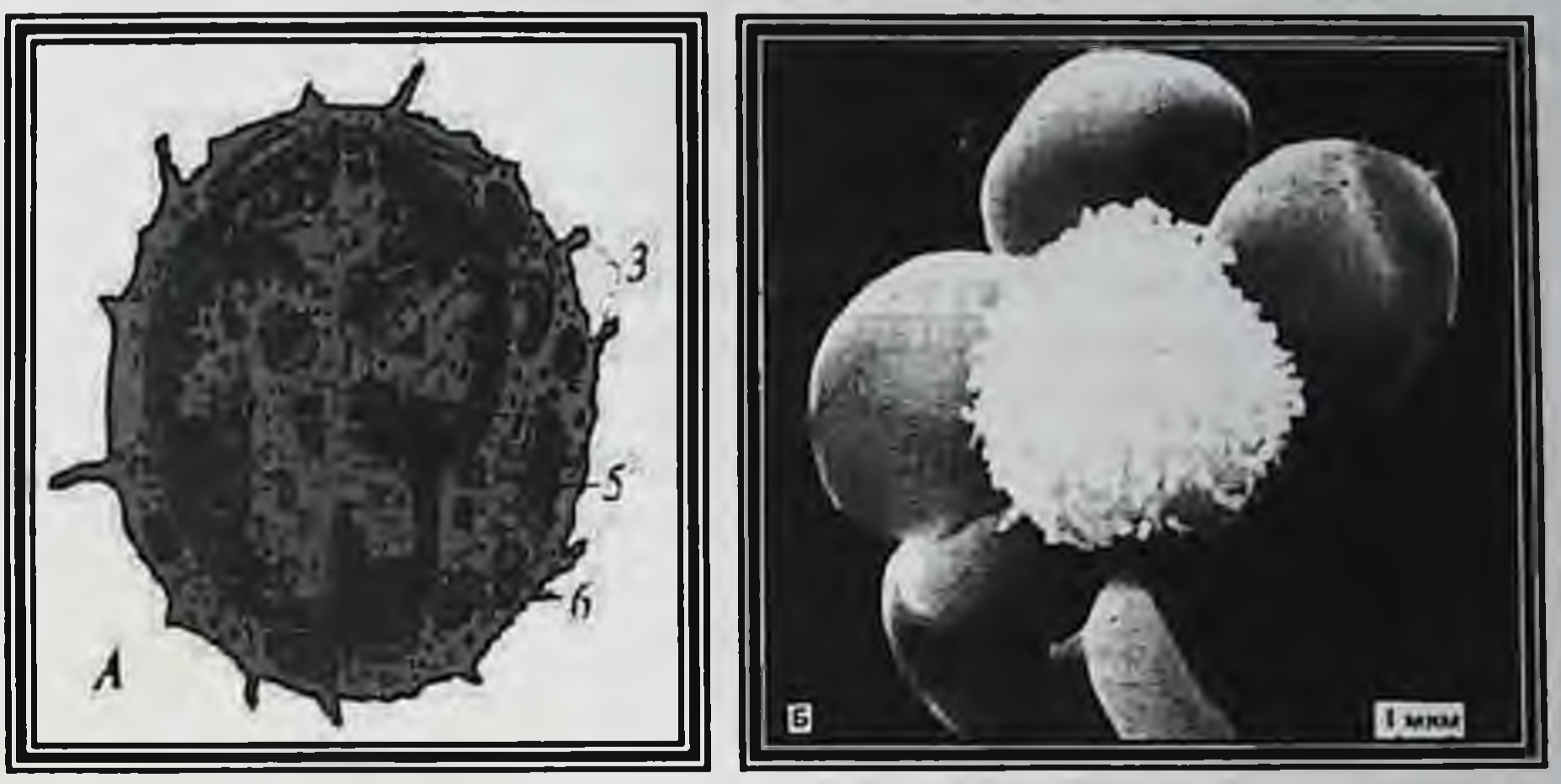
In addition to the sources of T-and B-cells differ and the functions they perform.

<u>Feature:</u>

* B-lymphocytes and plasma cells provide humoral immune system - the body's defense against foreign corpuscular antigens (bacteria, viruses, toxins, proteins, and others);

* T lymphocytes among the functions are divided into:

killers, helpers, suppressors. To identify T lymphocytes used sheep erythrocytes (pic-62).



Picture-62. **A-T-lymphocyte. B-T-cells form a rosette with sheep red blood cells.**

Killer cells or cytotoxic lymphocytes protect the body from foreign cells or genetically modified own cells by cell-mediated immunity. Helper T-cells and T-suppressors regulate humoral immunity: helpers - reinforce, suppressor - oppressed. In addition, in the process of differentiation and T-and B-lymphocytes first performed receptor function - recognize their respective antigen receptors, and after meeting with him transformed into effector and regulatory cells.

Within their subpopulations and T-and B-cells differ in the type of receptors to various antigens. The diversity of receptors is so great that there are only small groups (clones) of cells with the same receptor. At a meeting of lymphocyte antigen to which it has a receptor is stimulated lymphocyte becomes a lymphoblast and then proliferate to form a clone of cells with the same new receptors.

On life lymphocytes are divided into:short-lived (weeks, months), mainly B cells, long-lived (months, years), mainly T-lymphocytes.

Monocytes (img-63) are the largest blood cells (18-20 microns), with a round or bean-shaped horseshoe core and a well-defined basophilic cytoplasm, which contains numerous pinocytic vesicles, lysosomes and other common organelles. In function monocytes are phagocytes. Monocytes are not fully mature cells. They circulate in the

blood of 2 days, and then leave the bloodstream, migrate to different tissues and organs and are transformed into different forms of macrophage phagocytic activity is much higher than monocytes. Monocytes and macrophages are formed together in a single system or makrofagic mononuclear phagocytic system (МФС).

Age features of blood. In infants:

- 6-7 million erythrocytes in 1 liter (polycythemia);
- 10-30 thousand white blood cells in 1 liter (leukocytosis);
- Platelet 200-300 thousand per 1 liter, that is, as in adults.

After 2 weeks of red blood cells is reduced to that of adults (about 5 million in 1 liter). After 3-6 months, the number of red blood cells is reduced below 4.5 ml to 1 liter - a physiological anemia, and then gradually to the normal values for the period of puberty. White blood cell count in children over 2 weeks reduced to 9-15 thousand per 1 L and to the period of puberty reaches indicators adults.

Wbc in newborns

The greatest changes in leucocyte count observed in neutrophils and lymphocytes. Other indicators are not significantly different from that of adults. After giving birth, the 4-day is the first four-year second cross at 45-44%.

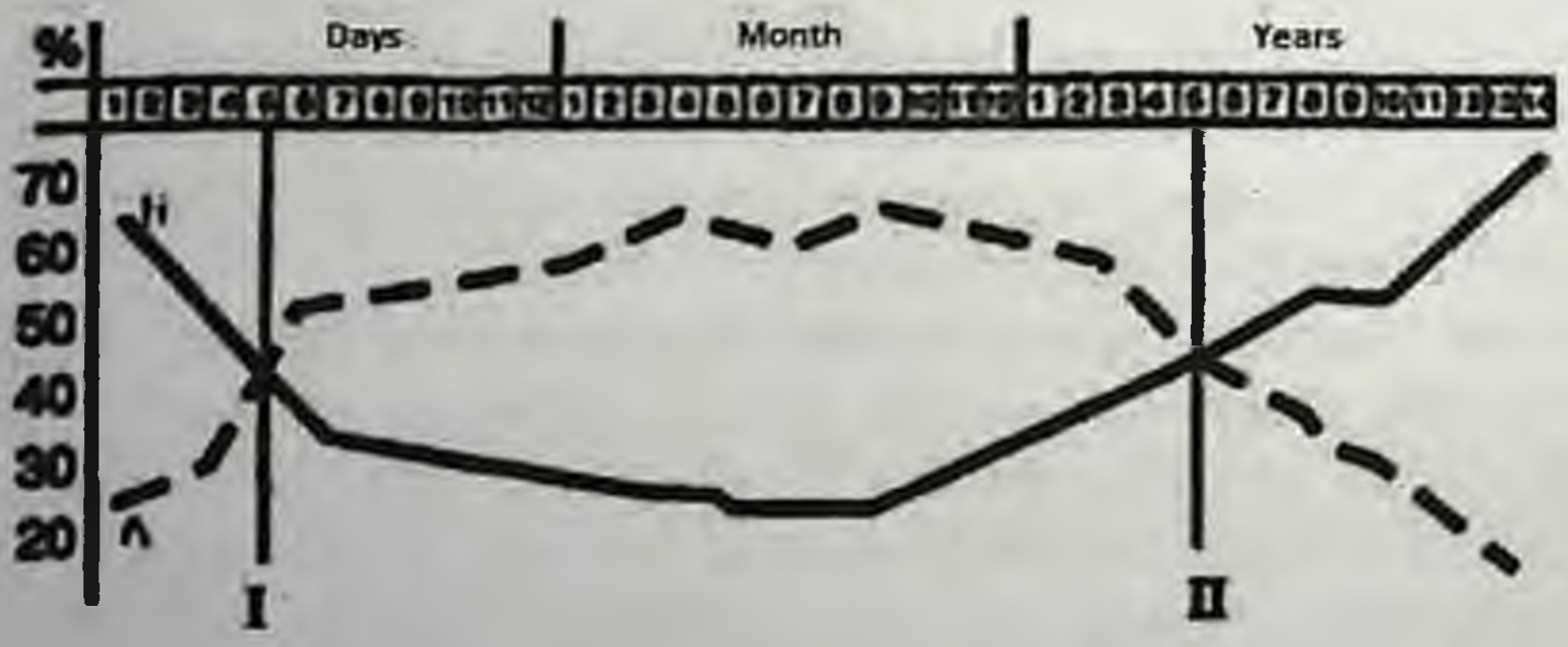
Newborns: neutrophils 65-75% 20-35% lymphocytes.

4th day - the first physiological cross:
neutrophils 45%, lymphocytes 45%.

2 years: neutrophils - 25%, lymphocytes - 65%.

4 years - the second physiological cross:
neutrophils - 45%, lymphocytes - 45%.

14-17 years: 65-75% neutrophils, lymphocytes 20-35%.



Picture-63. **1-11 - physiological cross**

Structural and functional characterization of platelet

Platelets or platelets are fragments of cytoplasm of special cells, bone marrow megakaryocytic.

Components of platelets:

* gialomer - the basis of the plate, surrounded tsitolemm;

* granulose - grain provided specific granules, as well as fragments of granular endoplasmic reticulum, ribosome's, mitochondria, and others (img-58).

Platelet size - 2-3 mm, and rounded, oval, Process. Platelets in maturity are classified as:young, mature, old, degenerative, gigantic.

The composition of the platelet

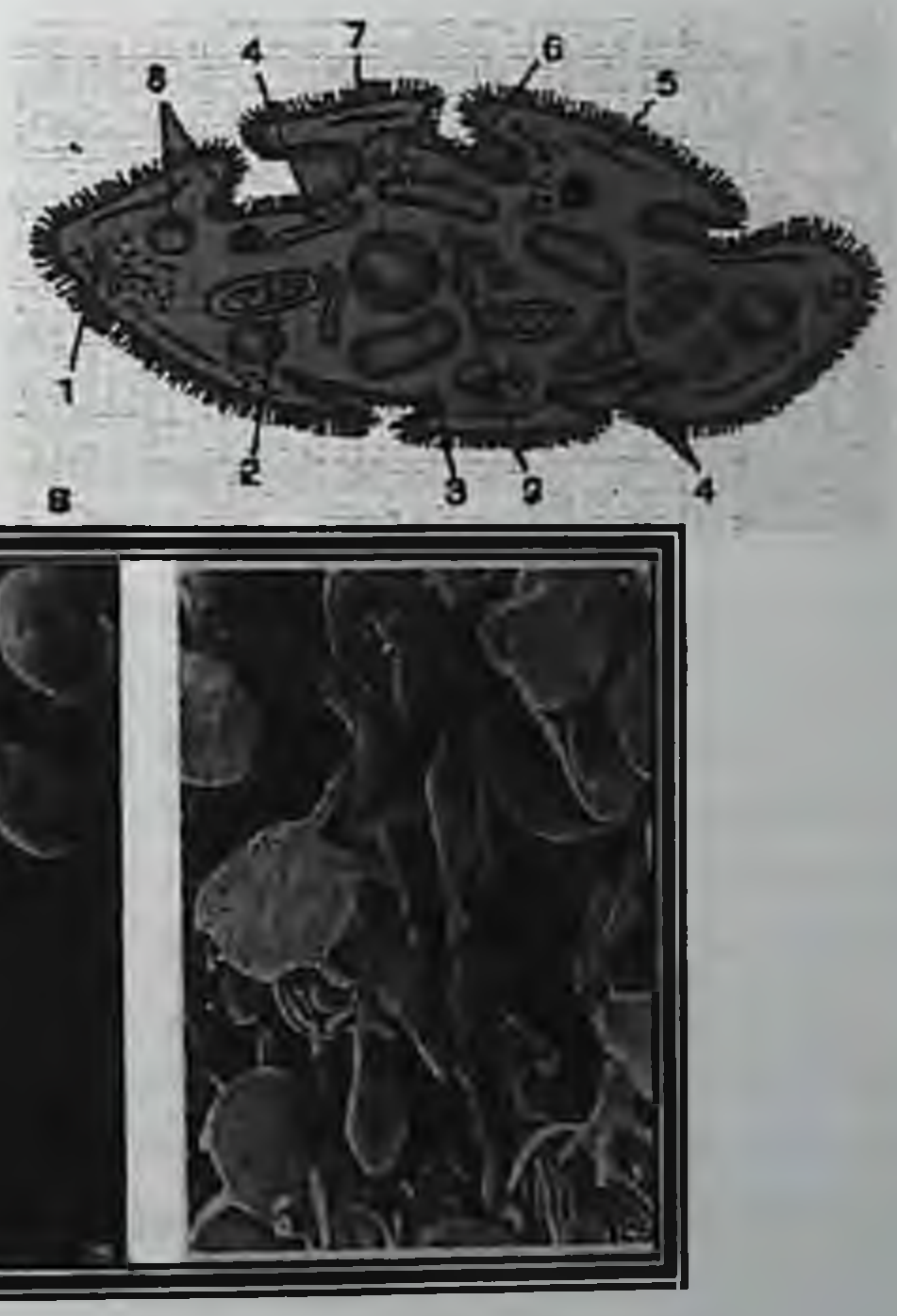
The life span of platelets - 5-8 days.

Platelet function:

* Participation in the mechanism of blood clotting by gluing plates and thrombus formation;

* The destruction of records and highlight one of the many factors contributing to the conversion of fibrinogen into globular filamentous fibrin.

1. microtubules
2. mitochondria
3. granuly (glycogen and ferritin)
4. dense tubular Network
5. microfilaments
6. tubules
7. glikokalliks
8. α-and β-granules



Picture-64. **A-platelets. B-platelet formation**

Function and composition of the lymph

Lymph consists of limfoplazm and cells, mainly lymphocytes (98%), as well as monocytes, neutrophils, and sometimes red blood cells. Limfoplazma formed by penetration (drainage) of tissue fluid in the lymph capillaries, and then removed through the lymphatic vessels of different caliber and flows into the venous system. On the movement of lymph passes through lymph nodes, where it is cleaned of exogenous and endogenous particles and enriched lymphocytes.

On the qualitative composition of the lymph may be:

- Peripheral lymph - to lymph nodes;
- Intermediate lymphoma - after lymph nodes;
- The central lymph - the thoracic duct lymph.

In the lymph nodes was not only the formation of lymphocytes, but the migration of lymphocytes from the blood into the lymph and then shock lymph they again fall into the blood and so on. These lymphocytes are recirculating pool of lymphocytes.

Function of lymph: drainage tissues enrichment lymphocytes, cleaning drainage from exogenous and endogenous substances.

Clinical significance

Reduction in the number of red blood cells is usually associated with the disease known as anemia. Increasing the number of red blood cells (polycythemia, or polycythemia) may be physiological adaptation. It found, for example, people who live in high altitudes, where oxygen tension is reduced. When polycythemia (Greek po - lots + ku - + cell - blood), which is often associated with diseases of varying severity, increased blood viscosity. When it is severe can break the blood circulation in the capillaries. Polycythemia can be accurately described as an increase in hematocrit, increase in the volume occupied by red blood cells. Erythrocytes with a diameter of more than 9 mm are described as macrocytes and a diameter less than 6 mm - as microcytes. Increase in the number of red blood cells with large variations in size known but anisocytosis (Greek al / band - unequal + ku - cell).

Inherited changes of hemoglobin molecules are responsible for a number of pathological conditions, as exemplified by the sickle mutation - the nucleotides (point mutations) in the DNA of the gene 3-chain of hemoglobin. GAA triplet (encoding glutamic acid) is replaced by the GUA, which encodes a valine. Consequently Broadcasts hemoglobin is abnormal presence of valine in place of glutamic acid. Meanwhile, the

substitution of a single amino acid has led to profound shifts. When such a modified hemoglobin (called NZ) loses oxygen (which occurs in the venous capillaries), it polymerizes and forms a rigid units, which give the characteristic sickle-shaped erythrocytes. Sickle cell does not have the flexibility and rather fragile, so the duration of his life is reduced, which leads to anemia. This results in increased blood viscosity, and can be damaged by the walls of blood vessels with , causing blood clotting. Blood flow in the capillaries slows or stops altogether, leading to severe lack of oxygen s tissues (anoxia).

Another disease of red blood cells is spherocytosis, characterized by spherical red blood cells are more vulnerable when

allocation and easier to destroy macrophages, leading to anemia and other symptoms. In some cases, spherocytosis associated with non sufficiency spectrin or defects of its molecule. Surgical removal of the spleen usually relieves the symptoms of hereditary spherocytosis due to loss of much of the macrophages present in the body.

Anemia is a pathological condition characterized by decrease in the concentration of hemoglobin in the blood below normal. Although anemia is usually associated with a reduced number of red blood cells, may also situations in which the number of cells is normal, but the content of hemoglobin in each cell decreased (hypochromic anemia). Anemia can be caused by hemorrhage (bleeding), a lack of red blood cell production by the bone marrow, the formation of red blood cells to reduce hemoglobin content, which is usually due to a deficiency of iron in the diet or to the accelerated destruction of blood cells.

In immature neutrophils, which recently the bloodstream, non-segmented nucleus, horseshoe (stab forms). Elevated levels of stab neutrophils in the blood indicates increased production of neutrophils, probably in response to bacterial infection. Neutrophils, in which the nucleus contains more than five shares (gipersegmentation) usually are old cells. Although under normal conditions as maturing neutrophil more nuclear lobes with no ¬ where pathological conditions there are young cells that contain five or more shares.

Neutrophils detect bacteria cover their pseudopodia and move into the cytoplasm, enclosed in vacuoles called phagosome, which membrane is from plasmolemm neutrophil. Immediately after this specific granules fuse with phagosoms, allocating them their content. Use of proton pump in the membrane of the phagosoms pH inside the vacuole is reduced to about 5.0, which is the optimum pH for maximum activity of lysosomal

enzymes. Next azurophilic granules throw their enzymes in an acidic environment, killing and digesting microorganisms. During phagocytosis burst of oxygen consumption leads to the formation of superoxide (O2) anion and hydrogen peroxide (H2O2). Superoxide anion is a short-lived free radicals produced by the addition of one electron to oxygen. This radical highly active and kills the microorganisms captured by neutrophils. Together with myeloperoxidase and halide ions, it forms a powerful microbicidal system. Other strong oxidizing agents (eg, hypochlorite) can inactivate proteins. The function of lysozyme is the specific cleavage of bonds in the molecule of peptidoglycan, forming cell walls of some gram-positive bacteria, causing their death. Lactoferrinum actively binds iron, because iron is an essential element of food bacteria, its inaccessibility leads to the death of bacteria. Acidic phago-vacuoles in itself can cause a loss of some microorganisms. The combined effect of these mechanisms can kill most of the microorganisms, which then digest lysosomal enzymes. Dead neutrophils, bacteria, half-digested mate and tissue fluid form a dense, usually a yellow liquid called pus. Describes several hereditary dysfunction of neutrophils. When one of them is not able to properly actin polymerize, resulting in Europhiles are sluggish. At the other identified ¬ is the inability to develop superoxide anions, hydrogen peroxide and hypochlorite, which reduces the ability of cells to destroy microbes. This dysfunction is a consequence of lack of NADPH oxidase (NADPH - the reduced form of nicotinamide adenine dinucleotide), which leads to defective respiratory explosion. Children with such dysfunction susceptible HN constant bacterial infections. More severe infections are the result of a combination of dysfunction of neutrophils and macrophages.

Increase of eosinophils in the blood (eosinophilia) associated with allergic reactions and invasion of worms (parasites). In the bodies of eosinophils are found in the connective tissue beneath the epithelium of the bronchi, the gastrointestinal tract, the uterus and vagina, as well as around the parasitic worms. In addition, eosinophils produce substances that affect inflammation, as they inactivate leukotrienes and histamine produced by other cells. They also phagocytize antigen-antibody complexes.

Corticosteroids (adrenal hormones) cause a rapid decline in the number of eosinophils in the blood, probably breaking their isolation from the bone marrow into the bloodstream.

For dermatological disease known as hypersensitivity skin basophils, basophils are the major cell type in inflammation.

Bone marrow stem cells as a source for a tissue. In contrast to the data of previous observations, it was found that the red bone marrow is rich in stem cells, which can ¬ may form various tissues, not just blood cells. With a huge potential differentiation, these cells make it possible to obtain the specialized cells that are not rejected by the body, because they come from bone marrow stem cells of the same person. The procedure is to obtain a bone marrow stem cells, culturing them in a suitable environment for their differentiation in the direction of cell types needed for transplantation, and then using the cells obtained in tissue culture, in order to replace the cells in which the patient needs. In this case, the donor and recipient are the same person, and there is a complete histocompatibility, which eliminates the possibility of rejection. Although these studies are only at the initial stage, to date, has promising results.

The emergence of a large number of immature neutrophils (stab cells) in the blood is called a left shift, and has clinical significance, because usually indicates a bacterial infection of the blood rejuvenation.

Changes in the content of neutrophils in the blood must be assessed in light of the existence of the notifications mentioned compartments. Thus, neutrophils - increase in the number of neutrophils in the blood stream - does not necessarily mean an increase of neutrophil production. Intense muscular work or administration of epinephrine cause movement of neutrophils from the marginal to the circulating compartment, resulting in clearly detectable neutrophils, even in the absence of enhancement of neutrophil production. However, glucocorticoids (adrenal hormones) increase the mitotic activity of neutrophil precursors in the bone marrow and increase the concentration of neutrophils in the blood.

Neutrophils can also be the result of release of large amounts of neutrophils from bone marrow storage compartment. This type is a transient neutrophilia, followed by a period of recovery, during which neutrophils are not secreted into the bloodstream.

In some forms of the disease, known as thrombocytopenic purpura, which is characterized by decreased platelet count in the blood, found that platelets retain contact with the cytoplasm of megakaryocytes in the breach mechanism of their selection. Platelet life span is about 10 days.

One of the main causes of the syndrome acquired immunodeficiency syndrome (AIDS) is the destruction of T-helper cells with a retrovirus infection. As a result, damages the immune system of the patient, making them to opportunistic infections, which are caused by microorganisms, usually do not you shows disease in people with normal immune systems.

5.4. Hematopoiesis

Blood (gemotsitopoezis) - the formation of blood cells. There are two types of blood:

Myeloid hematopoiesis: erythropoiesis; granulocytopoiesis; thrombocytopoiesis; monotsitopoezis.

Lymphoid blood: T limfotsitopoez, B-limfotsitopoez.

Furthermore, hematopoiesis is divided into two periods:

embryonic, postembryonic.

Embryonic period hematopoiesis results in blood as a tissue and therefore represents the histogenesis of blood. Postnatal hematopoiesis is the process of physiological regeneration of blood as a tissue.

Embryonic period hematopoiesis is achieved in stages, one after different organs of hematopoiesis. According to the embryonic hematopoiesis is divided into three phases:

- Yolk;
- Thymus-hepato-splenic;
- The medulla, thymus-lymphoid.

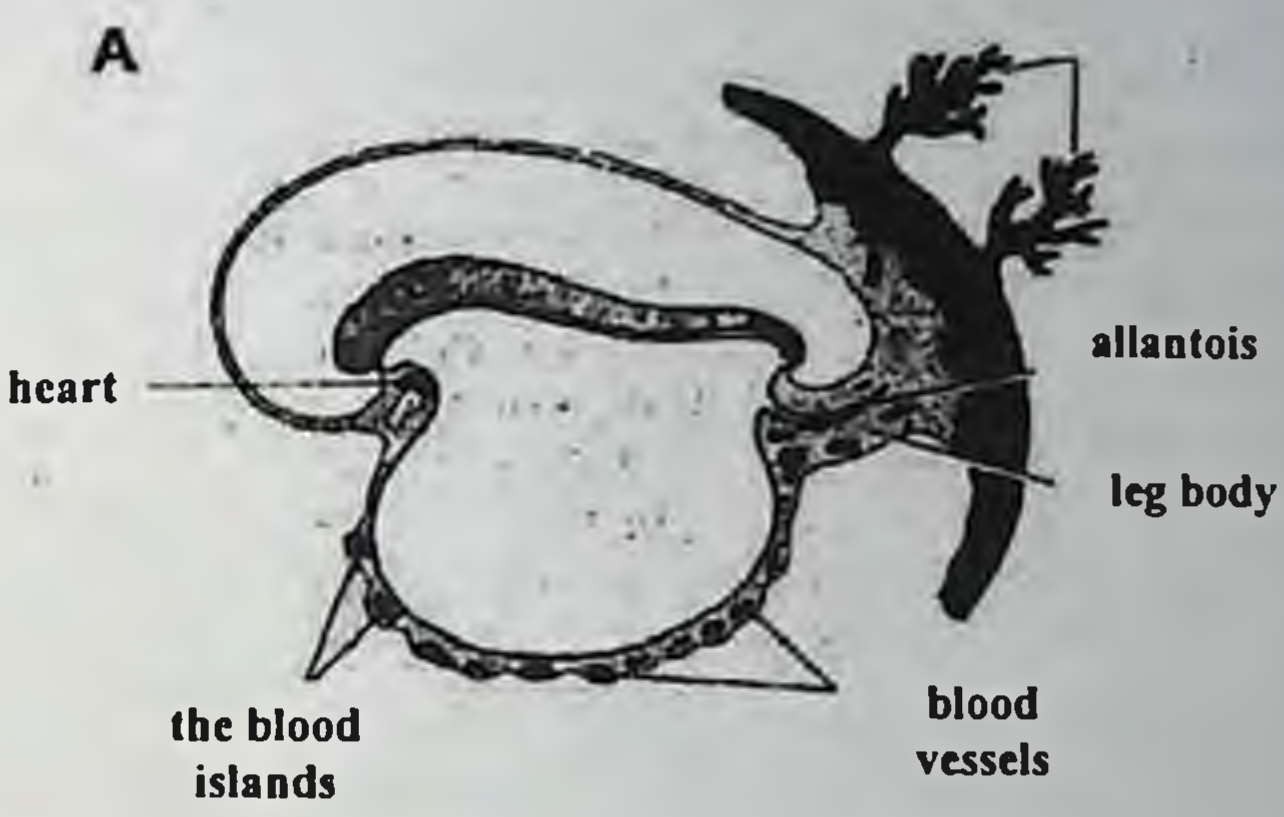
Yolk stage is in the mesenchyme of the yolk sac, from the 2-3rd week of embryogenesis, with the fourth week, he is reduced and at the end of the third month of full stops. Hematogenic process would be carried out as follows, first in the mesenchyme of yolk sac, resulting in the proliferation of mesenchymal cells, forming a "blood islands", which are focal accumulations mesenchymal cells. Then there is a differentiation of these cells in two directions-divergent differentiation (Figure 63):

• Peripheral islet cells are flattened, joined together to form the endothelial lining of the blood vessel;

• The central cells are rounded and converted into stem cells.

Of these cells in the blood vessels, that is, intravascularly, and the process of formation of primary erythrocytes (erythroblasts, megaloblasts). However, part of stem cell is outside the blood vessels (ex-

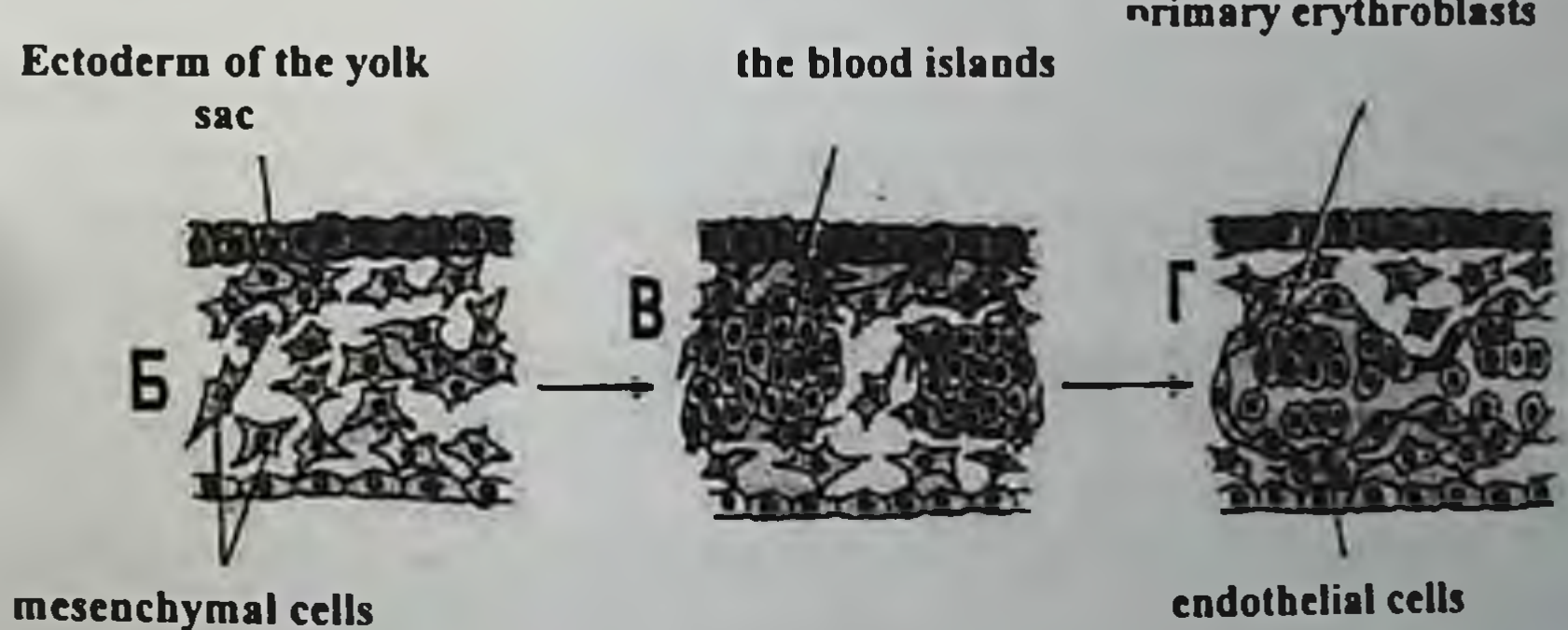
travascular) and are beginning to develop granular white blood cells, which then migrate to the blood vessels. Pretty soon, the yolk sac blood vessels connected to the blood vessels of the body of the embryo, for these vessels stem cells migrate into the body of the fetus and settle the tab.



The most important issues yolk stage is:

- The formation of blood stem cells;
- The formation of the primary blood vessels.

Somewhat later (in the third week) begin to form blood vessels in the mesenchyme of the body of the embryo, but they are empty of future blood-forming organs (especially the liver), which then is blood.



65-img.

Hepato-thymus-stage splenic hematopoiesis is early in the liver, a little later in the thymus (thymus), and later in the spleen. The liver is (only extravascular) mainly myeloid hematopoiesis from fifth week to the end of the 5th month, and then gradually decreased and by the end of embryogenesis ceases completely. The thymus is laid on the 7-8th week, and later it starts limfotsitopoezis T, which continues until the end of embryogenesis, and then in the postnatal period before its involution (25-30 years). The process of formation of T lymphocytes at this point is called an antigen independent differentiation. The spleen is laid at week 4, from 7-8 weeks it is populated by stem cells and it starts a universal blood, that is, and mieloilimfopoezis. Particularly active hematopoiesis in the spleen takes place from 5th to 7th months of fetal development, and then gradually suppressed myeloid hematopoiesis and by the end of embryogenesis (in humans), it stops completely. Lymphoid hematopoiesis is stored in the spleen until the end of embryogenesis, and then in the post-embryonic period. Consequently, the formation of blood in the second phase in these bodies are almost at the same time, only the extravascular, but its intensity and quality of the different organs in different.

The medulla of the thymus, lymphoid-stage blood. Bookmark the bone marrow starts with the 2nd month, hematopoiesis it starts with a 4-month and 6-month it is the main body of the myeloid and lymphoid hematopoietic part, that is the universal blood-forming organs. At the same time, in the thymus, the spleen and lymph nodes are lymphoid hematopoiesis. If the red bone marrow is unable to meet the increased demand for blood cell counts (for bleeding), the hematopoietic activity of the liver and spleen may be activated - extramedullary hematopoiesis.

Postnatal period blood - is in the red bone marrow and lymphoid organs (thymus, spleen, lymph nodes, tonsils, lymph follicles).

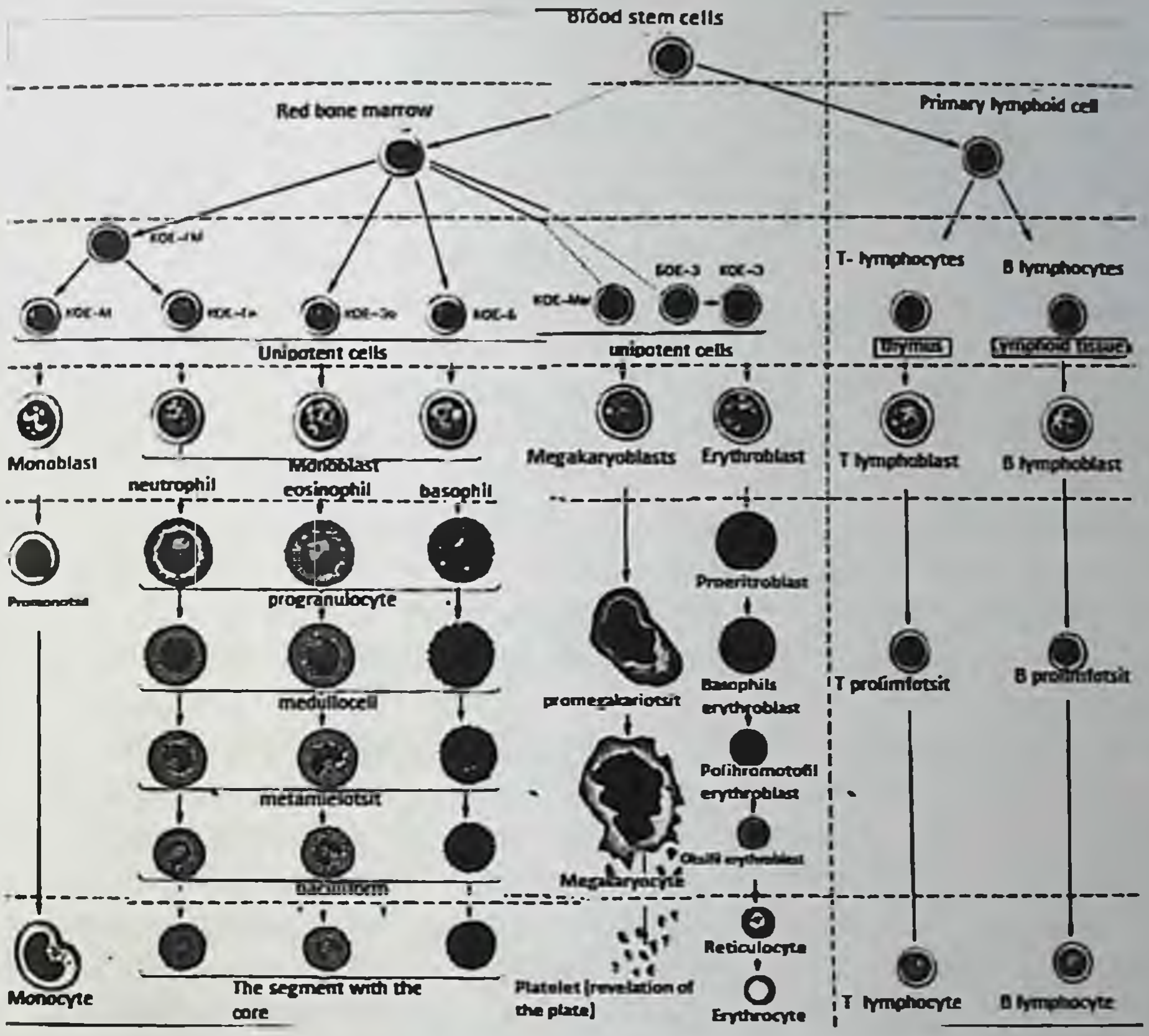
The essence of the process of hematopoiesis is the proliferation and differentiation of stem cells phased into mature blood cells. There are several theories of hematopoiesis.

I. Unitary theory (A.A. Maksimov, 1909) - all blood cells develop from a common precursor stem-cell;

II. Dualistic theory provides two sources of blood for myeloid and lymphoid;

III. Polyphyletic theory provides for each formed element of its source.

Currently, the standard is a unitary theory of blood, from which a scheme of blood (I.L Chertkov and A. Vorobiev, 1973).



Picture-66. **Postembryonic hematopoiesis.**
The diagram shows the 6 classes (stages) of hematopoietic cells.

In the process of gradual differentiation of stem cells into mature blood cells in each row formed intermediate types of blood cells, which in the scheme of hematopoiesis is the class of cells. Whole blood in the circuit distinguish six classes of cells:

Class 1 - stem cells;
Class 2 - semi stem cells;
Class 3 - unipotent cells;
Grade 4 - blast cells;

Grade 5 - maturing cells;

Grade 6 - mature forming elements.

Morphological and functional characteristics of different cell classes schemes hematopoiesis.

Grade1 - pluripotent stem cells capable of maintaining their populations. The morphology corresponds to a small lymphocyte is polypotent that is capable of differentiating into all blood cells. Directed differentiation of stem cells by the level in the blood of the formed elements, as well as the influence of the microenvironment of stem cells - the inductive effect of bone marrow stromal cells or other blood-forming organs. Maintaining a population of stem cells provided by the fact that after stem cell mitosis, one of the daughter cells following the path of differentiation, and the other takes the morphology of small lymphocytes and a stem. Stem cells divide infrequently (one every six months), 80% of the stem cells are dormant and only 20% in mitosis and subsequent differentiation. In the process of stem cell proliferation, each form a group or a clone of cells and because the stem cells in the literature are often called clone-forming units - CFU.

Grade 2 - semi stem, partially pluripotent (or part of committed) cells - the predecessor of myelopoiesis and lymphopoiesis. Have the morphology of small lymphocytes. Each produces a clone of cells, but only myeloid or lymphoid. They are divided more frequently (every 3-4 weeks), and also support the number of its population.

Grade 3 - unipotent poetin-sensitive cells - the predecessor of its range of hematopoiesis. Morphology also corresponds to a small lymphocyte. Able to differentiate only into one type forming elements. Often divided, but the descendants of these cells alone take the path of differentiation, while others maintain the population size of the class. Frequency division and the ability of these cells to differentiate further depends on the content in the blood specific biologically active substances - poetins specific to each series of blood (erythropoietin, thrombopoietin, and others).

The first three classes of cells are combined into a class of morphologically unidentifiable cells, because they all have the morphology of small lymphocytes, but their potential to develop different.

Grade 4 - blast (young) cells or blasts (erythroblasts, lymphoblasts, and so on). Differ in morphology as the three preceding and subsequent classes of cells. These cells are large and have a large loose (euchromatin) nucleus with 2-4 nucleoli, basophilic cytoplasm due to

the large number of free ribosomes. Often divided, but the daughter cells all take the path of further differentiation. By cytochemical properties can identify different series blasts hematopoiesis.

Grade 5 - Class of maturing cells, characteristic of a number of red blood cells. In this class, there may be several types of transitional cell - from one (prolimfotsits, promonotsits) to five in number of red blood cell. Some maturing cells in small amounts can get into the peripheral blood (eg, reticulocytes, young and stab granulocytes).

Grade 6 - mature blood cells. However, it should be noted that only the red blood cells, platelets and segmented granulocytes are mature end-differentiated cells or fragments. Monotsityne completely differentiated cells. Leaving the bloodstream, they differentiate into end cells - macrophages. Lymphocytes at a meeting with the antigens, become blasts and again divided.

The set of cells that make up the line of differentiation of stem cells into specific formed elements form its differons or histological series During the maturation of red blood cells in the 5th grade are: the synthesis and accumulation of hemoglobin, the reduction of organelles, the reduction of the nucleus. Normally, the completion of erythrocytes is mainly due to the division and differentiation of mature cells pronormotsits, basophilic and polychromatic normocytes. This type of blood is called hematopoiesis. In severe blood loss replenishment erythrocytes ensured not only reinforced the division of mature cells, and cells 4, 3, 2 or even 1 classes geteroplastichesky blood type prior to an already reparative regeneration of blood.

T-limfotsitopoez

Unlike myelopoiesis, limfotsitopoezis in embryonic and post-embryonic periods carried out in stages, replacing various lymphoid organs. In the T-and B-limfotsitopoezis three phases: 1-marrow stage, 2-stage antigen-independent differentiation, carried out in the central immune organs, 3-phase antigen-dependent differentiation, carried out in the peripheral lymphoid organs.

In the first stage of differentiation of stem cells produce progenitor cells, respectively, T-and B-limfotsitopoezis. In the second phase formed lymphocytes that can only recognize antigens. In the third phase of the second stage of the cells formed by the effector cells that can destroy and neutralize the antigen.

The process of development of T-and B-lymphocytes has both general trends and significant features, and therefore subject to a separate review.

The first phase of the T-limfotsitopoezis is in the lymphoid tissue of the red bone marrow, where the cells are formed following classes:

Class 1 - stem cells;

Class 2 - stem limfotsitopoezis progenitor cells;

Class 3 - T- cells unipotent progenitor cells T-limfotsitopoezis, these cells migrate into the bloodstream and blood reach the thymus.

The second stage - the stage of antigen-independent differentiation is in the cortex of the thymus. Here we continue the further process of T-limfotsitopoezis. Under the influence of the active substance of thymosin released by stromal cells, unipotent cells become T-lymphoblasts - Grade 4, then T-prolymphocytes - Grade 5, and the last in the T-lymphocytes - Grade 6. In the thymus of unipotent cells evolved independently three subpopulations of T lymphocytes: **the killers, helpers, suppressors.**

In the cortex of the thymus all of the subpopulation of T lymphocytes acquire different receptors to a variety of antigenic substances (the mechanism of T-receptor is still unknown), but the antigens in the thymus do-not get. Protection of the T-limfotsitopoezis from foreign antigenic substances is achieved by two mechanisms: the presence in the thymus special blood-thymus barrier, lack of lymphatic vessels in the thymus.

As a result, the second phase formed receptor (afferent or T0) T-lymphocytes - killers, helpers, suppressors. At the same cells in each of the subpopulations differ in different receptors, but there are clones of cells that have the same receptors. In the thymus, the T-lymphocytes with receptors and to its own antigens, but these cells are also destroyed by macrophages. Educated in the cortex of the T-lymphocyte receptor (killer cells, helper and suppressor), without going into the brain substance, enter the bloodstream and blood flow recorded in the peripheral lymphoid organs.

The third stage - the stage of antigen-dependent differentiation is carried out in the T-zone peripheral lymphoid organs - lymph nodes, spleen, and others where the conditions for meeting the antigen to T-lymphocytes (killer, helper or suppressor) having a receptor for a given antigen. However, in most cases affects lymphocyte antigen, not directly but indirectly - through a macrophage, that is first of phagocytic

macrophage antigen partially splits it intracellularly, and then the active chemical groups antigen - antigenic determinants tsitolemmy brought to the surface, contributing to their concentration and activation. Only then these determinants macrophages are transferred to the corresponding receptors of different subpopulations of lymphocytes. Under the influence of the antigen T cell is activated, change their morphology and converted to T-lymphoblasts, or rather in the T-immunoblast, because it is not a cell grade 4 (formed in the thymus), and arose from a cell under the influence of lymphocyte antigen.

The process of transformation of T-lymphocytes in the T-immunoblast called blast transformation reaction. After that, T-immunoblast arising from T-receptor killer helper or suppressor proliferates and forms a clone of cells. Killer T-cell clone immunoblast provides, among which are:

T-RAM (killer) T-killer cells or cytotoxic lymphocytes, which are the effector cells that provide cellular immunity, that is, the body's defense against foreign and genetically modified own cells.

After the first meeting foreign cells with the receptor of T lymphocytes develop the primary immune response - blast transformation, proliferation, the formation of T-killer cells and destruction of foreign cells. T-cell memory in the second meeting with the same antigen provided by the same mechanism as a secondary immune response that is faster and stronger than the primary.

T-helper cell clone immunoblast provides, among which distinguish T-memory T-helper cells that secrete a neurotransmitter - lymphokine stimulating humoral immunity - immunopoiesis inductor. Similar mechanism of T-suppressor lymphokine that inhibits antibody response.

Thus, at the end of the third stage of T-effector cells formed limfotsitopoeza cellular immunity (T-killers), the regulatory cells of humoral immunity (T-helper and T-suppressor) and T-memory all populations of T-lymphocytes, which are at the second meeting with the same antigen again provide immune defenses in the form of a secondary immune response. In providing cellular immunity consider two mechanisms of antigenic destruction killer cells:

- Contact interactions - the "kiss of death" to the destruction of the site tsitolemmyzis target cells;
- Distant interaction - through the provision of cytotoxic factors relevant to the target cell gradually and continuously.

B-limfotsitopoez

In the first stage, limfotsitopoezis performed in the bone marrow, where the cells are formed following classes:

Class 1 - stem cells;

Class 2 - stem precursor cell lymphopoiesis;

Class 3 - In- unipotent progenitor cells in-limfotsitopoezis.

The second stage differentiation in birds is a special central lymphoid organs - bursa of Fabricius. In mammals and humans is not such a body, and its counterpart is not certain. Most researchers believe that the second phase is also carried out in the bone marrow, where the unipotent of B-cells are produced in-lymphoblasts - Grade 4, then B-prolymphocytes - Grade 5 and lymphocytes - Grade 6 (receptor or B0). During the second phase of the B cells acquire different receptors for antigens. It was found that the receptors are proteins called immunoglobulins that are synthesized in the very same maturing B lymphocytes, and then brought to the surface and become incorporated into plasmolemma. Chemical groups at the end of these receptors is different, and this explains the specificity of the uptake of certain epitopes of different antigens.

The third stage - the antigen-dependent differentiation is in the B-zone peripheral lymphoid organs (lymph nodes, spleen, etc.) where there is a meeting with the appropriate antigen, the B-lymphocyte receptor, its subsequent activation and transformation in immunoblast. However, this is only with the involvement of additional cells - macrophages, T-helper cells, and possibly T-suppressor, that is for the activation of B-lymphocyte cells following co-operation is needed: In-receptor lymphocytes, macrophages, T-helper (T-suppressor) and humoral antigen (bacteria, viruses, proteins, polysaccharides, and other). The process of interaction occurs in the following sequence:

- Macrophages phagocytose antigen determinants and makes the surface;
- Affects antigenic determinants on receptors in lymphocytes;
- Affects these same determinants of the receptors of T-helper and T-suppressor.

Effect of antigenic stimulus for B-lymphocyte blast transformation enough for him. This occurs only after activation of T helper cells and providing them with the activating lymphokine. **After such a reaction occurs further incentive blast** transformation, that is, the transformation of B-lymphocytes in immunoblast, which is called plazmoblasta, as

a result of the proliferation of immunoblasts generated clone of cells, among which are distinguished:

In-memory;

Plasma cells, which are the effector cells of humoral immunity.

These cells synthesize and secrete into the blood or lymph immunoglobulins (antibodies) of different classes, which interact with antigens and form antigen-antibody complexes (immune complexes) and thus neutralize antigens. Immune complexes are then phagocytized by neutrophils or macrophages.

However, the antigen-activated B cells are capable to synthesize a small amount of non-specific immunoglobulins. Under the influence of lymphokines of T-helper comes first, the transformation of B-lymphocytes in the plasma cells, and secondly, is replaced by the synthesis of non-specific antibodies to specific third, stimulates the synthesis and secretion of immunoglobulins plasma cells. T-suppressor activated by the same antigen, lymphokine release, inhibits the formation of plasma cells and the synthesis of immunoglobulins, pending complete termination. Combined effect on activated B-lymphocyte lymphokine T-helper and T-suppressor cells and adjusts the intensity of humoral immunity. Complete immunosuppression is called tolerance or areactivity, that is the lack of immune response to an antigen. It could be due to a primary antigen stimulation of T-suppressor and inhibition of T-helper cells or loss of T-helper cells (such as AIDS).

Clinical significance

One form of the blood disease is hemophilia. Hemophilia A and clinically identical - they differ only in the factors that cause the disease. Both variants are due to recessive genetic defects associated with the floor. In patients with hemophilia hemocoagulation disrupted, with increased clotting time. In people with the disease, even after minor trauma such as a cut of the skin could be a significant bleeding, and in more severe injuries can result in bleeding death. In the blood plasma of patients with hemophilia A or missing clotting factor VIII (one of the plasma proteins involved in the formation of fibrin), or contains defects factor VIII. Haemophilia in violation due to a defect of factor IX. In severe case teas blood can not clot. In patients with spontaneous hemorrhages occur in abdominal structures, such as the large joints and urinary tract howl. Hemophilia A usually affects only men, as a recessive factor VIII gene is located on the X chromosome. In women, there is only one defective X chromosome, while the other is usually normal.

Therefore women hemophilia can occur only if there is a defective gene in the two X-chromosomes, which is rare. However, women with a defective X chromosome can transmit the disease to their male offspring.

Growth factors are used clinically to improve the content of cells in the bone marrow and blood. The use of growth factors to stimulate the proliferation of leukocytes is ample opportunity for clinical therapy. Potential areas for therapeutic use of growth factors include the increase in blood cell diseases or induced conditions (eg, chemotherapy, radiation), which lead to the reduction of the content of formed elements in the blood, bone marrow transplants more effective by increasing cell proliferation, STI emulation defenses in patients with cancer, infectious diseases and immunodeficiency and improving the flow of parasitic diseases.

Diseases of the blood are usually caused by filing or stimulation of the formation of some indifferentism cells, with subsequent reduction in the content, or excessive hematopoietic cells. For certain diseases, however, one can consistently or temporarily occur ¬ suppression of proliferation and stimulation of more than one type of stem cells. In such cases, there is a decrease the content of certain types of cells (eg, aplastic anemia - a disease characterized decreased production of cells) or high content of other cells (eg, leukemia, when there is an abnormal proliferation of white blood cells). Initial experiments to transplant normal ¬ mal bone marrow of irradiated mice formed the basis for a bone marrow transplant, which is now often used to treat certain disorders of proliferation of hematopoietic cells.The pathology of bone marrow-emerging diseases connected with the cells that are in it develop. Leukemias are characterized by formation of malignant clonezation predecessor nicknames leukocytes. They can occur in the lymphoid tissue (lymphoid leukemia) and bone marrow (myeloid leukemia and monocytic leukemia). In these diseases usually allocate tion in the blood of large amounts of immature cells. Symptoms of leukemia are the result of the shift of cell proliferation, in which some cell types are missing, and others - are produced in excessive number (which is often accompanied by ¬ violation of their function). Leukemia usually anemic and prone to infections. Clinical method and is useful for examining patients with leukemia and other disorders of the bone marrow is aspirated bone marrow. To do this, after the needle is compact bone (usually in the chest well) to obtain a sample of bone marrow. Material is applied to a glass slide, manufactures, which is then painted. The use

of labeled monoclonal antibodies specific to proteins located on the membrane precursors of blood cells, helps ratify cell types derived from stem cells, and contributes to a more accurate diagnosis of various types of leukemia.

The practical part

Compilation of logical structures, the study of drugs, electron diffraction, diagrams and sketches of blood cells into albums, view multimedia.

The objects under study: blood smear scheme of hematopoietic.

Sample test items

1. What is the main function of the blood?

a) safety;

b) participation in the humeral regulation;

c) participation in the maintenance of homeostasis;

d) transport;

e) participation in thermoregulation.

2. What term is called the increase in the number of red blood cells?-

a) eritropeniya;

b) poikilocytosis;

c) anisocytosis;

d) erythrocytes city.

3. What are the white blood cells responsible for the synthesis of histamine.

a) basophilic leukocyte;

b) neutrophil leukocyte;

c) eosinophilic leukocyte;

d) monocyte.

4. What is the average diameter of a red blood cell?

a) 5,1-5,9 m/km;

b) b.6,1-6,9 microns;

c) c.7,1-7,9 microns;

d) d.8,1-8,9 microns;

e) e.9,1-9,9 microns.

5. What is the function of the cell belongs Synthesis of immunoglobulins?

a) erythrocyte;
b) monocyte;
c) basophilic leukocyte;
d) plazmotsit;
e) eosinophilic leukocyte;
f) neutrophil leukocyte.

6. What is the main function of neutrophils?

a) antibody;
b) phagocytosis of microorganisms and particles;
c) phagocytosis of the antigen-antibody complex;
d) inactivation of histamine;
e) participation in allergic and anaphylactic reactions.

Approximate refereed report "Gistofiziologicheskie features hematopoiesis"

Subject: Connective tissues

I. Aims and objectives: 1. to study the types and functions of connective tissues. 2. To study the structure of the connective tissue

II. Questions for self-control students.

1. The concept of connective tissue.
2. Classification and function of connective tissue.
3. RVST-structure.
4. Functions and Features RVST.
5. The cellular tissue features.
6. Intercellular substance RVST.
7. Age features RVST.
8. The clinical significance.

The theoretical part

Conjunctive tissue

The concept of connective tissue (the tissue of the internal environment, support-trophic tissue) combine differing in morphology and function of tissue, but share some common characteristics and develop from a single source - the mesenchyme.

Structural and functional features of connective tissue:

- The internal arrangement of the body;
- The prevalence of the intercellular substance of cells;
- The variety of cell forms;
- A common source of origin - mesenchyme.

Functions of connective tissue:

- Trophic (metabolic)
- Support;
- Protection (mechanical, non-specific and specific –immunological);
- Reparative (plastic).

Classification of connective tissue:

* Blood and lymph;
* Proper connective tissue
* Fiber: loose, dense (decorated and loose);
* Special: reticular, fat, slimy, pigment;
* Skeletal tissue - **cartilage**: hyaline, elastic, fibrous, stringy, **bony**: lamellar, reticulo-fibrotic.

Despite the similarity in the structure and development of the various subgroups of the connective tissue, they are significantly different from each other, and above all the structure of the intercellular substance from a liquid - blood and lymph to the dense - cartilage, and even mineralized - bone. These structural features are due to their functional differences, which will be noted in the description of each tissue subgroups.

The most common in the body are the fibrous connective tissues, and especially loose fibrous connective tissue, which is a part of almost all organs, forming the stroma, the layers and layers, accompanying blood vessels.

5.5. Characteristics of loose fibrous connective tissue

It is composed of cells and intercellular substance, which, in turn, consists of fibers (collagen, elastic, reticular) and amorphous material (Figure 65). Morphological features that distinguish a loose fibrous connective tissue from other varieties of connective tissue:

The variety of cellular forms (9 cell types);

-Dominance in the intercellular substance of amorphous fibers.

Characteristics of loose fibrous

connective tissuefunctions:

-Trophic;

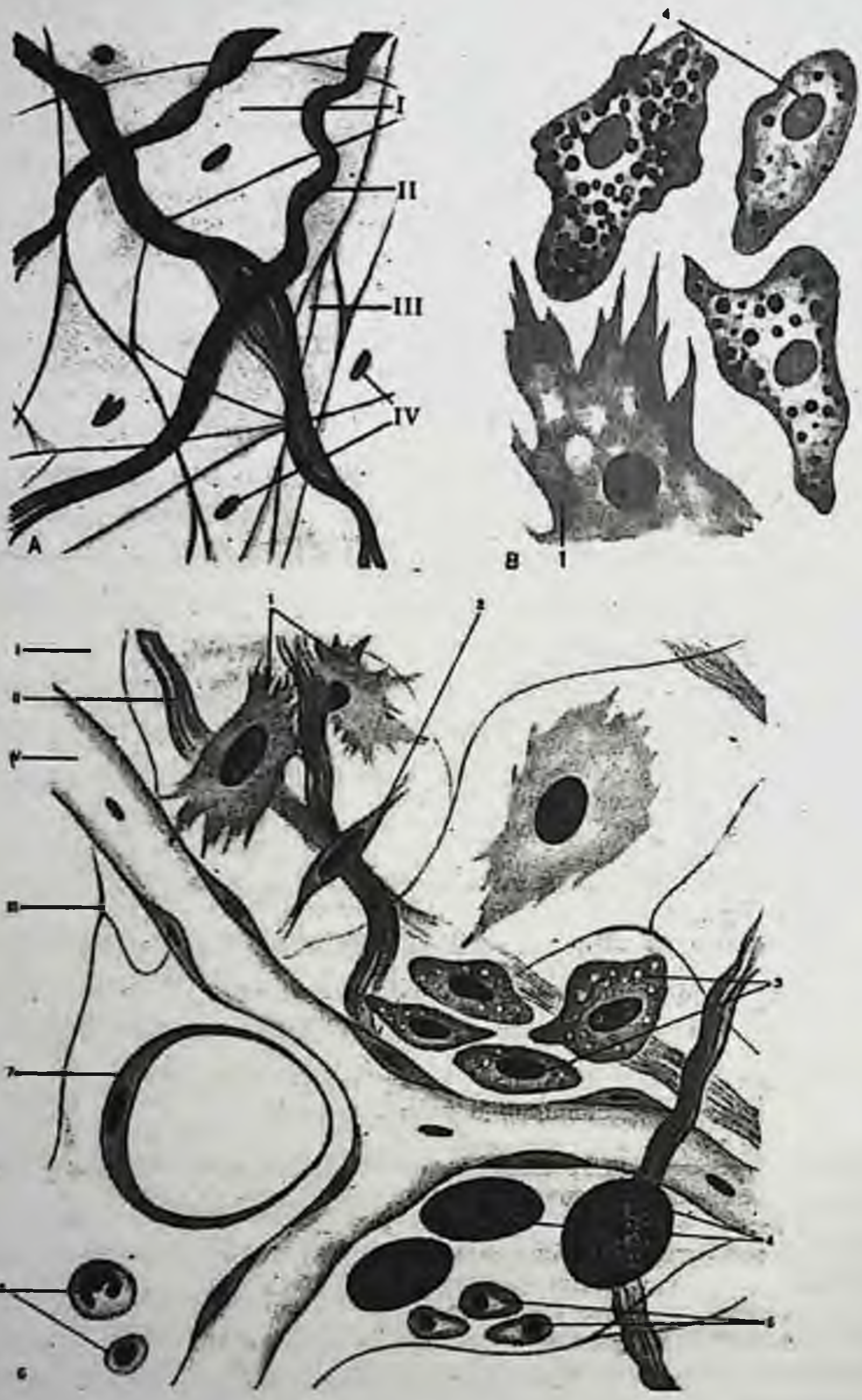
-Support: forming the stroma of parenchymal organs;

-Protection - non-specific and specific (participation in immune reactions) protection;

Depot water, lipids, vitamins and hormones;

-Reparative (plastic).

Functionally major structural components of loose fibrous connective tissue are cells of different morphology and function, which will be considered in the first place, and then the intercellular substance.

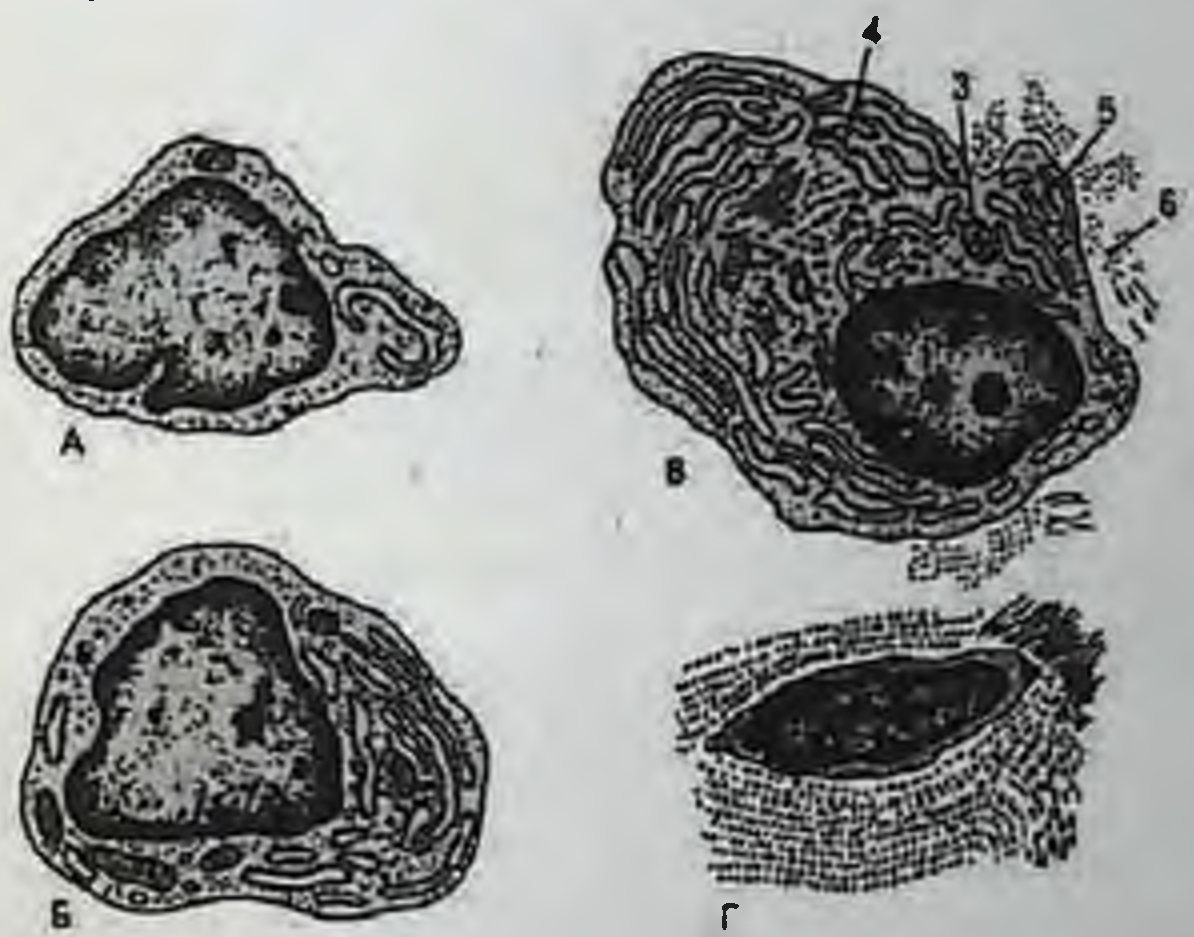


Picture-67. **Loose fibrous connective tissue of:** I-Base Material. II- collagen fibers. III- Elastic fibers. IV- cells. V- blood vessel. 1.2-fibroblasty. 3-Macrophages. 4-fat cells. 5-plasma cells. 6-leykotsites. 7-adiposities.

Structural and functional characteristics of fibroblasts. Fibroblasts - the dominant population of cells loose fibrous connective tissue. They are a mixed maturity and functional specificity, and therefore fall into the following sub-populations (Figure 66):

- Undifferentiated cells;
- Differentiated or mature cells, fibroblasts or proper;
- Old fibroblasts (definitive) fibroblasts, as well as specialized forms of fibroblasts;
- Myofibroblasts;
- Fibroclasts.

The predominant form is mature fibroblasts, whose function is to synthesis and release into the intercellular environment proteins - collagen and elastin, and glikozoaminoglikans of which are extracellular formation of different types of fibers and amorphous. Therefore, the intercellular substance is mainly a product of the fibroblasts, partly of other cells, and plasma.



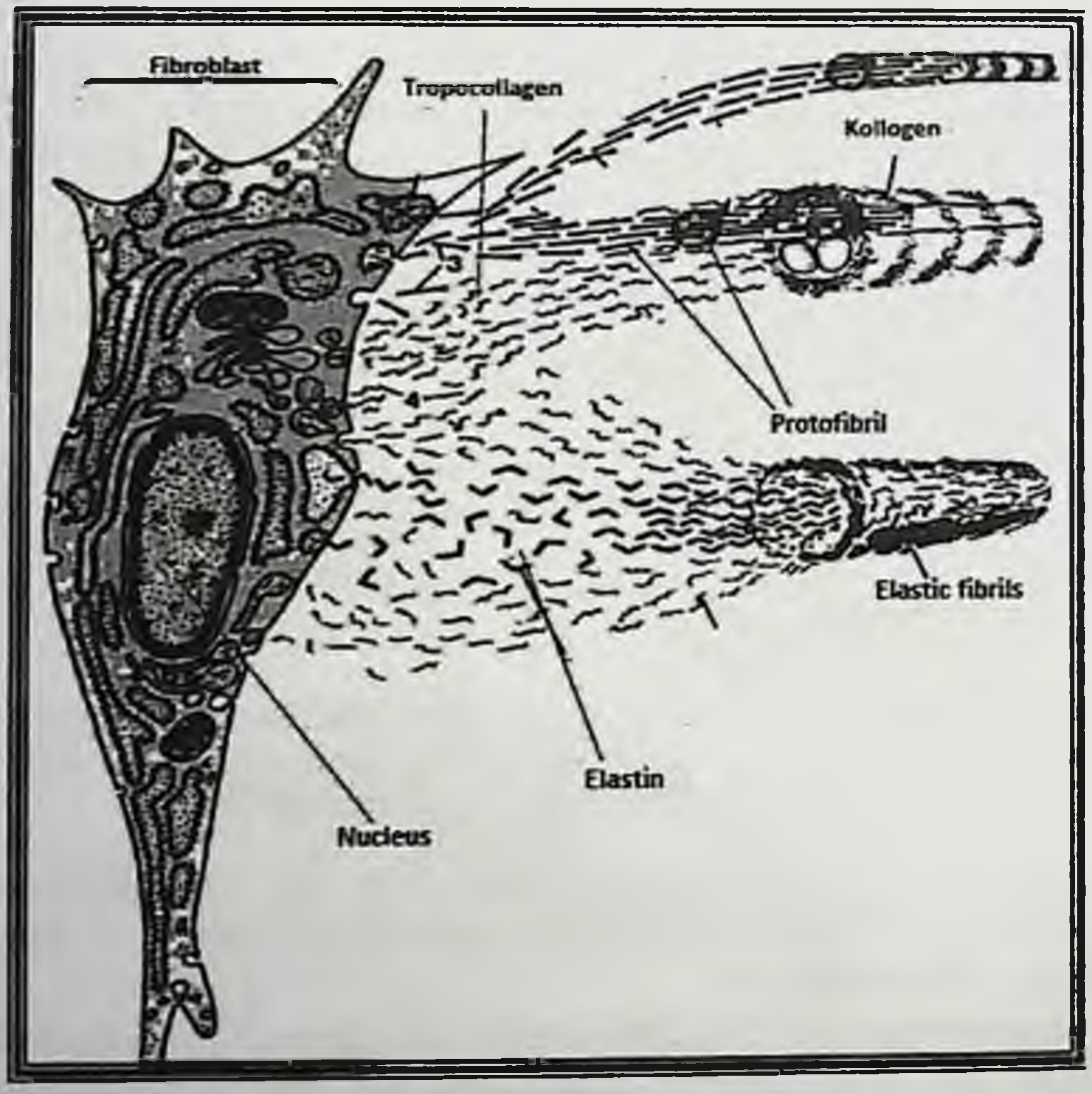
Picture-68. **Fibroblast differentiation:** A poorly differentiated; B-to-young adult; T-fibrotsit: 1 – fibrotsit; 2 - Golgi complex; 3- mitochondria; 4-ribo-and polysomes; 5 - granular ES; 6 - collagen fibers.

To structure the characteristic expression of fibroblast growth synthetic apparatus - the granular endoplasmic reticulum and transport system - plate Golgi complex.

The remaining organelles developed moderate (67-68-rice). In fibroblast granular endoplasmic reticulum and lamellar complex is largely reduced. In the cytoplasm of fibroblasts contained microfila-

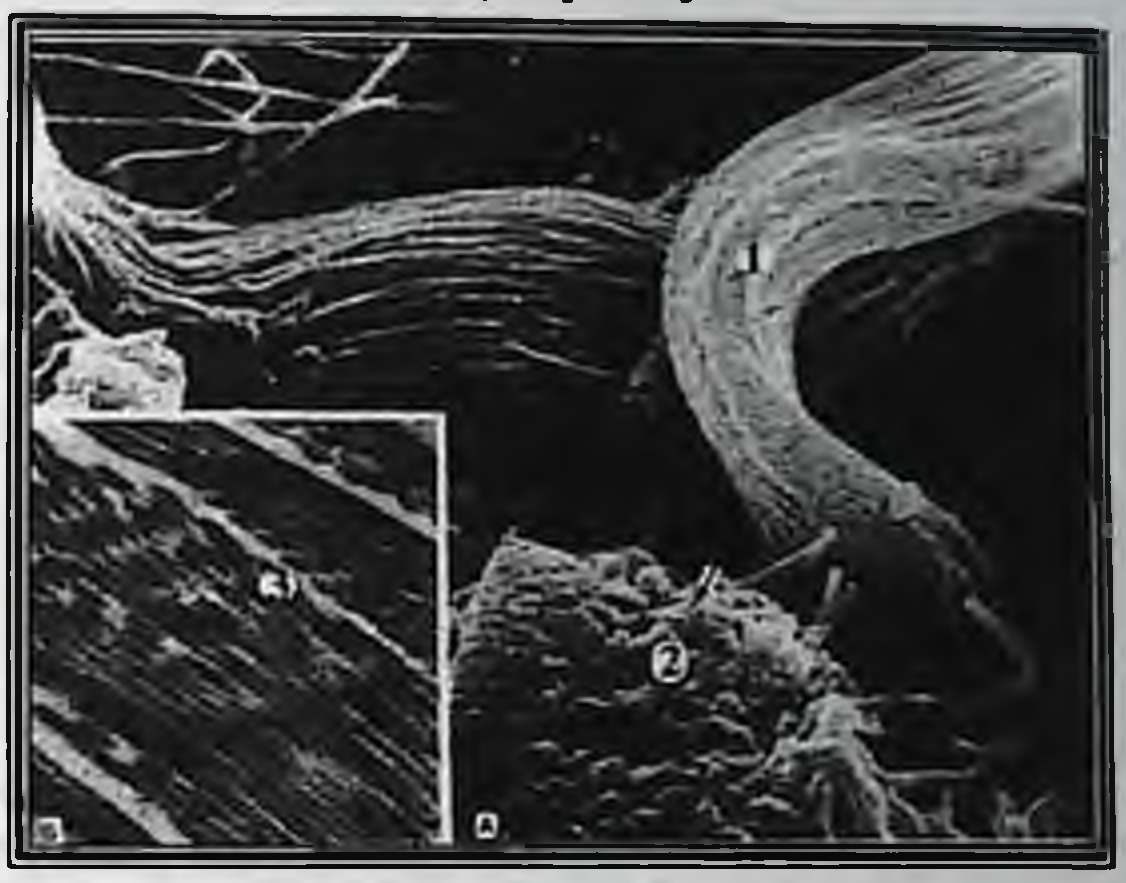
ments containing contractile proteins (actin and myosin), but especially developed these organelles into myofibroblasts, through which they implement traction (contraction, shrinkage) of young connective tissue and scar formation.For fibroblasts characteristic content in the cytoplasm of the large number of lysosomes.These cells are capable of releasing lysosomal enzymes into the intercellular environment and use them to break down the collagen and elastic fibers into fragments, and then phagocytose and these enzymes cleave intracellularly. Hence, for fibroclasts characteristic (under certain conditions) the implementation of lysis of intercellular substance, including fibers (eg, the involution of the uterus after delivery).

Thus, different forms of fibroblast form intercellular substance of connective tissue (fibroblasts), support it in a certain structural condition (fibroblasts), and destroy it under certain conditions (fibroclasts). Because of these properties of fibroblasts is a function of the fibrous connective tissue - reparative (plastic) (figure 70).



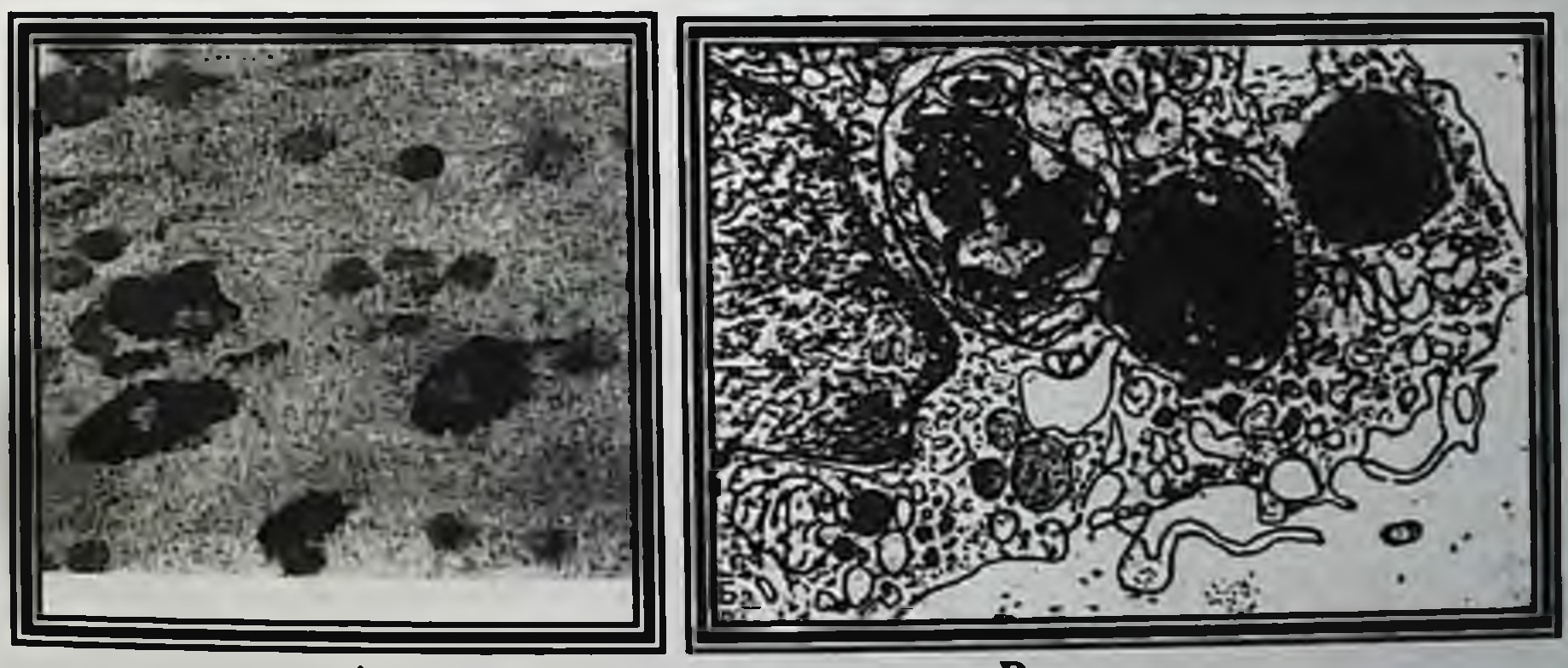
Picture-69. **Collagen and elastic synthesis in fibroblasts**

Macrophages - cells that provide a protective function, primarily by phagocytes of large particles, hence the name. However, phagocytes, albeit an important one, but not the only function of these cells. In modern data macrophages are multifunctional cells. Formed macrophages from blood monocytes after they are released from the bloodstream. Macrophages are characterized by structural and functional heterogeneity, depending on the degree of maturity of the field of localization, as well as their activation antigens or lymphocytes.



Picture-70. **Type of collagen and collagen bundle**
1, 2-Collagen fibers
3. Striated collagen fibers

First of all, they are divided into fixed and free (mobile). Connective tissue macrophages are moving or wandering and called histiocytes. There are also macrophages serous cavities (pleural and peritoneal), alveolar, macrophages of the liver - Kupffer cells, the macrophages of the central nervous system - glial macrophages and osteoclasts. All these different forms of macrophages together in mononuclear phagocyte system (MFS) or makrofagic systems.



A B

Picture-71. **Macrophages.** A-under a light microscope,
B under a the electron microscope

The most prominent structural feature of macrophages is expressed lysosomal apparatus, that is, in their cytoplasm contains many lysosomes and phagosomes (pic-71). The protective function of macrophages is manifested in different forms:

• non-specific protection - protection by phagocytosis of exogenous and endogenous particles and their intracellular digestion;

• allocation of the extracellular environment of lysosomal enzymes and other substances: pyrogen, interferon, hydrogen peroxide, singlet oxygen, and others;

• Specific or immunological protection - participation in a variety of immune responses.

In humoral immunity, they phagocytose immune antigen-antibody complexes in cellular immunity under the influence of lymphokine kil-

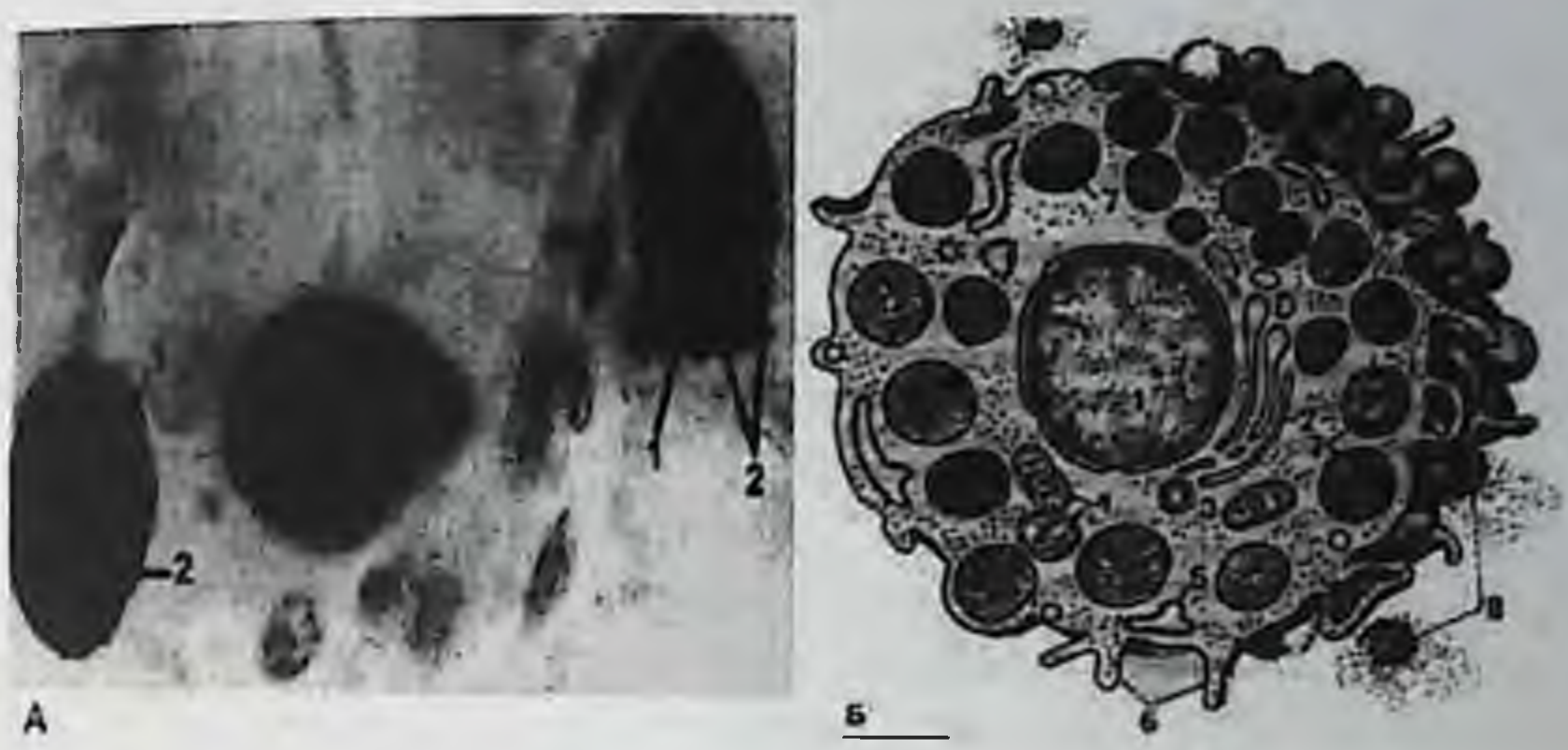
ler macrophages acquire properties and may destroy the alien, including tumor cells. Thus, while not immune cells, macrophages are actively involved in immune responses.

Macrophages also synthesize and secrete into the extracellular media about a hundred of various biologically active substances. Therefore, macrophages can be attributed to the secretory cells

Tissue basophils (mast cells, mast cells) are true RVST cells. The function of-these cells is the regulation of local tissue homeostasis, that is, to maintain the structural, biochemical and functional consistency of the microenvironment. This is achieved through the synthesis of tissue basophils and the subsequent allocation of the intercellular environment glikozoaminoglikans (heparin and hondroitinsernal acids), histamine, serotonin, and other biologically active substances, which have an impact on both the cells and the intercellular substance of connective tissue, and especially in the microcirculation, increasing the permeability gemokapillyars, thereby increasing the hydration of the intercellular substance. In addition products of mast cells have an effect on immune processes, as well as inflammation and allergies. Sources of mast cells have not been established.

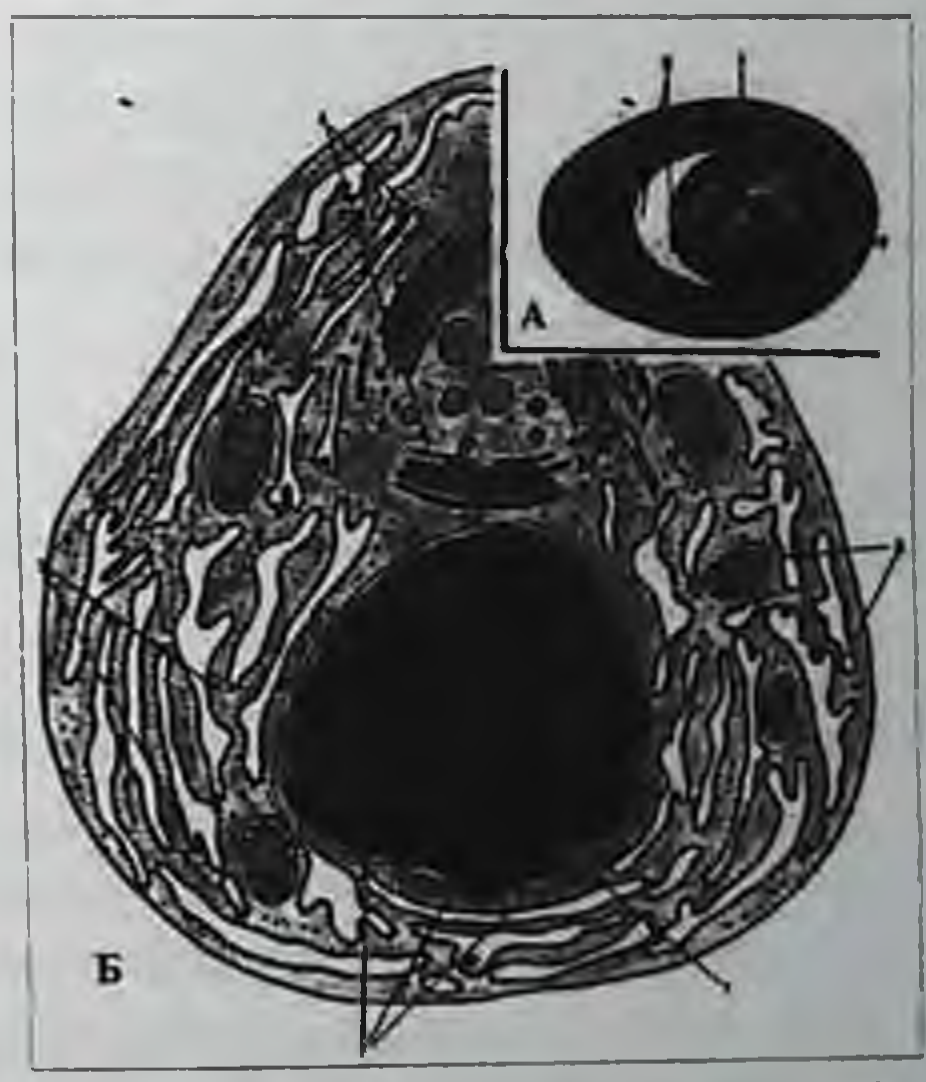
In the excitation tissue basophils of them are biologically active materials in two ways: by providing granule degranulation;

by diffusion through the membrane separation of histamine, which increases vascular permeability and causes hydration (swelling) of the base material, thus increasing the inflammatory response.



Picture-72. **Mast cells.** A subcutaneous connective tissue: 1-karnel; 2-core meta-chromatic granules in the cytoplasm of B-structural scheme: 1-karnel; 2- Golgi; 3- lysosome; 4 mitochondria; 5- EMF; 6- microvilli; 7- heterogeneous granules; 8- secretory granules in the intercellular substance.

Mast cells are involved in immune responses. When ingested, some antigenic substances plasmacytomas synthesized immunoglobulin E, which are then adsorbed on tsitolemm mast cells. Repeated ingestion of the same antigen on the surface of mast cells, the immune antigen-antibody complexes, which causes an abrupt tissue basophil degranulation, and standing out in a lot of the above active compounds cause the rapid development of allergic and anaphylactic reactions..



Picture-73. **A plasma cell under a light microscope, B-plasma cell under an electron microscope:**
1. Nucleus. 2 – Heterochromatin. 3 - Granular EMF. 4 - Golgi complex. 5, 6 – mitochondria

Plasma cells (plasma cells) are cells of the immune system - the humeral immune effectors cells Plasma cells are formed from B-lymphocytes when exposed to antigenic substances. Most of them localized in immune organs (lymph nodes, spleen, tonsils, follicles), but most plasma cells distributed in the connective tissue. Function of plasma

cells are in the synthesis and isolation of the intercellular environment antibodies - antibodies, which are divided into five classes. Based on the named function can be suggested that these cells is well developed synthetic and secretory apparatus. Indeed, in the electron plasma cells can be seen that almost all the cytoplasm is filled with granular endoplasmic reticulum, leaving a small area adjacent to the nucleus, which is a plate Golgi complex and cell center (Figure 98). In the study of plasma cells by light microscopy in normal histological staining (hematoxylin-eosin) They are round or oval in shape, basophilic cytoplasm, eccentric nucleus containing clumps of heterochromatin in the form of triangles (the wheel-core). Adherent to the core area of the cytoplasm stained pale - "the bright courtyard," which is localized Golgi complex. The number of plasma cells reflects the intensity of immune responses.

Fat cells (adipocytes) are contained in the loose connective tissue in varying amounts in different parts of the body and in different organs. They are located usually in groups near the microvascular. When in masses, they form white adipose tissue. Adipocytes have a characteristic morphology - almost all the cytoplasm is filled with a single oil globule, and organelles, and relegated to the periphery of the nucleus. When alcohol fixation and wiring fat soluble and the cell takes the form of a signet ring, and the accumulation of fat cells in a cellular tissue specimens. Lipids revealed only after formalin fixation histochemical methods (Sudan, osmium).

Function of fat cells:

* Depot of energy resources;
* Shed water;
* Depot fat-soluble vitamins.

Source for the formation of fat cells are adventitial cells, which under certain conditions, accumulate lipids and become adipocytes.

Pigment cells - (pigmentotsits, melanocytes) are cells forms containing pigment in the cytoplasm of inclusion - melanin. Pigment cells are not true connective tissue cells as well as the first, they are localized not only in the connective tissue, but also in the epithelial, and secondly, they are not formed from mesenchymal cells, neuroblasts from neural crests. Synthesize and accumulate in the cytoplasm of the pigment melanin (with the participation of specific hormones), serve a protective body from excessive UV radiation.

Adventitial cells are located in the adventitia of blood vessels. Are elongated and flattened shape. Slightly basophilic cytoplasm and contains few organelles.

Peretsits - cells flattened shape, are located in the wall of the capillaries in the cleavage of the basement membrane. They contribute to the movement of blood in the capillaries, adopting them.

White blood cells - lymphocytes and neutrophils. Normally, in the loose fibrous connective tissue are required in various quantities of blood cells - lymphocytes and neutrophils. In inflammatory conditions of their sharply increases (lymphocytic or neutrophilic infiltration). These cells serve a protective function.

Intercellular substance of connective tissue

Its first component - the main or amorphous material;

The second component - **the fibers.**

Primary or amorphous material composed of proteins: collagen,

Albumin, globulin, carbohydrates that are polymeric forms, mostly glikozoaminoglikans;

sulfated: hondro acid, dermatan sulfate, keratin, heparin;

nesulfativs: hyaluronic acid.

Carbohydrate components to form long polymer chains are able to hold water in varying amounts. The amount of water depends on the quality of the carbohydrate component. Depending on the water content of amorphous material can be more or less dense (in the form of sol or gel), which defines the functional role of the variety of connective tissue. Amorphous material provides transport of substances from the connective tissue to the epithelial tissue and back, including the transport of substances from the blood to the cells and back. Amorphous material is formed primarily by the activities of fibroblasts (collagen, glycosoaminoglycanes), as well as by agents of blood plasma (albumin, globulins).

Second - fiber component of intercellular substance represented fibers: collagen, elastic;

reticulum.

In various organs called fiber ratio varies. In the loose connective fibrous tissue collagen fibers predominate.

Collagen (glue-givers) fibers are white and different thickness (from 3.1 to more than 10 microns). They have high strength and low elongation, not branch out, when placed in water to swell when exposed to acids and alkalis increase in volume and shortened by 30%.

Each fiber is made up of two chemical components:

-Fibrous protein collagen;

-Carbohydrate components: glikozoaminoglikans and proteoglycans.

Both of these components are synthesized by fibroblasts and secreted into the extracellular environment, where they are being assembled and the building of the fiber (see Fig-67).

Depending on the order of the amino acids in the polypeptide chains of the degree of hydroxylation and the quality of the carbohydrate component distinguishes 12 types of collagen protein, of which five are well known types. The development of some pathological processes is the decay of collagen and its entry into the blood. In plasma biochemically defined type of collagen, and thus determined and the estimated area of decay and its intensity.

Elastic fibers are characterized by high flexibility, the ability to stretch and shrink but little strength, resistant to acids and alkalis, when immersed in water do not swell. Elastic fibers thinner than collagen (1-2 microns), have no cross-striation, along the branch and anastomose with each other, forming a common elastic network.

Chemical composition: protein elastin, glycoproteins.

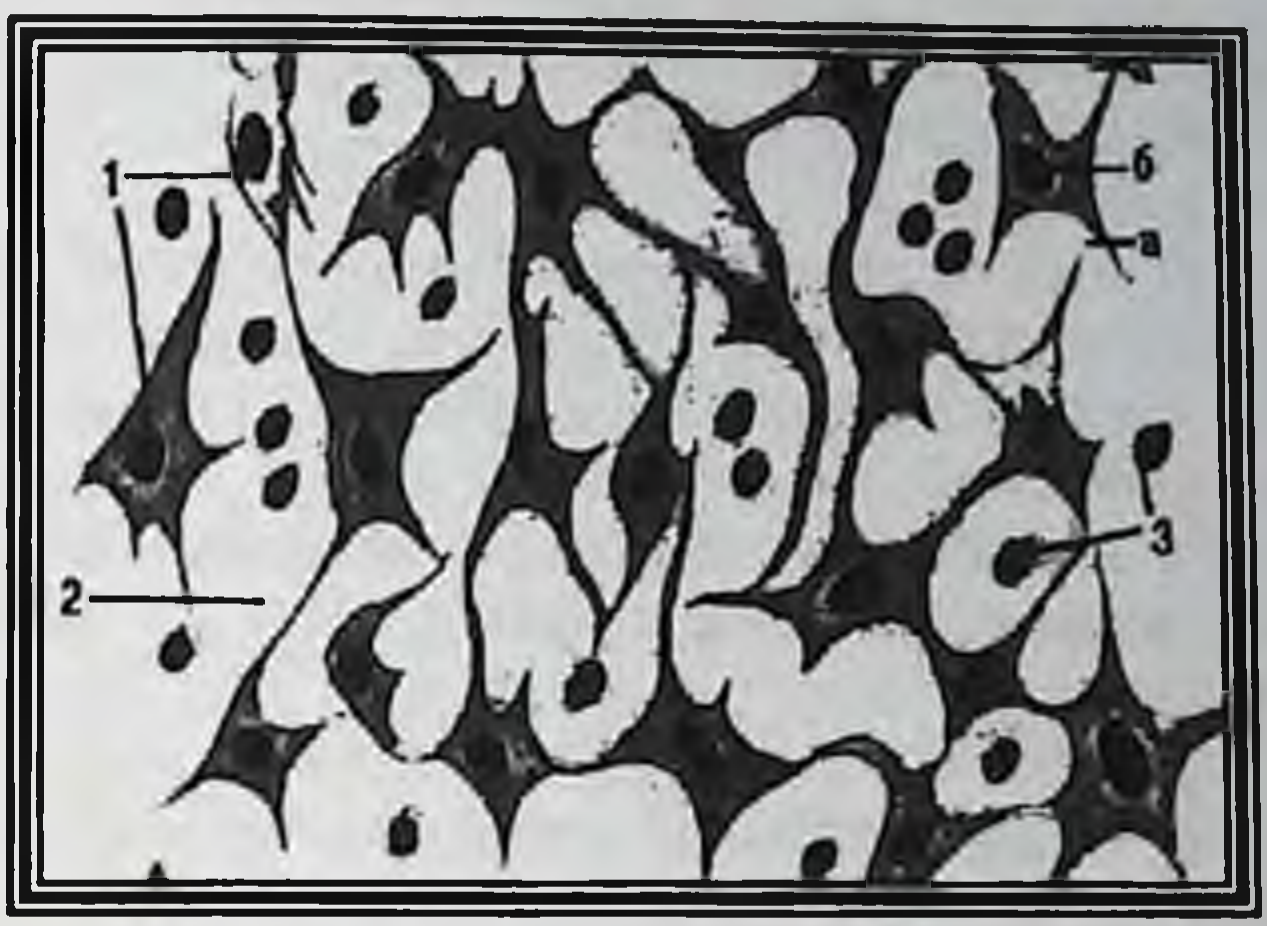
Both components are synthesized and secreted by fibroblasts and vascular wall - smooth muscle cells. Protein elating is different from protein collagen as a composition of amino acids, and their hydroxylation.

Structural elastic fiber is organized as follows: the central portion of the fiber is presented amorphous component of elastin molecules, peripheral portion represented mikrofibrillic network. Most fibers dominated amorphous component. In case of equality of amorphous and fibrillar components of fibers. There are also elastic fibers - oksitalan consisting only of fibrous component. Elastic fibers are located primarily in those organs that constantly change their volume (in lungs, blood vessels, the aorta, ligaments, etc.).

Reticular fibers in chemical composition similar to the collagen, as they consist of: collagen protein (type 3);

carbohydrate component.

Reticular fibers are thinner than collagen, have mild transverse striations. Branching and anastomozic they form network, hence the name of their (pic-74). In the reticular fibers, unlike collagen, more pronounced carbohydrate component, which is well detected salts of silver nitrate and because these fibers are also called argyrophilic.



Picture-74. **Reticulum:** 1-reticular cells; 2 - Main ingredient;
3 – Lymphocytes; 4 - Reticular fibers.

It should be remembered however, that the properties are argyrophilic and immature collagen fibers composed of protein procollagen. The physical properties reticular fibers are intermediate between collagen and elastic fibers. They are formed due to the activity of fibroblasts is not, and reticular cells. Localized mainly in the hematopoietic organs, making them the stroma

The practical part

Compilation of logical structures, the study of drugs, electron diffraction, diagrams, multimedia and sketch KVST building principles into albums, view multimedia.

The objects under study: 1. The preparation of skin cells and fibers electron diffraction RVST

Sample test items

1. Describe the main features of loose fibrous connective tissue:

a) variety of cells, the predominance of the basic substance disorder fibers;

b) the monotony of the cells, the predominance of ordered fibers;

c) uniformity of cells, the predominance of the base material, the ordering of the fibers;

d) the variety of cells, the prevalence of disordered fibers.

2. What are the common morphological and functional features of the actual connective tissue?

a) the cells form a layer;
b) develops from the mesenchyme;
c) develop from the endoderm;
d) a large number of intercellular substance;
e) they contain fiber.

3. Describe the main features of dense connective tissue:

a) predominance of the base material;
b) uniformity cells;
c) prevalence of fibers;
d) the variety of cells.

4. Specify the signs of collagen fibers:

a) contain striated protofibrils;
b) anastomoses;
c) do not anastomose;
d) thick (1-10 microns) to form beams;
e) have a high elasticity.

5. Specify the morphological characteristics of elastic fibers:

a) branch and anastomose;
b) do not ramify and anastomose;
c) thin filiform;
d) thick ribbon-like;
e) contain amorphous components.

6. The composition of any part of dense fibrous connective tissue decorated?

a) skeletal muscle;
b) skin;
c) bundles;
d) tendon;
e) forming organs;
f) fascia and aponeuroses.

7. The public bodies included reticulum?

a) tendons;
b) forming organs and immunogenesis;
c) skin;
d) the skeletal muscle;
e) vessels.

Approximate refereed report on "The role in the homeostasis of the organism RVST"

Subject: Dense fibrous connective tissue.

Fabrics with special properties

I. Aims and objectives:

1. To study the function and structure of dense fibrous connective tissue.

2. To study the structure and function of tissues with special properties.

II. Questions for self-control students:

1. The concept of dense fibrous connective tissue.
2. Differences from RVST.
3. The cellular organization of tissue.
4. Age features.
5. Fabrics with special properties.
6. Features.
7. Age-related changes.
8. The clinical significance.

The theoretical part

5.6. Dense fibrous connective tissue

It's different from a loose predominance in the intercellular substance of the fibrous component of the amorphous (figure 73).

Depending on the location of fiber dense fibrous connective tissue is broken down into:

Skins - fibers are ordered, that is generally parallel to each other;

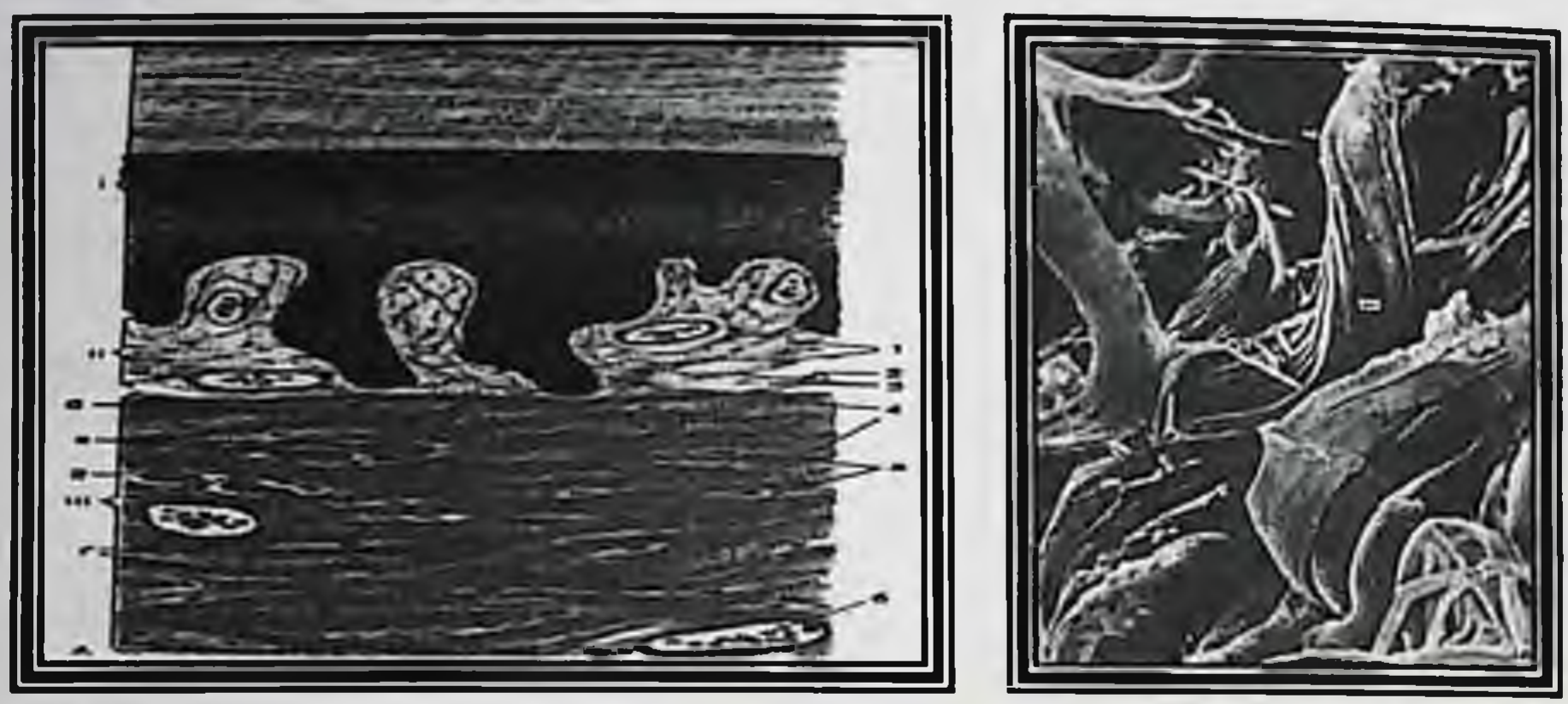
unformed - the fibers are disordered.

Dense connective tissue decorated represented in the body as the tendons, ligaments, fibrous membrane. Dense fibrous connective tissue forms unformed reticular layer of the dermis of the skin. In addition to the deployment of a large number of fibers, dense fibrous connective tissue characterized by poverty cellular elements, which consist principally of fibrocytes (74-img).

Tendon

Tendon consists mainly of dense decorated cloth, but also contains a loose fibrous connective tissue that forms the layer. A cross section of

the tendon can be seen that it consists of parallel-arranged collagen fibers forming the beams 1, 2, 3, maybe 4 orders of magnitude.



Picture-75. **Densely fibrous connective tissue A general view of the B-skin collagen and elastic fibers of the skin.** A: I- epidermis II- GVST III- SWCT: 1-base material; 2-collagen fiber; 3-cell; 4-bundle of collagen fibers; 5-elastic fibers; 6-vessels a) fibrocystic. B: 1-collagen fibers; 2-elastic fibers.

Beams 1 order, the most subtle, separated by fibrocystic. Two beams are composed of about one order of several beams, surrounded by peripheral layer of loose fibrous connective tissue component endotenon. 3 order bundles consist of bundles of 2nd order and surrounded by a distinct layers of loose connective tissue - peritenoniem. All the tendon is surrounded by peripheral epitenoniem. In the strata of loose fibrous connective tissue are vessels and nerves that provide trophic and innervation of the tendon.In infants and children in the fibrous connective tissue in an amorphous material contains a lot of water bound glikozoaminoglikans. Collagen fibers are thin and do not consist only of the protein collagen, and procollagen. Elastic fibers are well developed.

Amorphous and fibrous connective tissue components in the aggregate causes skin elasticity in children. With increasing age in postnatal glikozoaminoglikans content in amorphous material decreases, and with them, and the water content decreases.

Collagen fibers grow and form thick rough beams. Elastic fibers are destroyed to a great extent, therefore the skin of older people becomes stiff and flabby.

Picture-76. **SWCT:** 1-peritenony; 2-endotenony; 3-secondary beams; 4-fibrocytes; 5-primary beam

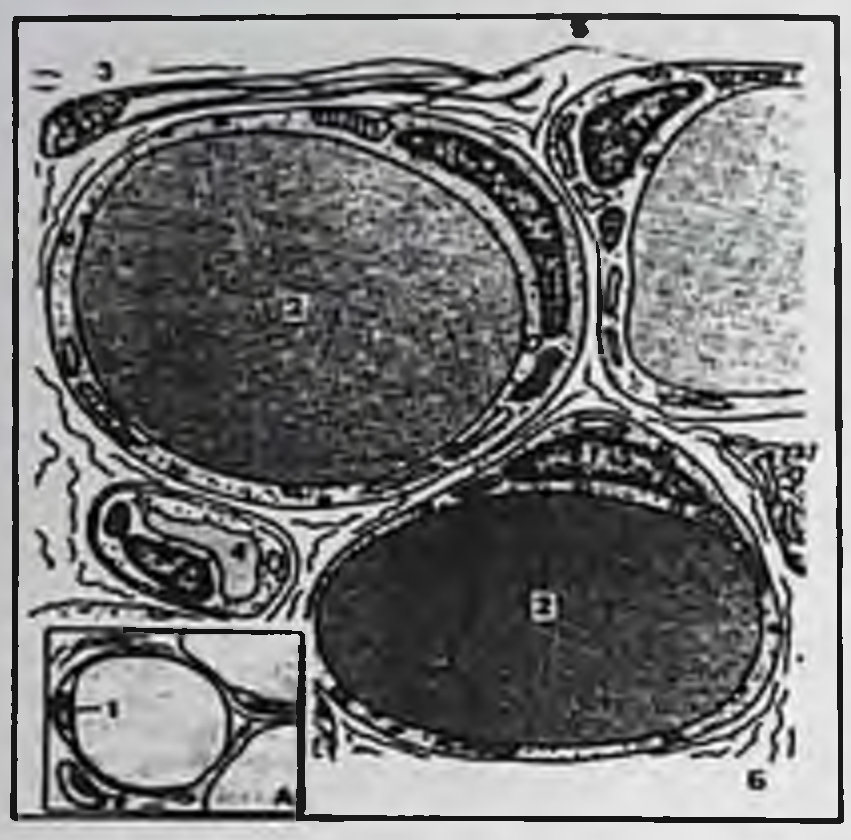
Connective tissue with special properties

By connective tissues with special properties are reticular, fatty, mucous and pigment fabrics.

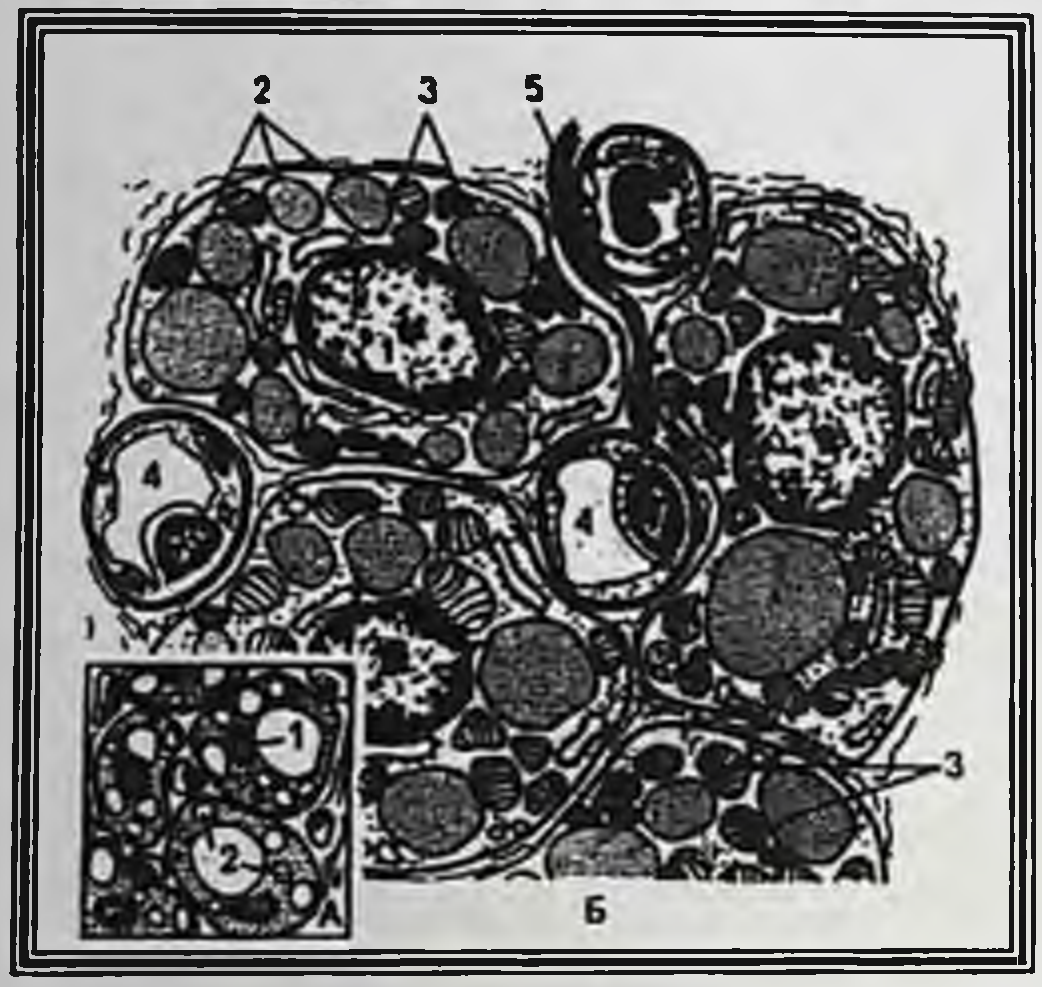
Reticulum consists of reticular cells and reticular fibers (see Fig-). This tissue forms the stroma of hematopoietic organs (except the thymus) and, in addition to the support function, and perform other functions: provide trophic hematopoietic cells, affect the direction of their differentiation during hematopoiesis and immunogenesis performs phagocytosis of antigenic substances and the presentation of antigenic determinants of immunocompetent cells.

Adipose tissue is composed of clusters of fat cells and is divided into two varieties: white and brown adipose tissue (75, 76, 77-rice).

White adipose tissue is widely distributed in various parts of the body and the internal organs, is expressed differently in different subjects and during ontogeny. It consists of a cluster of typical fat cells. Group of fat cells form lobules of adipose tissue, between which the thin layer of connective tissue containing blood vessels and nerves. In fat cells actively proceeds metabolism.



Picture-77. **Cells were white and brown adipose tissue of A- cell B- ultrastructure of fat cells:** 1-core; 2-oil drop; 3-nerve fiber; 4-gemokapillyar; 5-mitochondria.



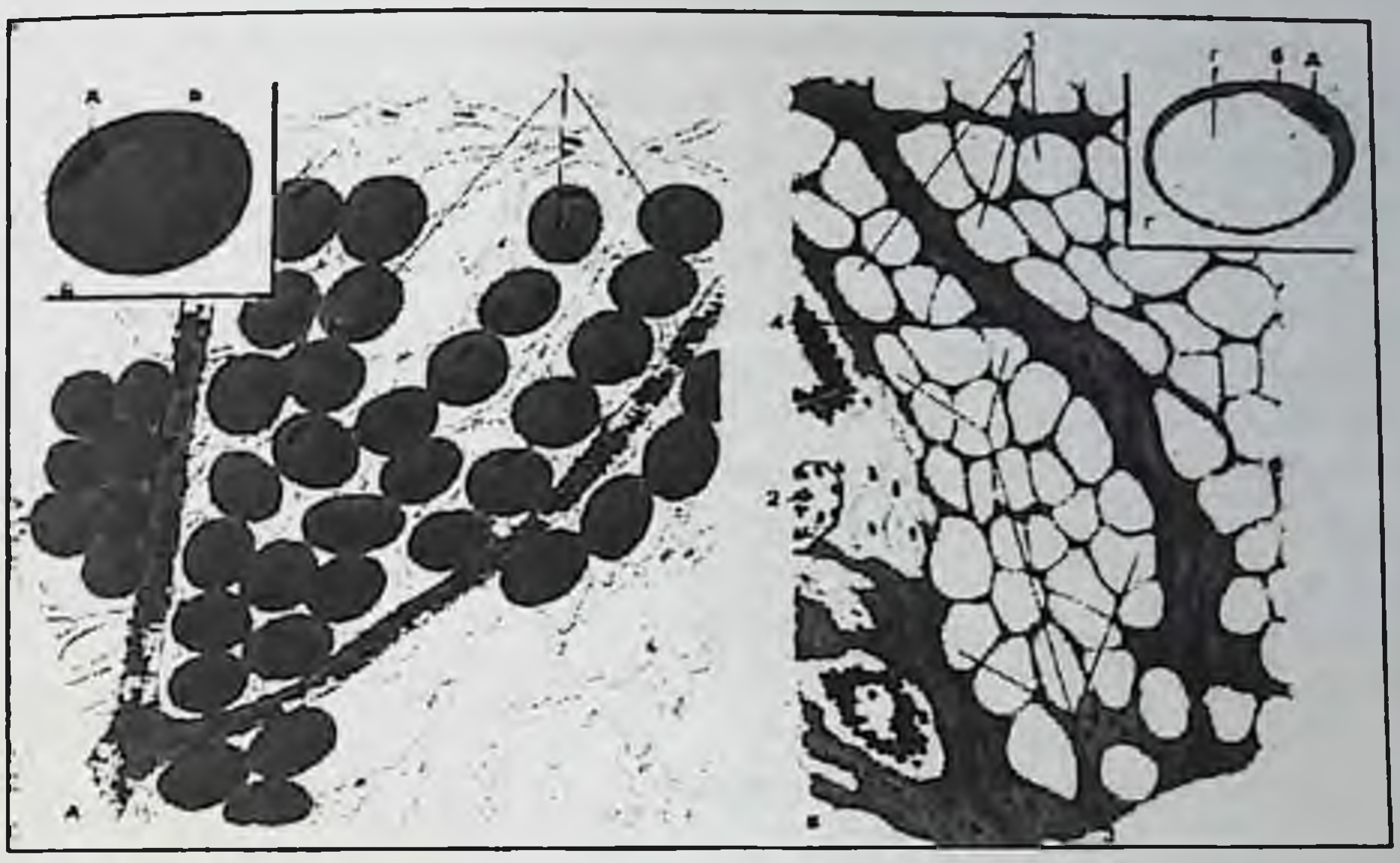
Picture-78. **Brown adipose tissue of A- cell B- ultrastructure of fat cells:** 1-core: 2-Lipid: 3-mitochondrion; 4-gemokapillyar; 5-nerve fiber

Function of white adipose tissue:

- depot energy (macro ergs);
- shed water;
- depot fat-soluble vitamins;
- thermal protection;
- mechanical protection of certain organs (the eyeball and others).

Brown adipose tissue is found only in newborn infants. It is localized only in certain places: in the chest, around the blades, in the neck, along the spine.

Brown adipose tissue is composed of a cluster of brown adipocytes and morphology, and the nature of metabolism in them. In the cytoplasm of brown fat cells contain a large number of small liposomes, evenly distributed throughout the cytoplasm. Kernel is located in the center of the cell. The cytoplasm contains a large number of mitochondria containing cytochromes, which give her a brown color. Oxidation processes in brown fat cells occur up to 20 times more intense than in whites.



Picture-79. **White adipose tissue fat cells: 1-2-3-vessel blood fat lobules; 4 and connective tissue:** a) cytoplasm's;b) cytoplasm; c) fat granules; d) kernel.

The image of the oxidation and phosphorylation are separated and the energy that is formed by the oxidation of lipids is released as heat.

Therefore, the main function of brown adipose tissue is to heat buildup, which occurs particularly intense when the temperature of the environment.

Mucous connective tissue is found only in the embryonic period in the provisional organs, primarily in the umbilical cord (pic-80).

Picture-80. **1 fibroblast, 2-intercellular substance, 3-a blood vessel.**

It consists mainly of the intercellular substance in which localized fibroblast-like cells that synthesize mucins (mucus). Amorphous material contains a large amount of hyaluronic acid, which binds a large number of water molecules. In the later stages of embryonic development in the intercellular substance defined thin collagen fibers. The large amount of water in the amorphous material is provided by the elasticity (turgor), which prevents compression of blood vessels in the umbilical cord and placental blood flow disturbance.

Pigment is a connective tissue areas of tissue, which contains cluster of melanocytes: the nipple, scrotum and anus, uvea, birthmarks. Value clusters of melanocytes in these areas is not fully elucidated. As part of the eyeball iris melanocytes prevent the passage of light through tissue.

The practical part

Compilation of logical structures, the study of drugs, schemes, electron diffraction and sketch the principles of the structure of dense connective tissue and tissue with special properties in albums.

The objects under study: drugs tendon, lymph node, the umbilical cord.

Sample test items

1. Determine the function of plasma cells:

a) production of antibodies;
b) education intercellular substance;
c) uchastie in inflammation;
d) produktsiya biogenic amines.

2. Mast cells. All right. Except:

a) granules contain heparin and histamine;
b) ability to migrate;
c) the number of increases in allergic reactions;
d) comes from precursors in the bone marrow;
e) synthesizes antibodies.

3. Select the cells capable of secreting histamine:

a) eosinophils;
b) basophils;
c) monocytes;
d) mast cells;
e) plasma cells.

4. The loose fibrous connective tissue:

a) accompanies blood vessels;

b) forms fascia and aponeuroses;

c) it is located beneath the basement membrane of the epithelium, providing him food;

d) forms stroma of many organs.

5. Brown adipose tissue.

a) present neonates;

b) cells braided hemocapillars;

c) cell cytoplasm many mitochondria;

d) color tissue mitochondrial cytochrome determined;

e) the cytoplasm contains a large drop of fat.

6. Select the cells that are actively involved in phagocytosis:

a) neutrophils;

b) lymphocytes;

c) macrophages;

d) basophils.

7. Identify the signs of tissue basophils (mast cells):

a) basophilic cytoplasm;

b) the cytoplasm contains metachromatic granules;

c) highly developed granular cytoplasmic network;

d) arranged around blood vessels;

e) granules contain heparin and histamine.

Approximate refereed report on "Age peculiarities of connective tissue"

5.7. The skeletal tissue. Cartilage and bone

I. Aims and objectives: 1. to study the function and structure of cartilage.

2. To study the function and structure of bone tissue.

II. Sample questions for self-training:

1. The concept of skeletal tissue.
2. Properties of skeletal tissue.
3. The functions and features of skeletal tissues.
4. Cartilage.
5. Properties of the cartilage.
6. Age characteristics of bone tissue.

7. Age characteristics of cartilage.
8. The clinical significance.

The theoretical part

Skeletal connectivetissues

To skeletal connective tissues are cartilage and bone tissues that perform support, safety and mechanical features as well as taking part in the exchange of minerals in the body.

Cartilage

Cartilage tissue is composed of cells:

chondrocytes, chondroblasts and dense intercellular substance consisting of an amorphous component and the fiber component.

Chondroblasts arranged singly on the periphery of the cartilage. Are elongated flattened cells with basophilic cytoplasm containing a well-developed granular endoplasmic reticulum and Golgi apparatus. These cells synthesize the components of the intercellular substance secreted into the intercellular environment and gradually differentiate into definitive cartilage cells - chondrocytes. Chondroblasts are capable of mitotic division. In the perichondrium surrounding the cartilage, are inactive, poorly differentiated forms of chondroblasts, which under certain conditions, to differentiate into chondroblasts, synthesizing extracellular material, and then in the chondrocyte

Chondrocytes in maturity, on the morphology and function of cells divided into I, II and III type. All varieties of chondrocytes are located in the deeper layers of cartilage in special cavities - gaps. Young chondrocytes (I type) mitotically divide, but the daughter cells are in a gap and form a group of cells - Isogenies group. Isogenic group is a common structural and functional unit of the cartilage. Arrangement of chondrocytes in isogenic groups in different cartilaginous tissues differently.

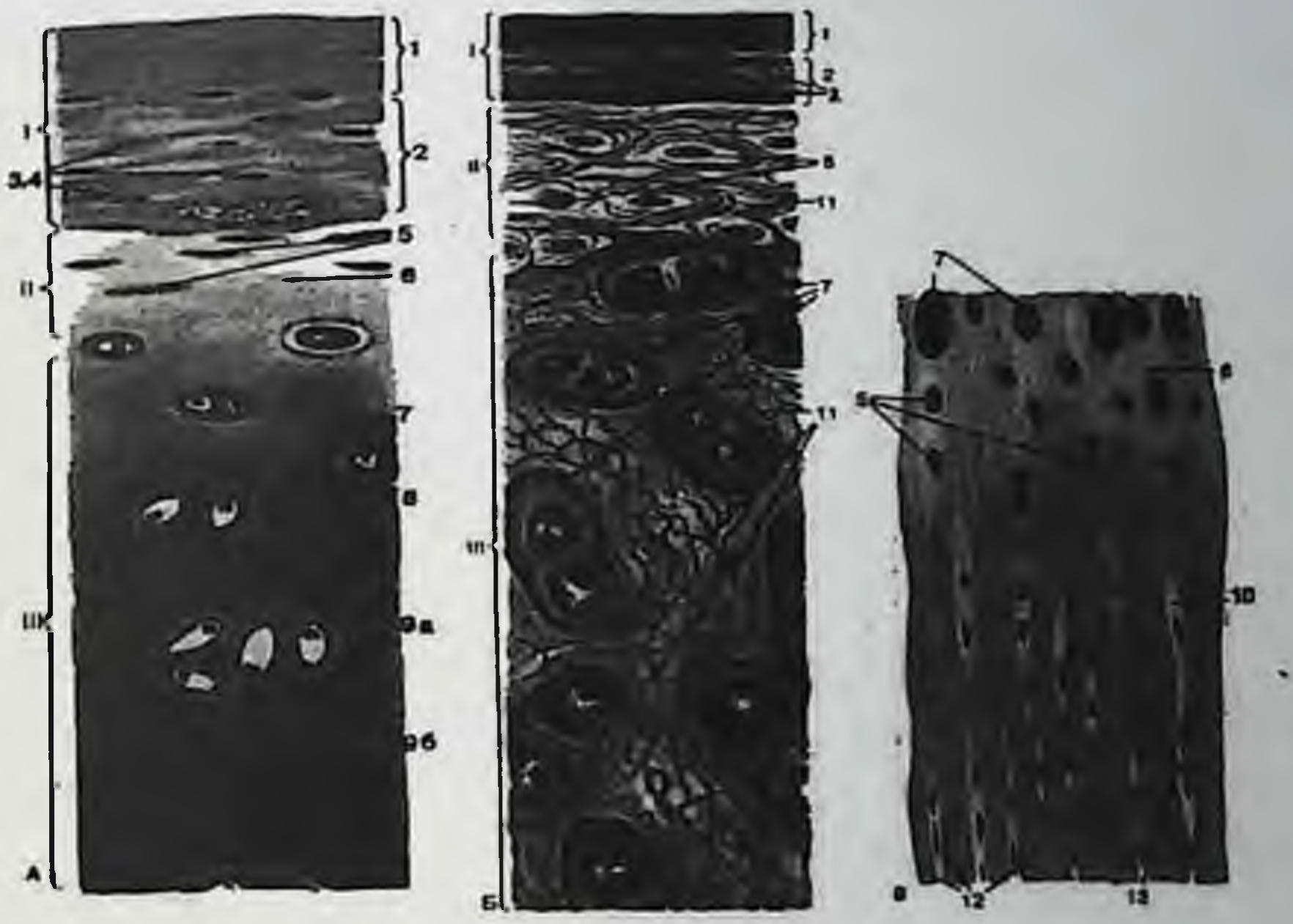
Intercellular substance of cartilage is composed of:

- fibrous component (collagen and elastic fibers);
- amorphous material, which contains mostly sulfated glycosoaminoglycanes and proteoglycans. Glycosoaminoglycanes bind large amounts of water and determine the density of the intercellular substance. In addition, the amorphous material contains a significant amount of minerals that do not form crystals.

Vessels in cartilage is normally absent.

Depending on the structure of the intercellular substance of cartilage divided into: hyaline, elastic, fibrous cartilage (pic 81).

Hyaline cartilage is characterized only in the intercellular substance of collagen fibers. In this case, the refractive index of the fibers and amorphous material is the same and so on histological preparations fibers in the intercellular substance are not visible. This also explains why certain transparency cartilage composed of hyaline cartilage.



Picture-81. **A cartilage hyaline-B-B-elastic fiber I-II-young cartilage zone III-mature cartilage zone:** 1-perichondral cartilage; 2 - perichondral cellular tissue; 3.4-5.6-chondroblasts podhryaschnitsa; 7,8-isogenic cell; 9 basophilic zone; 10-base material; 11 elastic fibers; 12-collagen fibers.

Chondrocytes in isogenic groups hyaline cartilage arranged in rosettes. On physical properties of hyaline cartilage is characterized by transparency, low density and elasticity. The human hyaline cartilage is widespread and is a member of: the major laryngeal cartilages (thyroid and cricoid), trachea and major bronchi of the cartilaginous portion of the ribs, cover the articular surfaces of bones.

In addition, almost all of the bones of the body in the process of going through the stage of development of hyaline cartilage.

Elastic cartilage is characterized by the presence of intercellular substance as collagen and elastic fibers. In this case, the refractive index of the elastic fibers is different from the refractive index of the amorphous substance and because the elastic fibers are clearly visible in the histological preparations. Chondrocytes in isogenic groups in the elastic tissue arranged in the form of columns or columns.

On physical properties of elastic cartilage is opaque, elastic, less dense and less transparent than hyaline cartilage. It is part of the elastic cartilage ear and cartilage of the outer ear canal, the outer cartilage of the nose, small laryngeal cartilages and medium bronchi, and is the basis of the epiglottis.

Fibrous cartilage is characterized by the content in the intercellular substance of intense beams of parallel-arranged collagen fibers. In this case, the chondrocytes are arranged between bundles of fibers in the form of chains. Physical properties characterized by high strength. In the body, is found only in limited areas: forms part of the intervertebral disc (annulus) is also localized in the attachment of ligaments and tendons to hyaline cartilage.

In these cases, clearly traced the gradual transition of fibrocytes of the connective tissue in the chondrocytes of cartilage.

There are the following two concepts that can not be confused with: cartilage and cartilage.

Cartilage - a type of connective tissue, the structure of which is set out above.

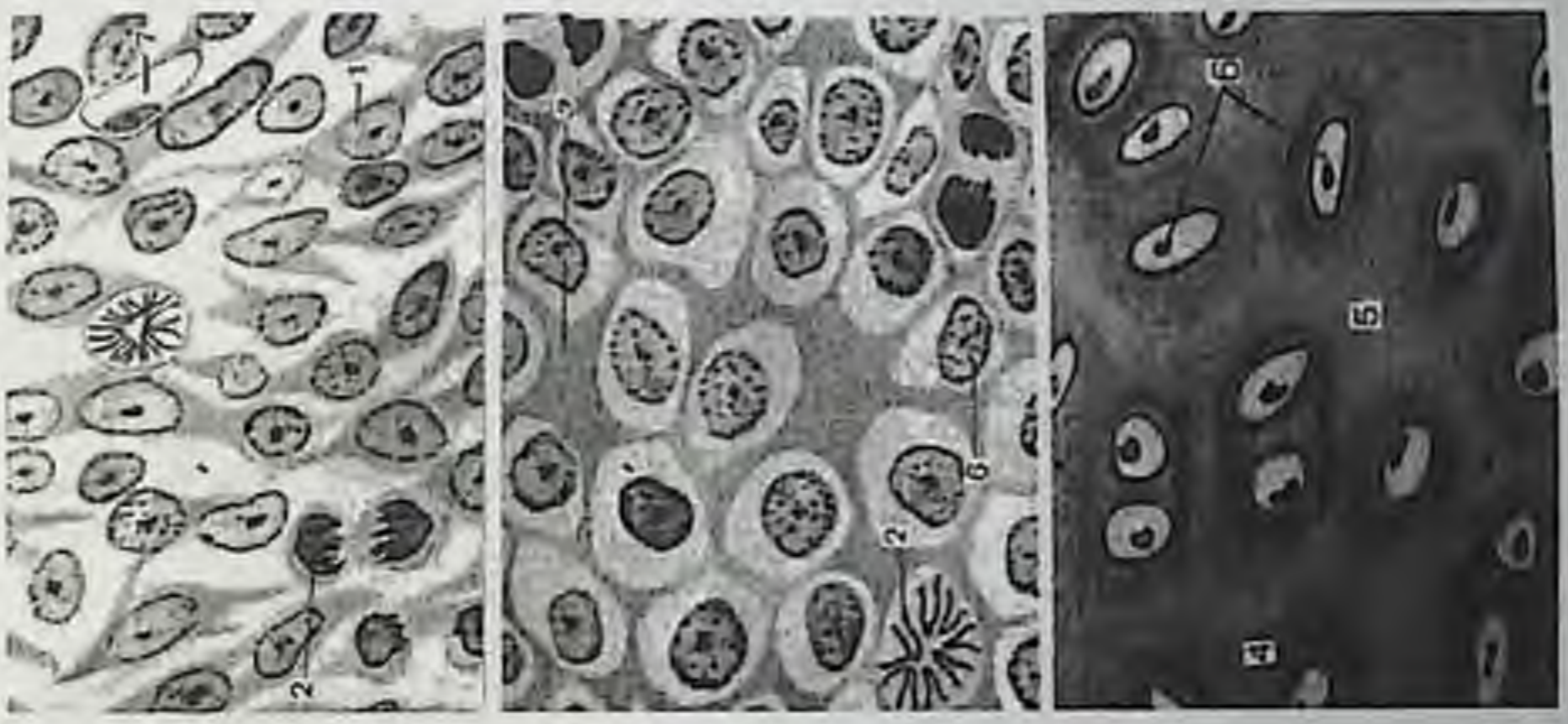
Cartilage - is an anatomical body, which is made up of cartilage and perichondrium. Perichondrium covers the cartilage on the outside (with the exception of the articular cartilage surfaces) and is composed of fibrous connective tissue.

In the perichondrium are two layers: the outer one - the fibrous, inner - or cambial cell (germ).

In the inner layer of undifferentiated cells are located - and inactive prehondroblastic chondroblasts that during embryonic and regenerative histogenesis become first in chondroblasts and then into chondrocytes. In the fibrous layer is a network of blood vessels. Consequently, the perichondrium, as part of the cartilage, the following functions: provides trophism avascular cartilage and protects cartilage, to regenerate cartilage tissue when it is damaged.

Trophic hyaline articular cartilage surface provides synovial fluid of joints, as well as vascular bone.

Development of cartilage and cartilage (hondrogistogenez) is from the mesenchyme. Initially, the mesenchymal cells in the very spot where the cartilage strongly proliferate and form a rounded focal accumulations of cells - chondrogenic islets. Then these rounded cells differentiate into chondroblasts, synthesize and secrete into the intercellular environment fibrillar proteins. Then chondroblasts differentiate into chondrocytes of type I, which synthesize and secrete not only proteins, but also glycosoaminoglycans and proteoglycans, that is, form intercellular substance. The next stage in the development of cartilage is the stage of differentiation of chondrocytes, while appearing chondrocytes II, III type and form of the gap. From the mesenchyme surrounding cartilage islands formed (pic-82).



Picture-82. **1-chondrogenic islets, 2- education hondronocytes, 3-isogenic education groups:** 1) Mesenchymal cells; 2) mitotic division.

• In the development of cartilage observed two types of growth of cartilage: interstitial growth - at the expense of reproduction and isolation of chondrocytes intercellular substance

• Opposition growth - through the work of chondroblasts perichondrium and cartilage overlay on the periphery of the cartilage.

Age-related changes are more marked in the hyaline cartilage. In the elderly and old age in the deep layers of hyaline cartilage marked deposition of calcium salts (omelen cartilage), sprouting of vessels in this area, and then fill calcified cartilage bone - ossification. Elastic cartilage is not subject to calcification and ossification, but the elasticity of the cartilage in the elderly is also reduced.

Clinical significance

Cartilage cells can give rise to benign (chondroma) or malignant (hondrosomam) tumors.

Degenerative changes. Unlike other tissues, hyaline cartilage is very susceptible to degenerative processes associated with aging. Some hrya ¬ soup often is calcification of the matrix, which is preceded by an increase in the size and volume of chondrocytes and followed by their death. The so-called asbestos degeneration, often develops in the cartilage with age, due to the formation of focal abnormal accumulation of thick collagen fibrils.

Slipped disk

Rupture of the fibrous ring, which often occurs in its rear section, where the collagen bundles are less numerous leads to protrusion of nucleus pulposus with simultaneous flattening disk. Consequently, the drive often shifts or slides, changing its normal position between the vertebrae. If it moves in the direction of the spinal cord, it can squeeze the nerves, causing severe pain and neurological disorders. Pain that accompanies displacement disk can be felt in the areas innervated by Compression of the nerve fibers - usually in the bottom of the back.

Obesity causes a significant overload of articular cartilage, accelerating its degeneration. Joint diseases more often affects people with obesity.

Bone

Bone tissue is a type of connective tissue composed of cells and intercellular substance, which contains a lot of minerals, mainly calcium phosphate. Minerals make up 70% of the bone, organic - 30%.

Of bone tissue: support, mechanical, protective, participation in the mineral metabolism of the body - the depot of calcium and phosphorus.

Bone cells

- *osteoblasts;*
- *osteocytes;*
- *osteoclasts.*

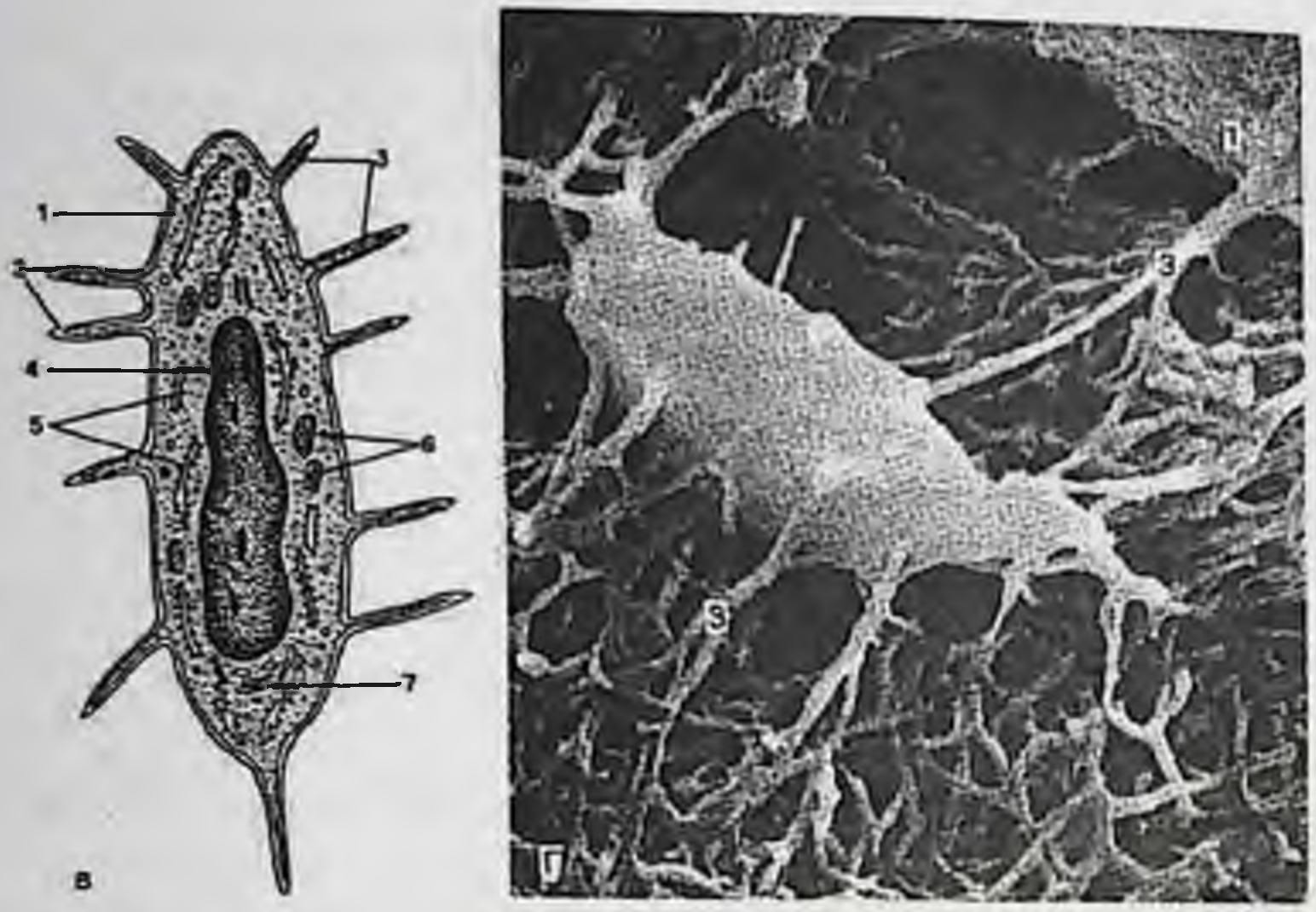
The main cells in the bone are formed **osteocytes**. This cell shape with large nucleus and cytoplasm of the low-grade (nuclear cell type). Cell bodies are located in the bone cavities - the gaps and branches - in bone tubules. Numerous bone tubules anastomozis together, permeate the entire bone, communicating with perivascular spaces, and form a drainage system of bone. This drainage system contains tissue fluid,

which is provided by the metabolism not only between cells and tissue fluids, and intercellular substance. For ultrastructure of osteocytes characterized in the cytoplasm mild granular endoplasmic reticulum, a small number of mitochondria and lysosomes, centrioles are absent. At the core of dominant heterochromatin. All these data suggest that osteocytes have little functional activity, which is to maintain the exchange of substances between cells and intercellular substance. Osteocytes are the definitive forms of cells and do not divide. They are formed of osteoblasts (figure 80).

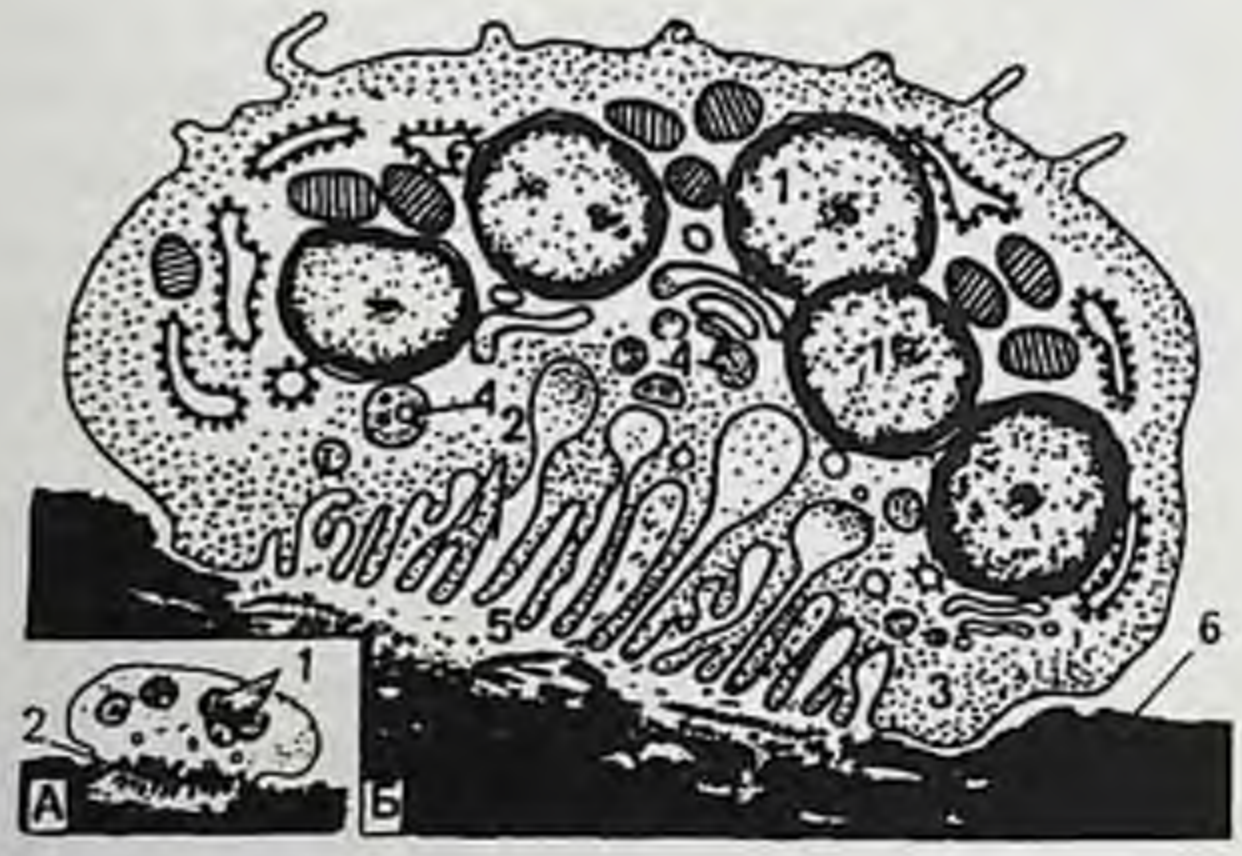
Osteoblasts are found only in developing bone. Formed bone absent, but are usually in an inactive form in the periosteum. In developing bone, they cover the periphery of each bone plate, firmly adhering to each other, forming a kind of epithelial layer. Form of actively functioning cells can be cubic, prismatic, angular. In the cytoplasm of osteoblasts contained a well-developed granular endoplasmic reticulum and Golgi complex plate, lots of mitochondria.

Such ultrastructural organization suggests that these cells are synthesized and secreted. Indeed, osteoblasts synthesize protein collagen and glycosoaminoglycanes, which then secrete into the extracellular space. Through these components form the organic matrix of bone. Then these same cells provide mineralization intercellular substance by providing calcium. Gradually, highlighting the intercellular substance, as if they walled up and become osteocytes. In this case, the intracellular organelles are reduced to a great extent, the synthetic and secretory activity decreases and remains functional activity characteristic of osteocytes. Osteoblasts localized in the cambial layer of the periosteum, are inactive, synthetic and transport organelles are poorly developed. During stimulation of these cells (in case of injuries, broken bones and so on) in the cytoplasm rapidly evolving granular endoplasmic reticulum and lamellar complex, there is an active synthesis and secretion of collagen and glikozoaminoglikans, the formation of the organic matrix (callus), and then the formation of the definitive bone . In this way, through the activity of osteoblasts, periosteum, bone regeneration occurs during inflammation.

Osteoclasts - depleting bone cells formed in the bone tissue available. But are contained in the periosteum and in the places of destruction and rebuilding of bone. Since the ontogeny of continuously developing a local process of rebuilding bone tissue, these places are always present and osteoclasts (pic-84).



Picture-83. **A) Ultra scheme osteocytes B) osteocyte (SEM):** 1 – osteocyte; 2.3- processes of osteocytes; 4-core granular; 5- endoplasmic reticulum; 6-mitochondria.



Picture-84. **Structure osteoclast A) under a light microscope B) ultramicroscopic structure:** 1-core; 2-part; 3-gavrirovannaya light area; 4-lysosome area; 5- resorption; 6-mineralized zone

During embryonic osteogistogenezis these cells play an important role and are determined in large quantities. Osteoclasts have a characteristic morphology:

-these cells are multinucleated (3-5 or more cores);

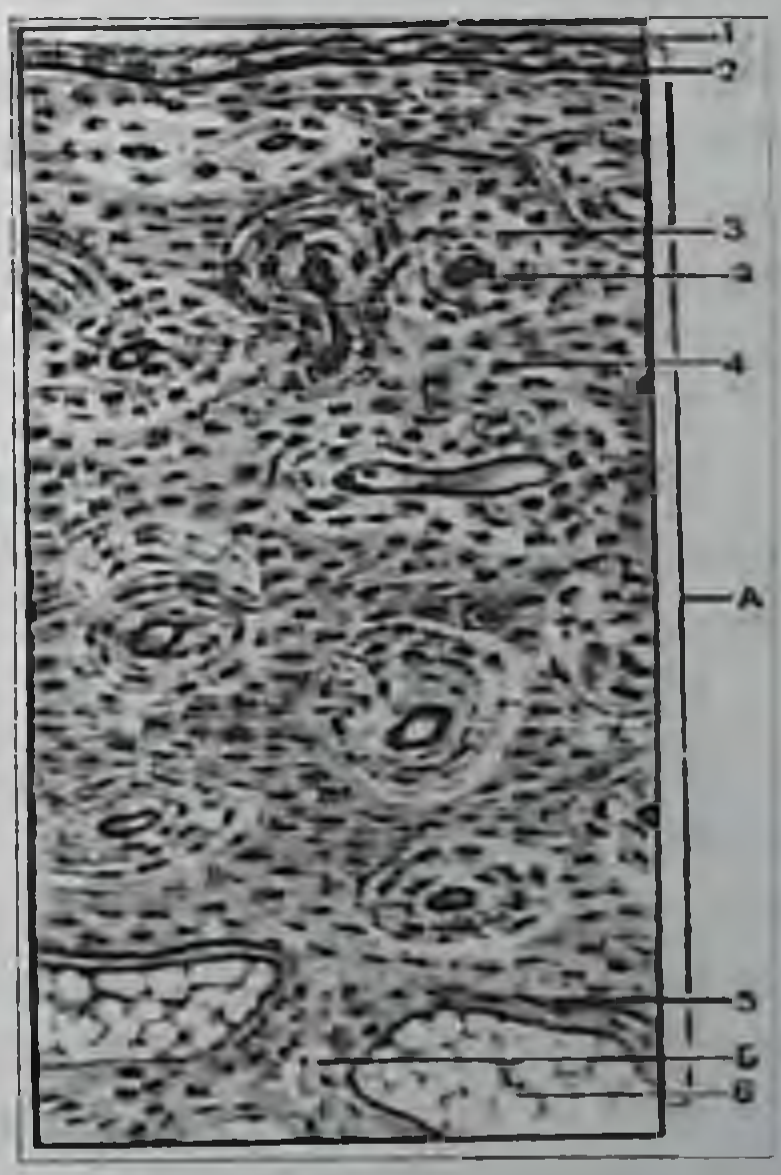
is a fairly large cells (diameter 90 mm);

-They have the characteristic shape - the cell has an oval shape, but part of it adjacent to the bone is flat.

In the flat part of the identified two areas.

The central part - crinkled, contains numerous folds and islets; периферическая (transparent) part is closely connected with the bone.

In the cytoplasm, a nucleus, there are numerous lysosomes and vacuoles of various sizes. The functional activity of osteoclasts is shown as follows: in the center (corrugated) zone of the base cell cytoplasm allocated carbonic acid and proteolytic enzymes. Released carbonic acid causes demineralization of bone tissue, and proteolytic enzymes destroy the organic matrix of the intercellular substance. Fragments of collagen fibers phagocytized osteoclasts and destroyed intracellularly. Through these mechanisms is resorption (breakdown) of bone tissue and because osteoclasts are usually localized in the recesses of the bone tissue. After the destruction of bone tissue due to the activity of osteoblasts, were evicted from the connective tissue of blood vessels, is the construction of new bone.Intercellular substance of bone is made up of: a base material and fibers, which contain calcium.Fibers consist of type I collagen and formed into bundles, which may be parallel (organized) or disordered, based on which the histological classification and builds bones.The main substance of bone tissue, as well as other types of connective tissue, consisting of: glikozo aminogli kanov and proteoglycans.



Picture-85. **Lamellar, bone tissue. A dense (compact) the substance of the bone.** 1-periosteum; 2 outdoor common plate; 3-osteons and osteon channel; 4-system of intercalary plates. **B-cancellous bone.** 6-yellow marrow.

However, the chemical composition of these substances are different. In particular, bone contains less hondroitinsernyh acids, but more citric and other acids that form complexes with calcium salts. In the development of bone organic matrix is formed at first-base material and

collagen (osseins, collagen type II) fibers, and then they are deposited calcium salts (mainly phosphate).

Calcium salts form crystals gidroksiappatita, save, in an amorphous substance, and in the fibers, but a small part of salt deposited amorphous. Providing strength of bones, calcium phosphate salts are also depot of calcium and phosphorus in the body. Therefore the bone is involved in mineral metabolism.

Classification of bone

There are two types of bone:

- retikulofibrozis (coarse-fibered);
- plate (parallel fiber).

In retikulofibrozis bone collagen fiber bundles of thick, wavy and are disordered. In the mineralized material in the intercellular gaps are randomly (87-img.)

Lamellar bone consists of bony plates in which the collagen fibers or bundles are arranged parallel to each plate, but at right angles to the fibers in the adjacent plates. In the gaps between the plates are osteocytes, whereas their processes take place in the tubules through the plate.

The human bone is represented almost exclusively lamellar form. Retikulofibrozis bone occurs only as a stage in the development of some of the bones (parietal, frontal). In adults, they are in the region of attachment of tendons to bone, as well as on-site ossified skull sutures (sagittal suture scale frontal bone)In the study of bone should be differentiated concepts bone tissue and bone.

The structure of the bone

Bone - this anatomical organ, the main structural component of which is the bone. Bone as the body consists of the following elements: bone, periosteum, bone marrow (red, yellow), blood vessels and nerves.

Periosteum (periostitis) around the periphery of the bone (except for the joint surfaces) and has a structure similar to the perichondrium. In the periosteum secrete outer fibrous and inner cellular or cambial layer. In the inner layer contains osteoblasts and osteoclasts.

In the periosteum of localized severe vascular network from which the small vessels through perforating canals penetrate the bone.

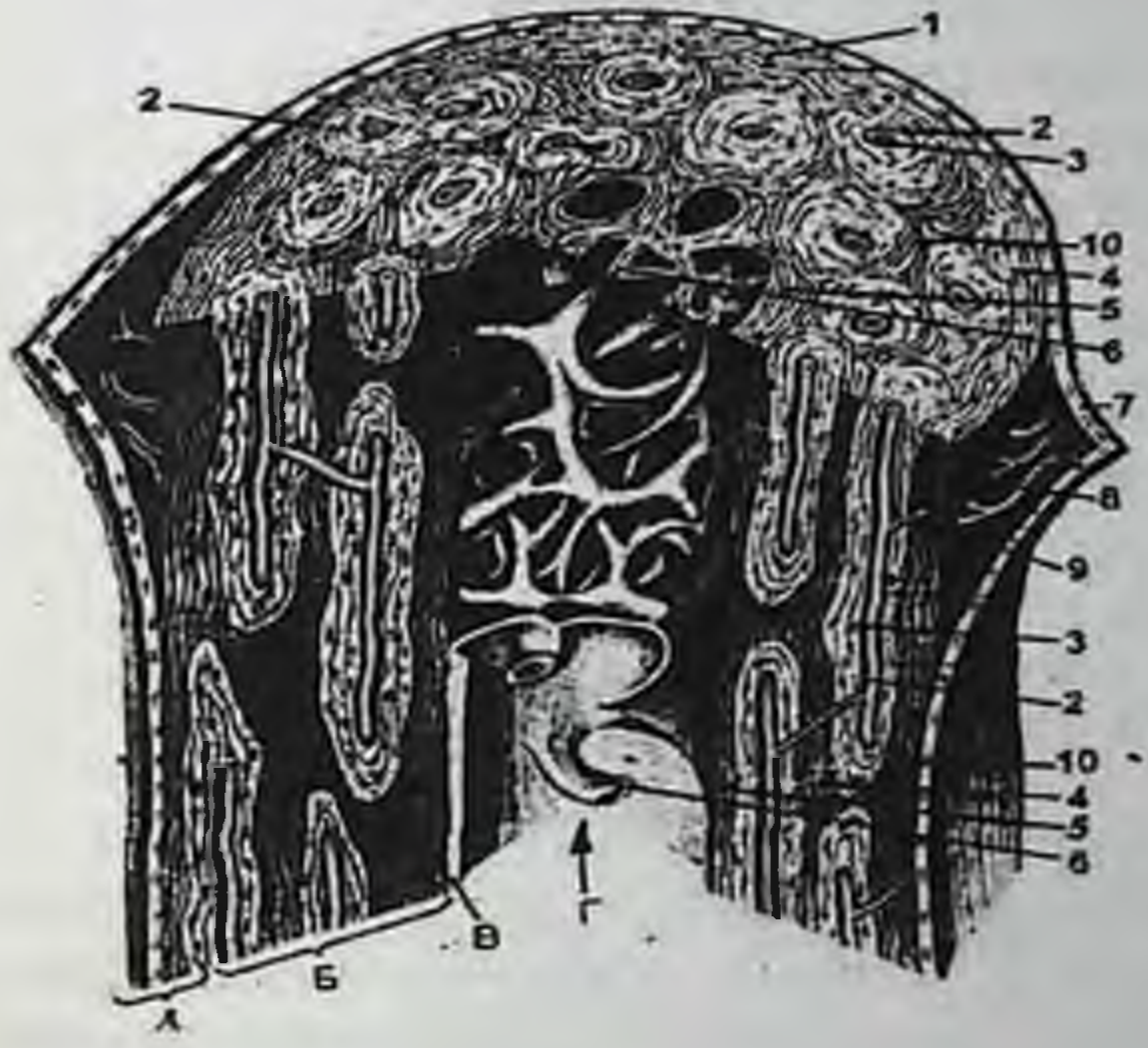
Red bone marrow is seen as a body and to the organs and blood monogenesis.

Bone tissue formed bone represented only a plate form, but in different bones in different parts of a single bone, it has a different structure. In the flat bones and epiphysis of long bones bony plates form a

crossbar (trabeculae) forming cancellous bone. In the diaphysis of long bones plates to each other and form a compact material. However, in a compact form the substance of one plate osteons, other records are shared.

Diaphysis of long bone structure

On cross-section of the shaft tubular bones are following layers: periosteum (periosteum), the outer layer of the general or master plates; osteons layer, the inner layer of the general or master plates, internal fibrous plate (endosteum) (pic-86).



Picture-86. **The structure of a tubular bone (scheme for V.G Eniseevu, Y. Afanasyev, E.F Kotovsky) A) periosteum B) compact matter in the bone) endosteum d) kostomozgovaya cavity** 1-layer exterior common plates; 2-osteon; 3-channel; 4 osteon - intercalary plate; 5-general internal layer plates; 6-bone trabecular bone trabecula; 7-fibrous layer of periosteum; 8-vessels periosteum; 9-intermittent channel; 10-osteocytes.

External common plate located under the periosteum in layers, but not forming complete rings. Between the plates are located in the gaps of osteocytes. After perforating the outer plates are the channels through which the periosteum of the bone tissue penetrating perforating fibers and vessels. With perforating vessels in the bone provides trophic and perforating fibers bind with the periosteum of the bone tissue.

Osteons layer consists of two components: the osteons and intercalary plates between them.

Picture-87. **Osteon structure. Electron diffraction.** Fragment osteons (at N.P.Omelyanenko) 1-channel; 2-osteocytes osteons; 3-bony plates; 4-transverse and longitudinal sections of collagen fibers.

Osteon is the structural unit of the compact substance of the tubular bones (pic-87). Each osteon consists of:

5-20 concentric layered plates;

Channels between adjacent osteons are anastomoses. Osteons make up the bulk of bone diaphysis of tubular bones. They are placed longitudinally along the tubular bones, respectively, and the gravitational force lines and provide the support function. When the direction of the lines of force as a result of fracture or distortion of bone osteons are not load-bearing destroyed by osteoclasts. However, such is not completely destroyed osteons and some bony plates along its length osteon remains, and the remaining parts are called osteons intercalary plates. During postnatal ontogenesis constantly is changing the bone - some osteons destroyed (resorbed), others are formed and therefore always between osteons are intercalary plate, as the remnants of the previous osteons.

The inner layer of the general structure of the plates has a similar appearance, but it is less pronounced, and in the transition of the diaphysis to epiphyses overall record going into trabeculae.

Endosteum - a thin connective tissue plate, lining the cavity of the channel of the shaft. The layers in the endosteum not clearly marked, but among the cellular elements are osteoblasts and osteoclasts.

Osteogistogenessis

All varieties of bone develop from a single source - from the mesenchyme, but the development of different bones are not the same. There are two ways to osteogistogenezium:

• development directly from the mesenchyme - direct osteogistogenessis;

• The development of the mesenchyme through the stage of cartilage - indirect osteogistogenenessis.

Through direct osteogistogenesis develop a small amount of bone (skull blanket). In this case, initially formed retikulofibrozis bone, which soon destroyed and replaced by a plate (Figure 85).

Direct osteogistogenessis occurs in stage IV:

I stage of education skeleton islets in the mesenchyme;

II stage of education osseoissis fabrics - organic matrix;

Stage III mineralization (calcification) osseossis tissue and bone formation retikulofibrozic;

Stage IV conversion retikulofibrozic bone lamellar bone.

Indirect osteogistogenez starts

with the 2nd month of embryogenesis.

Initially, in the mesenchyme through activities chondroblasts laid cartilage model of the future bone of hyaline cartilage, covered with perichondrium.

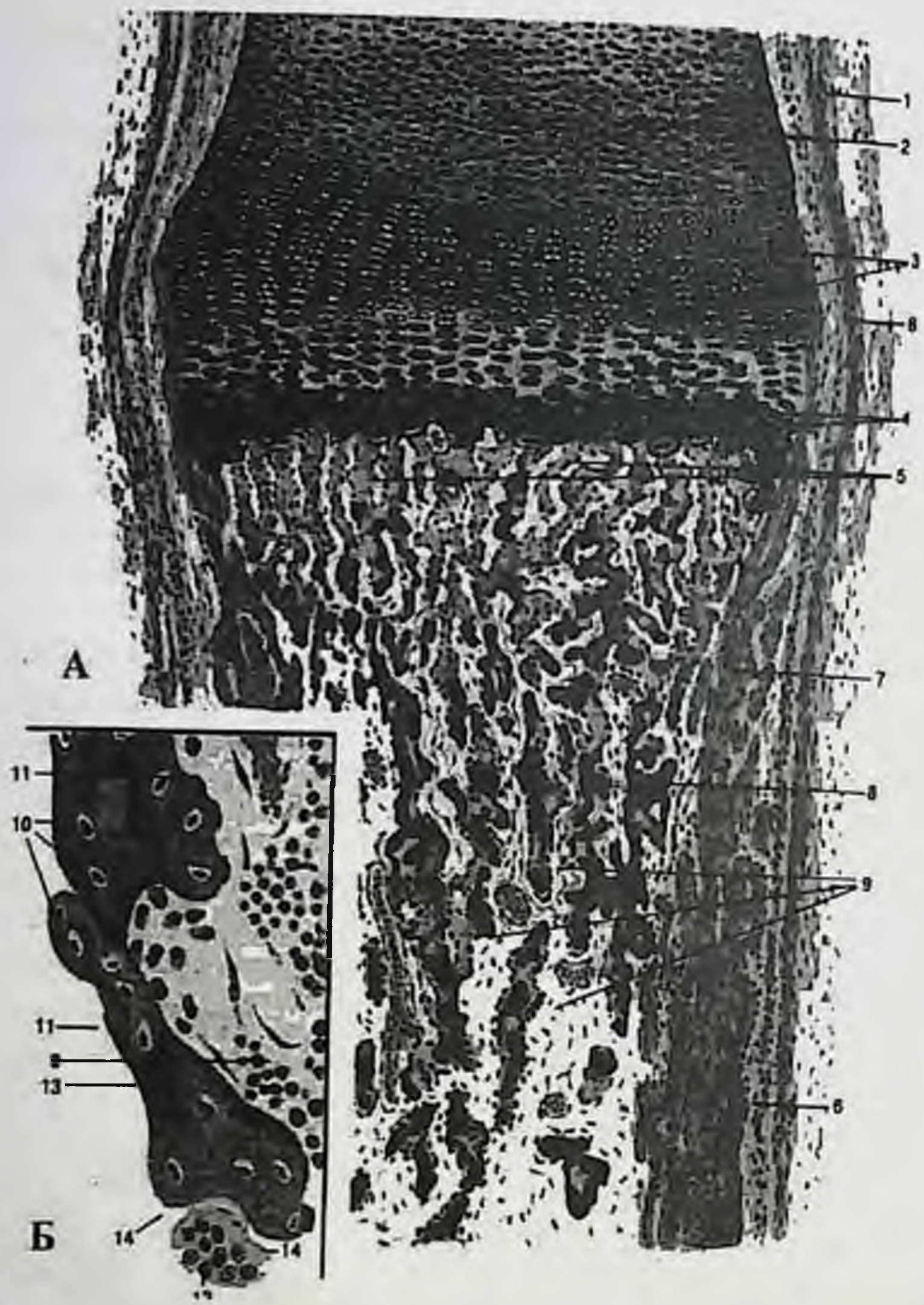
Then the replacement of cartilage bone, initially in the diaphysis, and then in the epiphysis (86-img).

Ossification in the diaphysis in two ways:

• perichondral;

• enchondral.

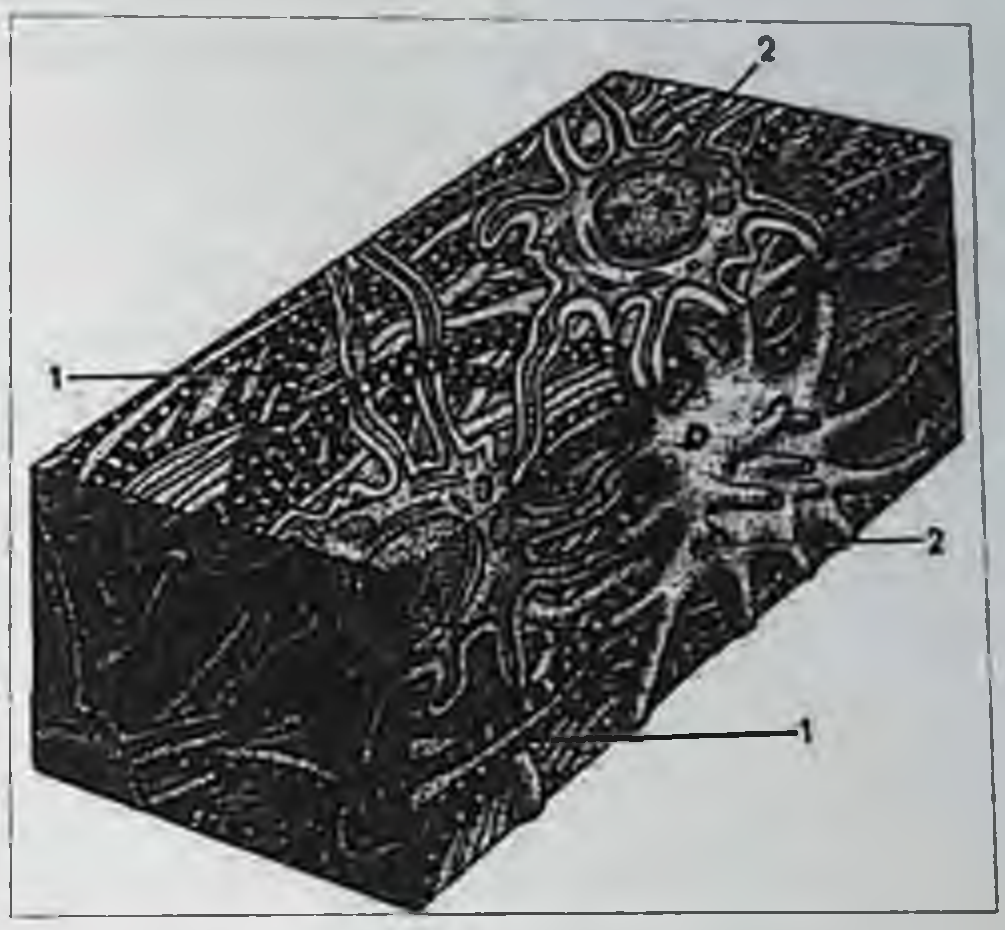
Picture-88. **Direct osteogistogenessis** A) general view B) fragment of a large increase in: 1-mesenchyme (a-b-cell intercellular substance); 2 – blood; 3-vessel osteocyte; 4-mineralized matrix; 5- osteocyte; 6-osteoblast osteoid; 7- mineralized matrix; 8-9-osteoclasts; 10-osteogenic island.



Picture-89. **Indirect osteogistogenez (bone development on the site of the cartilage)** a) general view B) fragment of a large increase in 1-2-perihondr perichondrium zone of normal cartilage; 3-columnar zone; 4 – zone; 5 bubble-zone resorption periosteum; 6-7-8-perichondral bone Endochondral; 9-bone marrow cavity of the primary; 10 - 11 osteocytes, osteoblasts, osteoclasts;
12-13-residue cartilage; 14 - resorption lacun.

Initially, in the diaphysis of the bone cartilage bookmark perichondrium evicted retikulofibrozis osteoblasts to form bone (pic-90), which includes a cuff around the periphery of cartilage.

As a result, the perichondrium becomes the periosteum. Such a method of bone formation called perichondral.



Picture-90. **Reticulate fibrous bone tissue (in Yu.I.Afanasevu)**
1-randomly-arranged collagen fibers
2-osteocytes (located in the gaps

After the formation of bone cuff disrupted trophic deepest parts of hyaline cartilage in the area of the shaft, making here is deposited calcium salts omelen cartilage.

Then, under the inductive effect of calcified cartilage in the area of the periosteum through a hole in the bone cuff grow blood vessels in the adventitia containing osteoclasts and osteoblasts.

Osteoclasts break cartilage, through the activity of osteoblasts, the bone plate is formed as primary osteons, which are characterized by a wide lumen (channel) in the center and blurred boundaries between the plates. Such a method of bone formation in the depth of cartilage and is called enchondral. Simultaneously, there is a reorganization of enchondral ossification coarse-fibered bone cuff in lamellar bone, the outer layer of the general component of the plates. As a result perichondral and enchondral ossification in the cartilage is replaced by bone diaphysis. Which generate a cavity of the diaphysis, fills first bone marrow, then gives way to yellow bone marrow.

Epiphyses of the long bones and spongy bones develop only enchondral. First in the deepest parts of the cartilage epiphysis. Then there osteklasts penetrating vessels and osteoblasts and through their activities is replaced cartilage plate in the form of trabeculae. Peripheral part of the cartilaginous tissue is stored in the form of joint cartilage. Between the diaphysis and epiphysis long preserved cartilage - metaepifizarnum plate, constant multiplication of cells is a growth plate metaphyseal bone in length (pic-91).

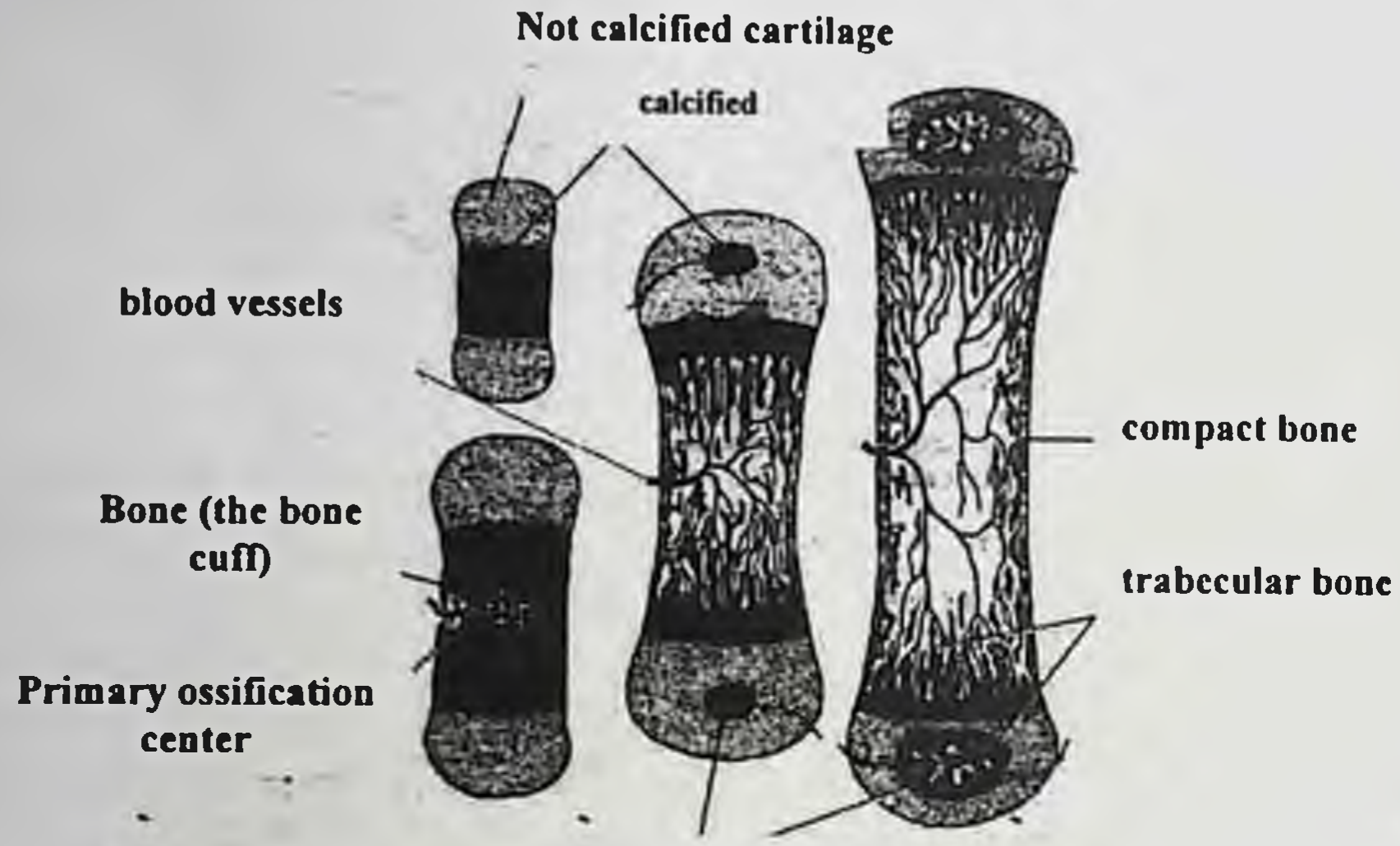
In metaepifizarnic plate divided into three zones of cells:

– **border zone, zone of columnar cells, vesicular zone cells.**

By about 20 years metaepifizarnic plates are reduced, there is synostosis epiphysis and diaphysis, after which the long bone growth

stops. In the development of bones due to the activity of osteoblasts periosteal bone growth occurs in thickness.

Bone regeneration after injury and fractures are due to the activity of osteoblasts periosteum. Restructuring of bone is constantly throughout ontogeny - one osteons or parts break down, others are formed. Factors influencing the osteogistogenezis and bone health:



Picture-91. **Enchondral osteogistogenez**
(by E.G.Ulumbekovu and Yu.A.Chelyshevu)

• The content of vitamins C, D, A. Lack of vitamin C in the diet leads to disruption of the synthesis of collagen fibers, and the disintegration of existing ones, which manifests enhanced fragility and brittleness of bones. Lack of vitamin D production in the skin leads to disruption of calcification of bone and bone deficiency is accompanied by their flexibility (in rickets). Excess vitamin A activates osteoclast activity, accompanied by bone resorption;

• parathyroid hormone levels and thyroid gland (paratina and calcitonin) that regulate calcium in the bones and blood plasma. On bone health also affected by sex hormones;

• curvature of the bones leads to the piezoelectric effect, and osteklasts stimulation of bone resorption;

• Social factors - power, lighting, and others;

• Environmental factors - the environment.

Age changes in the bones:

With increasing age of the change in the ratio of organic and inorganic components of bone tissue in the direction of increasing inorganic and organic decrease, accompanied by bone fragility. This explains the much higher incidence of fractures in older people.

Clinical significance.

Fluorescent antibiotic tetracycline interacts with high affinity with the recent ¬ but formed mineralized bone matrix. On this basis, developed a method for measuring the interaction rate of bone apposition, which is an important parameter in the study of bone growth and diagnosis of his violations. Tetracycline is administered to patients twice with an interval between injections lasting 5 days. Next, a bone biopsy and sections studied using fluorescence microscopy. The distance between two layers fluorescence proportional to the rate of bone apposition. This procedure is important in the diagnosis of diseases such as osteoma insulation, which breaks the mineralization, and fibrocystic osteitis determined by growing ac ¬ efficiency of osteoclasts, which causes the removal of bone matrix and fibrous degeneration.

Genetic disorder characterized by osteopetrosis dense, heavy bones ("marble bone") in the bones of these patients do not contain corrugated osteoclasts and bone resorption rims broken.

Fracture healing

At the turn of the bone breaks down bone matrix and bone cells die near the fracture. As a result of damage to blood vessels is a local hemorrhage and emerging ¬ is a blood clot.

During the healing blood clot times violations damaged cells and bone matrix are removed by macrophages. Periosteum and endosteum around the fracture react assertion cell proliferation, resulting in a tissue that surrounds and penetrates the fracture between the edges of a broken bone.

Then the formation of the primary mechanisms of endochondral bones and internal membranous ossification and fracture healing provides ¬ Xia simultaneously by both of these processes. In the ongoing regeneration primary bone with an irregular shape, temporarily hold the edge of a broken bone, formed callus). Loads that affect the bone during healing and for a gradual return to the patient's activity, methodic restructuring callus. If the loads are identical BEFORE during bone growth - and thus affect its structure - primary bone callus is gradually

resorbed and replaced by secondary tissue. Thus there is a restructuring of the bones and the restoration of its original structure. Unlike other connective tissue bone heals without scar formation.

Since the concentration of calcium in the tissues and blood should be maintained at a constant level, the lack of calcium in the diet leads to decalcification of bones, these bones are more susceptible to fractures and more transparent to X-rays.

The practical part

Compilation of logical structures, the study of drugs hyaline cartilage plate and coarse-fibered bone, electron diffraction, and viewing of multimedia sketch of the principles of building them into albums.

The objects under study:

1. Hyaline cartilage of the trachea.
2. Lamellar bone.
3. Coarse-fibered bone. The electron cartilage and bone cells.

Sample test items

1. Specify the source of the development of bone and cartilage:

a) ganglion plate;
b) sclerotome (sclerotomic mesenchyme);
c) dermatitis (dermatomnaya mesenchyme);
d) ectoderm;
e) splanhnotom (splanhnotomnaya mesenchyme);

2. What processes ensure the growth of cartilage tissue after birth?

a) neoplasm of the mesenchyme;
b) opposition growth;
c) interstitial growth;
d) neoplasm of endoderm.

3. What processes provide bone growth after birth?

a) neoplasm of the mesenchyme;
b) apposition growth;
c) interstitial growth;
d) neoplasm of the ectoderm.

4. Where are the cells that mediate bone regeneration after bone fractures?

a) in the center osteones, perivascular;
b) in the fibrous layer of the periosteum;

c) in the cambium layer of the periosteum;
d) in endosteum;
e) in the reticular tissue of the bone marrow.
5. Name the structure of compact substance shaft:
a) layer osteones;
b) outside the general system of records;
c) the internal system of common records;
d) trabeculae.
6. What types of bone tissue?
a) the plate;
b) spongy;
c) coarse fiber;
d) kompaktnaya.
7. What cells (symplasts) destroy bone?
a) steotsity;
b) osteoblasts;
c) hondroklasty;
d) osteoclasts;
e) fibroblasts.
8. Plot of hyaline cartilage transplanted to another place. What will happen tohondrinovymi fibers?.
a) no changes will be;
b) there will be a re-orientation of the current vector parallel to the tension force;
c) there will be a re-orientation of the vector perpendicular to the current security tensions.

Approximate refereed paper on "The histological features of the development of the bones in place of cartilage"

5.8. Muscle tissue. Striated and smooth muscle tissue

I. Aims and objectives:
1. The study of the structure and function of smooth muscle tissue.
2. The study of the function and structure of striated muscle tissue
II. Questions for self-control students:
1. General principles of the structure.
2. Features myocytes.
3. The functional significance of muscle tissue.

4. Types of muscle tissue.
5. Sources of muscle tissue.
6. Age characteristics of muscle tissue.
7. Contraction feature different types of muscle tissue.
8. The clinical significance.

The theoretical part

Myshechnyetissue

General characteristics Property contractility have almost all kinds of cells, thanks to the cytoplasm of the contractile apparatus, submitted network of thin microfilaments (5-7 nm), consisting of contractile proteins - actin, myosin, tropomyosin, and others. Through the interaction of proteins called contractile microfilaments implemented process and allow movement in hyaloplasm cytoplasm, organelles, vesicles, formation of pseudopodia and invaginations plasmolemm and processes phage and pinocytosis, exocytosis, cell division and movement. The content of the contractile elements, and hence the contractile processes differently expressed in different cell types. The most pronounced contractile structures in cells whose main function is to reduce. These cells or their derivatives form muscle tissue that provide contractile processes in hollow internal organs and blood vessels, the movement of the body relative to each other, maintaining the posture and movement of the body in space. In addition to the motion for reduction of a large amount of heat, and thus, muscle fibers are involved in the thermoregulation of the body.

Muscle fibers are different in structure, origin and innervation of functional features. Finally, it should be noted that any type of muscle tissue, in addition to contractile elements (muscle cells and muscle fibers) includes cellular elements and fiber loose fibrous connective tissue and blood vessels that provide trophic muscular elements, transmitted effort to reduce muscular elements on the skeleton. However, the major functional elements of muscle cells are muscle or muscle fiber. Classification of muscle tissue:

- Special - neural origin and epidermalof origin;
- cross-striped (striated)skeletal, cardiac.
- smooth (of smooth) - mesenchymal;

As seen from the classification of muscle tissue in the structure is divided into two main groups - the smooth and striated. Each of the two

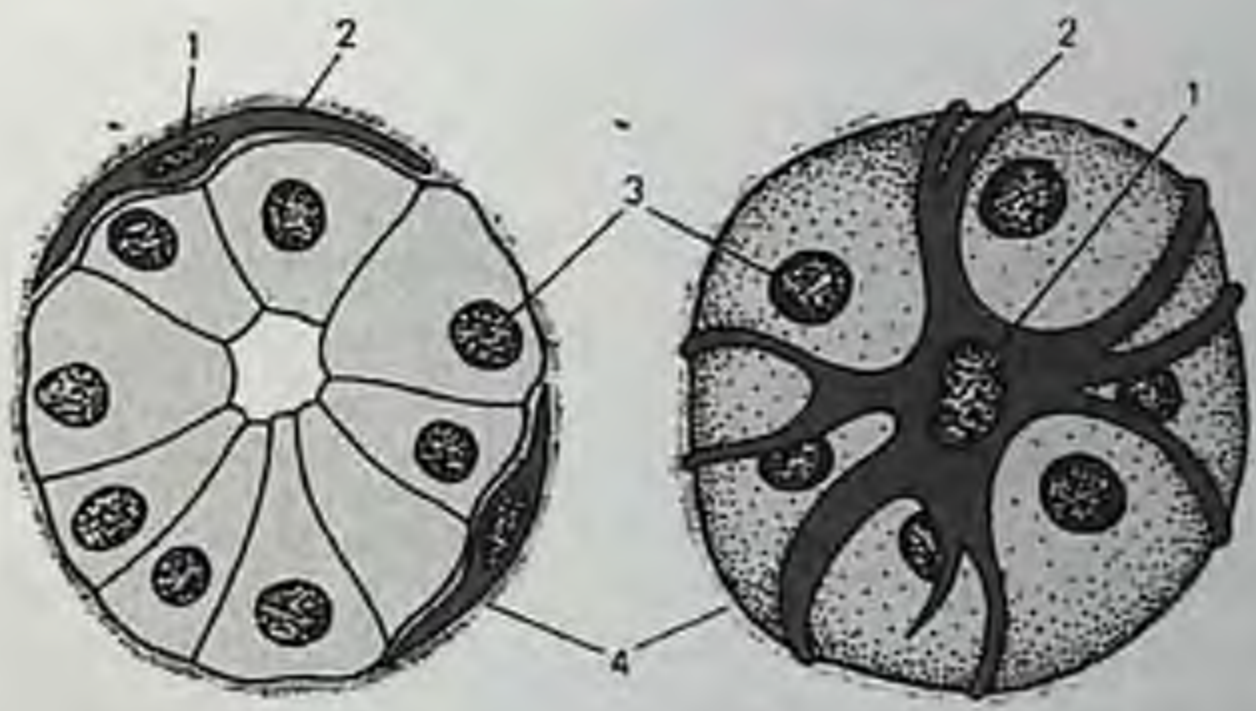
groups in turn subdivided into species, like the sources of origin and on the structure and functional features.

Smooth muscle, which is part of the internal organs and blood vessels, develop from the mesenchyme (see also private cytology).

The special muscle tissue of neural origin include the smooth muscle cells of the iris, the epidermal origin - myoepithelial cells of the salivary, lacrimal, sweat and mammary glands (img89)

Special smooth muscle tissue

Special smooth muscle tissues of neural origin develop from neuroectoderm of the edges of the walls of the optic cup, which is a protrusion of the diencephalon. From this source, developing myocytes, which form the two muscles of the iris - the muscle narrows the pupil and the arm extends the pupil. The morphology of the iris myocytes do not differ from mesenchymal myocytes, however, differ in innervation. Each myocyte receives autonomic efferent innervation (muscle extending pupil - sympathetic, muscle narrowing the pupil - parasympathetic). Because of this, called the muscles contract rapidly and in a coordinated, depending on the power of the light beam.



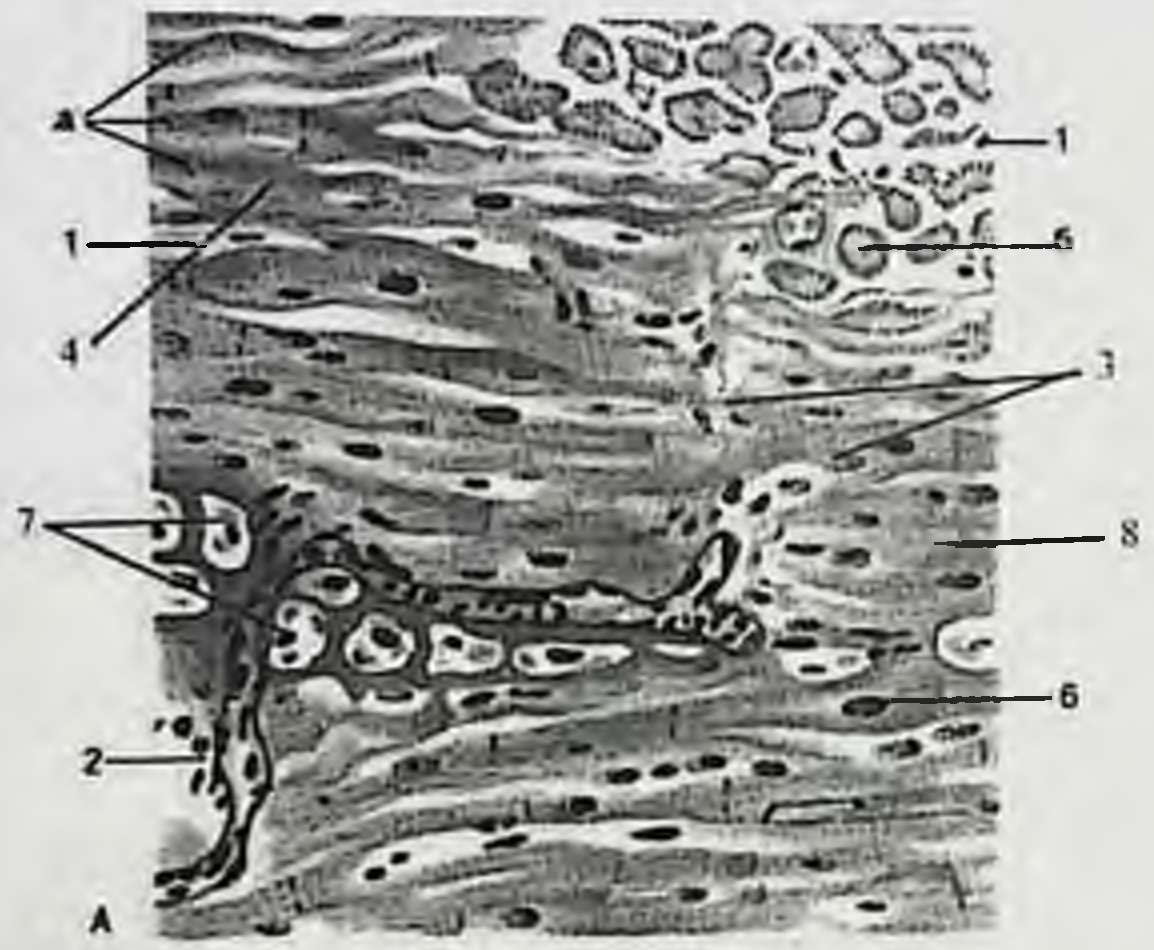
Picture-93. **Myoepithelial cells in the terminal section of salivary gland (schema GS Katinas)** A) cross-section B) top view of: 1-core myoepitheliocytes processes; 2-myoepitheliocytes; 3-core secretory myoepitheliocytes; 4-basement.

Epidermal origin of developing cutaneous ectoderm and are not the typical spindle-shaped myocytes, the cells are star-shaped - myoepithelial cells, which are located in the terminal regions of the salivary, mammary, lacrimal glands and sweat glands, the outside of the secretory cells. In its appendages myoepithelial cells contain actin and my-

osin filaments, which processes through interaction of cells and contribute to reduced secretion of the end sections and small ducts called the glands in the larger ducts. Efferent innervation also obtained from the vegetative part of the nervous system.

Striated muscle tissue is divided into skeletal and heart (pic-94). Both of these varieties are developed not only from the mesoderm, but from different parts of it:

Skeletal - from myotomes of somites;heart - of visceral leaf splanchnotome.



Picture-94. **Striated muscle of the heart. Overview.** 1- endomysium 2-perimizy. 3-intercalated disk. 4-side anastomosis of the. 5-cardiomyocyte nucleus. 6-cardiomyocyte. 7-conductive cardiomyocytes. 8-myofibril.

Each variety has its own muscle tissue structural and functional unit. Structural and functional unit of the smooth muscle tissue of internal organs and the iris is smooth muscle cells - myocyte; special muscle epidermal origin - korzinchaty mioepiteliotsit, cardiac muscle tissue - cardiomyocyte, skeletal muscle tissue - muscle fiber.

The organization of the striated skeletal muscle tissue

Structural and functional unit of cross-striated muscle is the muscle fiber ((Figure 91). It is an elongated cylindrical formation with pointed ends in length from 1 mm to 40 mm (and according to some estimates up to 120 mm), 0.1 mm in diameter. muscle fiber is surrounded by a shell - the sarcolemma, which under an electron microscope clearly distinguished two sheets: internal - is typical plasmolemma and the outer is a thin connective plate - basal plate. in the narrow gap between

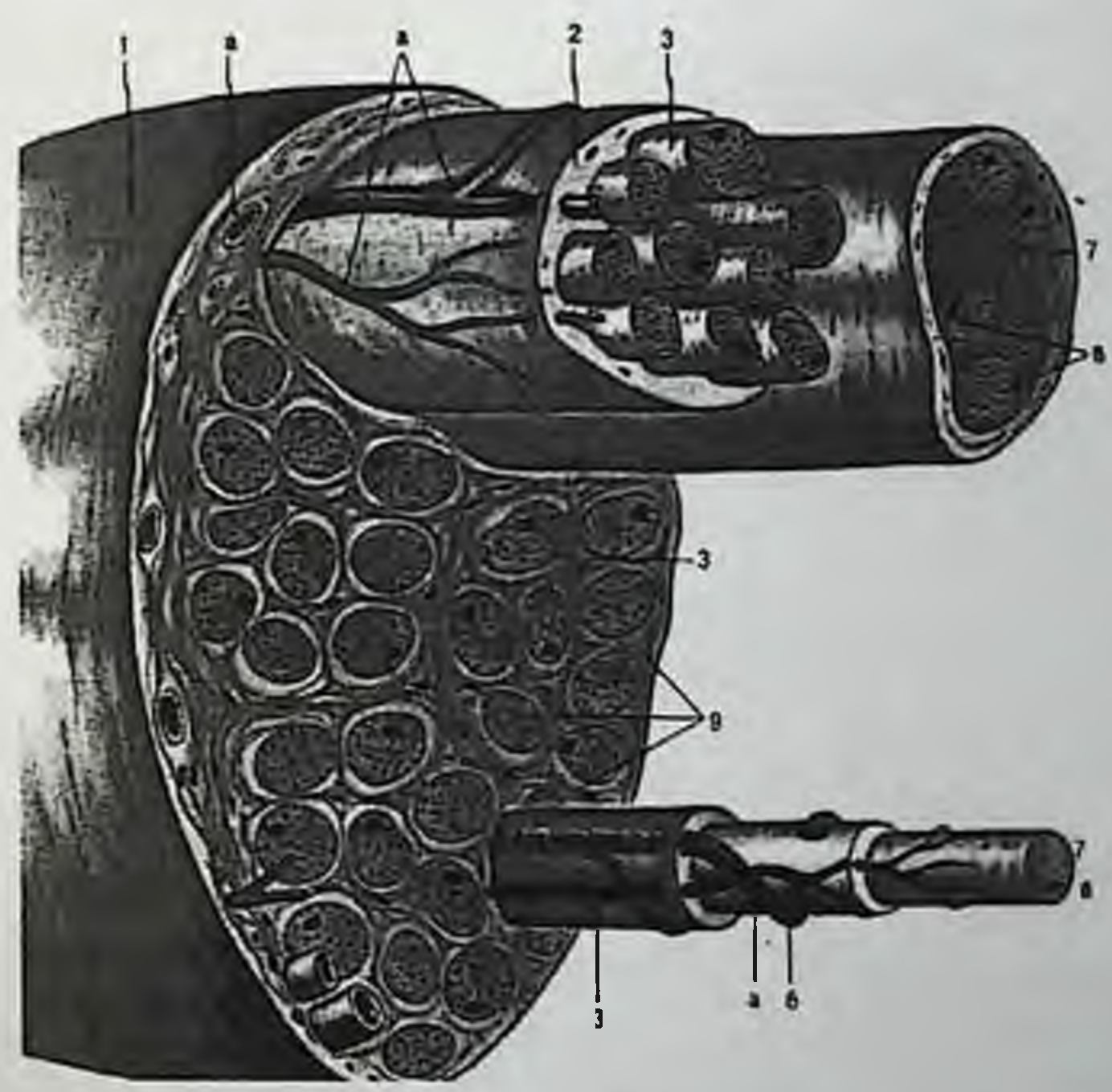
plasmolemm and basal plate are small cells - miosatellits. So , the muscle fiber is a comprehensive education and consists of the following structural components:

- myosymplasts;
- miosatellit cells;
- basal plate.

Basal plate is formed by thin collagen and reticular fibers, refers to a support unit and a supporting role in the transfer of forces to reduce muscle connective elements.

Miosatellit cambial cells are (germ) elements of the muscle fibers and play a role in the physiological and reparative regeneration.

Myosymplasts is a major structural component of muscle fiber in terms of volume, and by function. It is formed by the merger of independent non-differentiated muscle cells - myoblasts. Myosymplasts can be seen as an elongated multinucleated giant cell, consisting of a large number of nuclei, cytoplasm(sarcoplasm) plasmolemm, inclusions, general and special organelles (91-fig.).



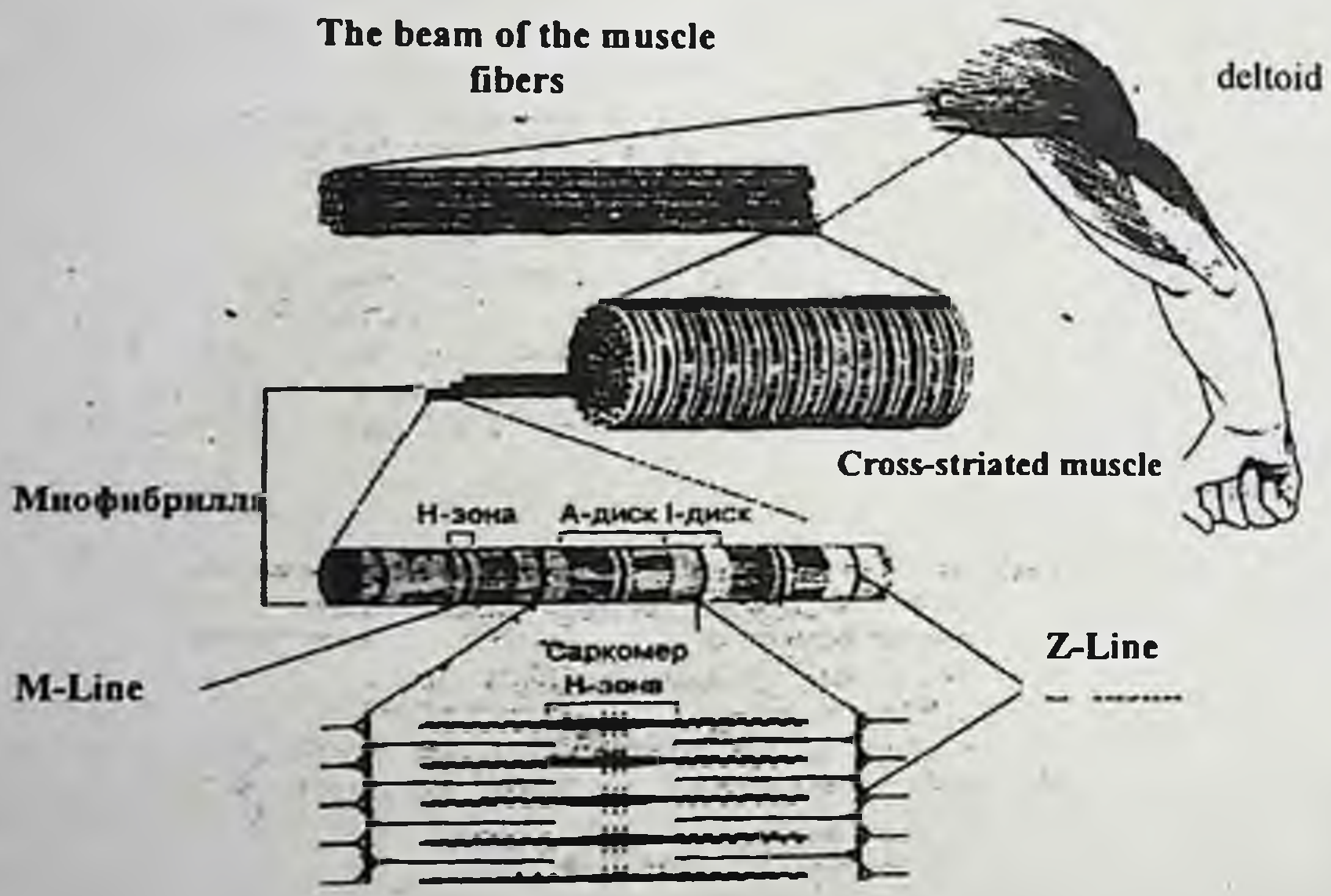
Picture-95. **The structure of the striated muscles of the tongue.**
1-epimizyc; 2-perimizyc; 3-endomysium a) vessels b) nerves; 4-muscle fiber; 5-6-7-sarcolemmal cytoplasm (sarcoplasm); 8-core fibers; 9-core fibroblast.

In myosymplasts contains several thousand (10 000) longitudinally elongated light nuclei, which are located on the periphery of a plasmolemm. Localized near the nuclei fragments mild granular endoplasmic reticulum, a plate set and a small number of mitochondria. In the sarcoplasm contains inclusions of glycogen and myoglobin, hemoglobin analogue erythrocytes.

Myosymplasts distinctive feature is the presence in it of specialized organelles, which include:

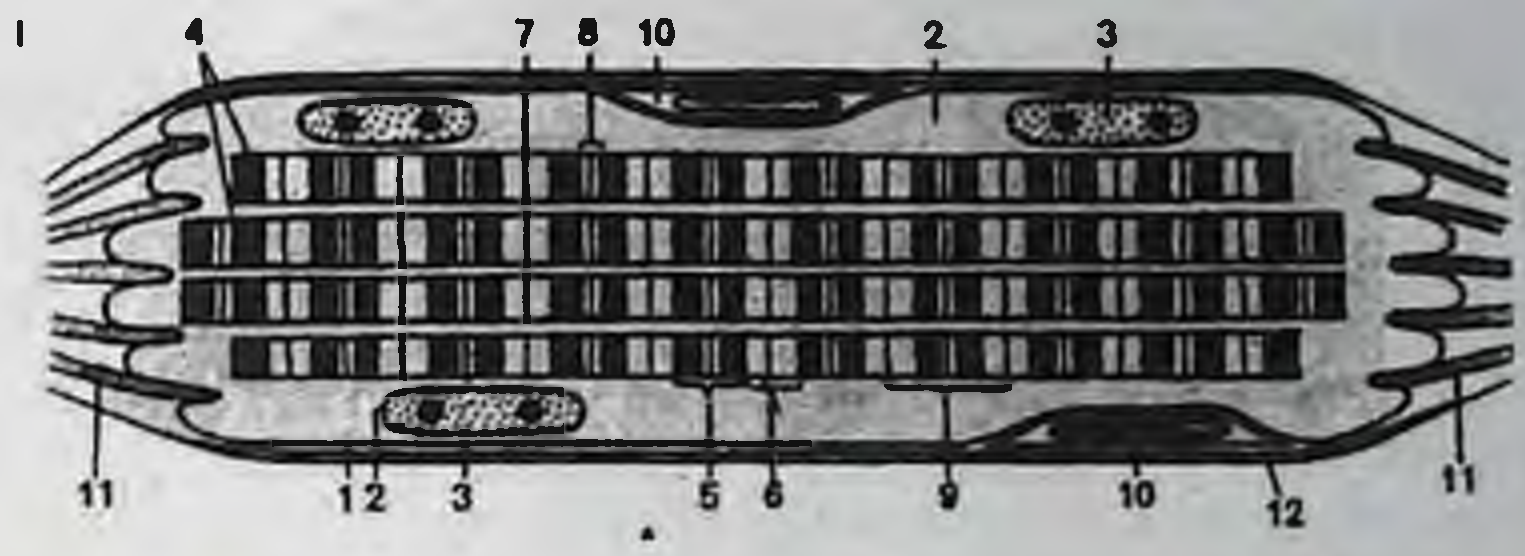
- myofibrils;
- sarcotubules;
- T-tubule system (img.92).

Myofibrils - myosymplasts contractile elements - in large quantities (up to 1000-2000) are located in the central part of the sarcoplasmic myosymplasts.



Picture-96. **The principle structure of the skeletal muscle**

They are grouped in bundles, between which is layers sarcoplasm. Between myofibrils localized large number of mitochondria (sarkosom, 93-rice). Each myofibril extends longitudinally throughout myosymplasts and their free ends attached to his plasmolemma have tapered ends. The diameter of the myofibrils is 0.2-0.5 microns.



Picture-97. **Fiber striated muscle.** 1- sarcolemmal sarcoplasm; 2- miosimplastnye; 3-core 4-myofibril anizatrop; 5-A iso disk; -6- I-Drive; 7-telofragma; 8-H band sarcomere; 9-miosatelliotsit; 10-fiber; 11-joint; 12-basement membrane.

In structure myofibrils heterogeneous in length and are divided into:

• dark (anisotropic) or A-ROMs, which are formed by a thick myofilaments (10-12 nm), composed of protein myosin;

• light (isotropic) or I-drives, which are formed by thin myofilaments (5-7 nm), composed of the protein actin.

Dark and light discs of all myofibrils are on one level and cause cross striation of the muscle fiber.

Dark and light discs in turn are composed of thinner fibrils - protofibrils or myofilaments. In the middle of I-drive cross-actin myofilaments goes dark stripe - telofragma or Z-line, in the middle of a drive is less pronounced M-line or mesophragma. Actin myofilaments in the middle of I-Drive bonded proteins that make up the Z-line, free-end partially included in the A drive between thick myofilaments. At the same time, around a single myosin filaments of actin are 6. In case of partial reduction of myofibrils actin myofilaments as it pulled into a drive and it formed light area or H-band, limited the free ends of the actin myofilaments. The width of the H-bars depends on the reduction of myofibrils.

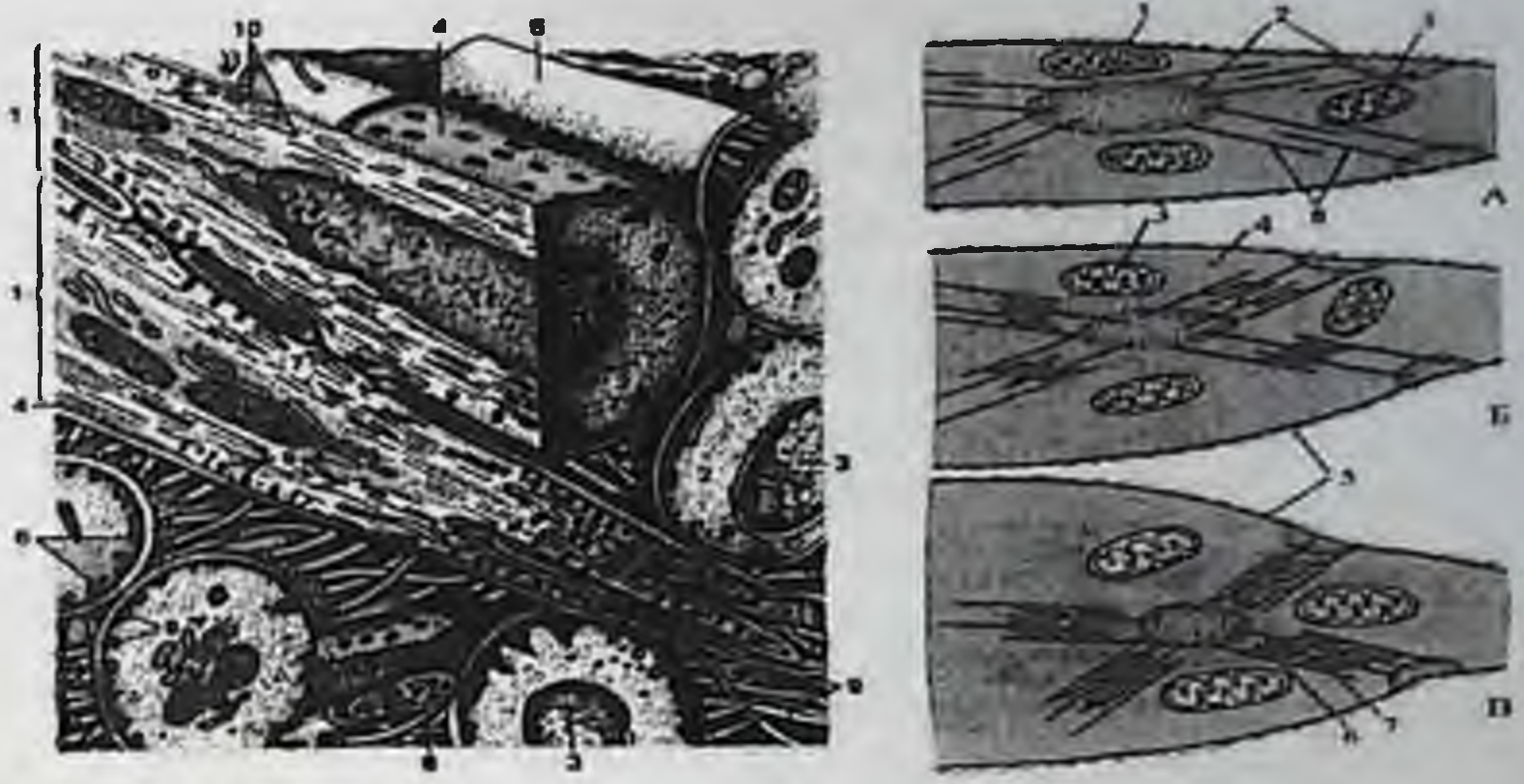
Plot myofibril located between two Z-lines is called the sarcomere is the structural and functional unit of myofibrils. Sarcomere includes a disk and placed on the sides of the two halves of I-drive. Therefore, each myofibril is a collection of sarcomeres. It is in the process of sarcomere contraction. It should be noted that the end of each sarcomere myofibrils attached to plasmolemma myosymplasts actin myofilaments. The structural elements of the sarcomere in a relaxed state can be expressed by the formula: Z +1 / 2I +1 / 2A + M +1 / 2A +1 / 2I + Z.

Muscle contractions

Reduction process is carried out through the interaction of actin and myosin filaments and education between the two actin-myosin bridges, through which there is retraction of the actin myofilaments in the A-drives sarcomere shortening. For the development of this process requires three conditions: the availability of energy in the form of ATP, the presence of calcium ions, the presence of biocapacity. ATP is formed in sarcosome (mitochondria) in a large number of localized between myofibrils. Implementation of the last two conditions by means of two more specialized organelles - the sarcoplasmic reticulum and T-tubules (figure 94).

Sarcotubules as a modified smooth endoplasmic reticulum and contains extended cavities and anastomosing tubules surrounding myofibrils. In this sarcotubules divided into fragments that surround the individual sarcomeres. Each fragment consists of two terminal tanks, connected hollow anastomosing tubules - L-tubules. In this case, the terminal tank cover sarcomere of I-drive, and canals - in the A drive. In the terminal tanks and tubules contain calcium, which when entering the nerve impulse and the achievement of a wave of depolarization sarcoplasmic reticulum membranes, out of the tanks and canals and are distributed between the actin and myosin myofilaments, initiating their interaction. After the wave of depolarization, calcium ions rush back to the terminal tanks and canals. Thus, sarcotubules is not only a reservoir for calcium ions, but also plays the role of the calcium pump.

Depolarization wave is transmitted to the network from the sarcoplasmic nerve ending on plasmolemma first, and then the T-tubules, which are not separate structural elements. They are a tubular protrusion plasmolemma in the sarcoplasm. Gouged out the T-tubules and cover every branch of myofibrils within a bundle strictly on one level, usually at the level of Z-bars or more medial - at the junction of the actin and myosin myofilaments. Consequently, each sarcomere fit and surround him two T-tubule. On both sides of each T-tubule are two terminal tanks adjacent sarcomeres sarcoplasmic reticulum, which, together with the T-tubules are triad. Between the wall of the T-tubule and the walls of the terminal tanks have contacts through which the wave is transmitted to the depolarization of the membrane tanks and causes egress of calcium ions and the beginning of contraction. Thus, the functional role of the T-tubules is to transfer to the biocapacity plasmolemma on sarcotubules.



Picture-98. **Relaxed (A), partially reduced (B) and completely smooth muscle**
1 – sarcolemma; 2-dense bodies; 3-sarcosome; 4-sarcoplasm;
5-basement membrane; 6-actin filaments; 7-myosin filaments.

For the interaction of actin and myosin myofilaments and subsequent reduction of calcium than is necessary as the energy in the form of ATP, which is produced in sarcosome in large numbers ranging between myofibrils.

The process of interaction of actin and myosin filaments can be simplified as follows. Under the influence of calcium stimulated ATPase activity of myosin, which leads to the splitting of ATP to form ADP and energy. Thanks to the energy released established bridges between actin and myosin (and more specifically, forms a bridge between the heads of the protein myosin and the specific point on the actin filaments) and by shortening these bridges are pulling actin filaments between the myosin. Then they fall due (again using energy) and myosin head form new contacts with other points on the actin filament, but located distal to the previous one. So there is a gradual retraction of actin filaments between the myosin and shortening the sarcomere. The extent of this reduction depends on the concentration of calcium ions near the myofilaments and the content of ATP. After the death of the body sarcosome ATP is formed, its remnants are spent on education actin-myosin bridges, and the decay is not adequate, resulting in muscle stiffness occurs after death, which stops after autolysis (decay) tissue elements.

At full reduction sarcomere actin filaments reach the M-strip sarcomere. This eliminates the H-bars and I-drive, and the formula of the sarcomere can be expressed in the following form: Z +1 / 2IA + M +1 / 2AI + Z.

With partial reduction formula sarcomere can be summarized as follows: Z +1 / nI +1 / nIA +1 / 2H + M +1 / 2H +1 / nAJ +1 / nI + Z.

The simultaneous reduction of all friendly each myofibril sarcomeres leads to a reduction of muscle fiber. The end of each sarcomere myofibrils attached to the actin myofilaments plasmolemma myosymplasts which ends muscle fiber is folded nature. In this case, the ends of the muscle fiber basal lamina does not go into the folds plasmolemma. Pierce her delicate collagen and reticular fibers, penetrate deeper folds plasmolemma and attach it in the ground, to which are attached to the inside of the actin filaments distal sarcomeres. This creates a strong link with fibrous structures myosymplasts endomysium. Collagen and reticular fibers end of muscle fibers, together with the fibrous structure of the endomysium and perimiziya together form tendons that attach to specific points of the skeleton, or woven into the reticular layer of the dermis of the face. By reducing muscle is moved part or all of the body, and changing terrain of the face.

Types of muscle fibers

In muscle tissue are two main types of muscle fibers, between which there are intermediate, differing primarily features metabolic and functional properties, and to a lesser extent - the structural features.

- **Type I fibers** - red muscle fibers - characterized primarily high in the sarcoplasm myoglobin (which gives it the red color), large numbers sarkosom, high activity at the succinate dehydrogenase (SDH), high activity of ATPase of slow type. These fibers have the ability to slow but prolonged tonic contraction and low fatigue;

- **Type II fibers** - white muscle fibers - producing minor content of myoglobin, but high glycogen phosphorylase high activity and ATP-base type fast. Functionally characterized by the ability to fast, strong, but short cuts. Between the two extreme types of muscle fibers are intermediate, characterized by different combinations of these inclusions and different activity these enzymes.

Muscle as the body is made up of muscle fibers, fibrous connective tissue, blood vessels and nerves. Muscle - this anatomical formation, the main leading structural and functional component of which is muscle. Therefore not be seen as synonymous with muscle tissue and muscle.

RVST forms a layer in the muscle: endomysium; perimizium; epimizium (see figure 91).

Endomysium surrounds each muscle fiber is made up of loose fibrous connective tissue and contains blood and lymph vessels, mainly capillaries operations which provide trophic fibers. Collagen and reticular fibers endomycium penetrate into the basal plate of the muscle fiber, which is closely related to it and transmit power to the point of reducing the fiber skeleton.

Perimisium surrounds several muscle fibers collected in bundles. It contains larger vessels (arteries and veins, as well as arteriolo-venular anastomoses).

Epimizium or fascia surrounds the muscles, promotes muscle function as a body. Any muscle contains all types of muscle fibers in a different proportion. In muscles that maintain posture, dominated by red fibers. In muscles that provide movement of the fingers and hands, dominated by white or transitional fibers. The nature of the muscle fiber can vary depending on the load and functional training. Found that the biochemical, structural and functional features of muscle fibers depends on innervation. Cross-transplantation efferent nerve fibers and their endings with red fibers on white and vice versa leads to a change in the exchange, as well as the structural and functional characteristics of these fibers to the opposite type.

Histogenesis and regeneration of muscle tissue

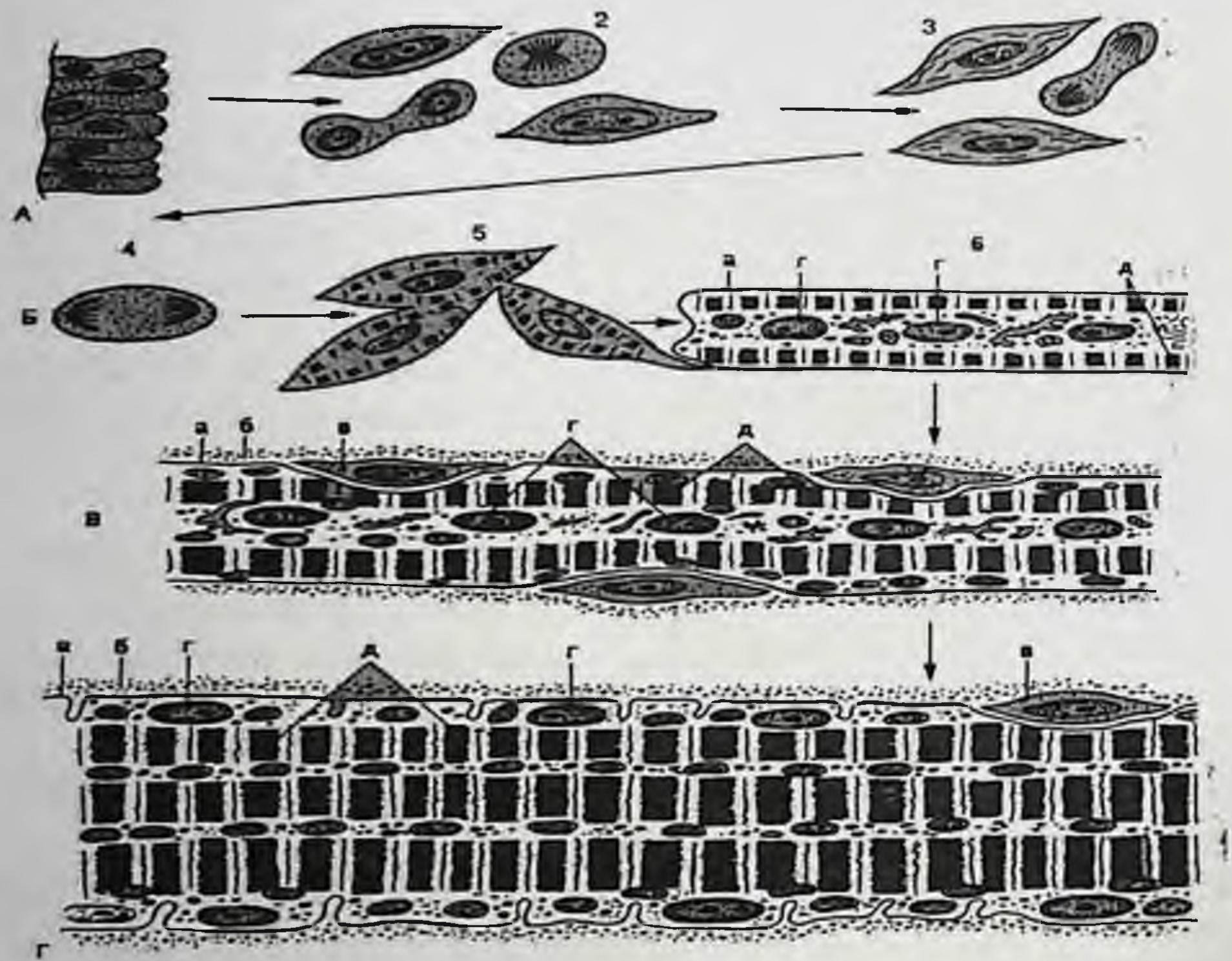
Myotomes of mesoderm in certain parts of the mesenchyme evicted undifferentiated cells - myoblasts, part of which is built in the form of a chain in the joint together. In the area of contact myoblasts disappears formed education - miotubulles, in which the nucleus in the form of a chain located in the middle, and on the periphery of the myofilaments begin to differentiate myofibrils. By miotubulles grow nerve fibers, forming a motor nerve endings. Under the influence of efferent nerve impulses begin rebuilding muscle tubes in muscle fiber: the nuclei move to the periphery of the symplast plasmolemma and myofibrils occupy the central part of the smooth endoplasmic reticulum develops sarcotubules surrounding each myofibril in its entirety. Cytolemma myosymplasts forms deep tubular invaginations - the T-tubules. Through the activity of the granular endoplasmic reticulum of myoblasts first, and then the muscle tubes are synthesized and secreted by lamellar complex proteins and polysaccharides that make up the muscle fiber basal lamina (figure 95).

It should be noted that, when the miotubes and then the differentiation of muscle fibers myoblasts part not included in the symplast, and

adherent to it, lying under the basal plate. These cells are called miosatellits and play an important role in physiological and reparative regeneration. Found that the tab of striated skeletal muscle fibers (myogenesis) occurs only in the embryonic period. In the postnatal period by their further differentiation and hypertrophy, but the number of muscle fibers even in the face of intensive training does not increase.

Regeneration of skeletal muscle tissue

In muscle, as in other tissues, there are two types of regeneration - physiological and reparative.



Picture-99. **Development of skeletal muscle.** A) myoblast stage B) In stage myosymplasts) stage muscular tube D) definitive stages. 1-cells miotomnye; 2-promioblast; 3-myoblasts; 4-dividing cells; 5-sioblasts; 6-merging education and myoblasts) sarcolemma b) in the basement membrane) miosatellit g) kernel myosymplasts.

Physiological regeneration is manifested in the form of hypertrophy of the muscle fibers, resulting in the increase of their thickness, and even the length, increasing the number of organelles, mainly myofibrils

and the increase in the number of nuclei, which eventually manifested increase functional capacity of muscle fibers. Radioisotope method found that the increase in the number of nuclei in the muscle fibers in hypertrophy is achieved by cell division and subsequent miosatellits myosymplasts entry into daughter cells.

Increase in the number of myofibrils is through the synthesis of proteins actin and myosin free ribosomes and the subsequent assembly of these proteins actin and myosin myofilaments in parallel with the respective filaments of sarcomeres.

As a result, first thickening of myofibrils, and then they split and the formation of subsidiaries myofibrils. In addition, the formation of new actin and myosin myofilaments are not parallel, and the butt prior myofibrils, thus achieving their elongation. Sarcotubules and T-tubules in hypertrophied fibers are formed by the proliferation of the preceding elements. In certain types of muscle training can be formed mainly red muscle fiber type (for stayers) or white type of muscle fibers (sprinters). Age hypertrophy of muscle fibers is shown from the beginning of intense physical activity of the body (1-2 years), which is primarily due to the increase in neural stimulation. In the elderly, as well as in low-load muscle atrophy specific organelles and general thinning of muscle fibers and a decrease in their functional capacity.

Reparative regeneration occurs following damage muscle fibers. Thus the way of regeneration depends on the size of the defect. With significant damage throughout the muscle fiber miosatellit in damage to the surrounding areas and disinhibited, strongly proliferate and then migrate to the area of the defect of muscle fibers, which are arranged in a chain, forming miotubulles. Subsequent differentiation miotubulles results fill the defect and restore the integrity of the muscle fiber. In the small defect of muscle fibers at the ends, due to the regeneration of intracellular organelles formed muscle buds that grow towards each other and then merge, leading to the closure of the defect. However, reparative regeneration and integrity of muscle fibers can be made under certain conditions: first, when the stored motor innervation of muscle fibers, and secondly, if the injury does not fall into the elements of connective tissue (fibroblasts). Otherwise, the location of the defect develops muscle fibers of connective tissue scar.

Soviet scientists Studitskii proved possible autologous skeletal muscle and whole muscle under certain conditions:

• mechanical crushing muscle transplant in order to release satellite cells and their subsequent proliferation;

• The room is ground tissue in the fascial bed;

• suturing motor nerve fibers to the particulate graft;

• presence of contractile muscle movement antagonists and synergists.

Innervation and blood supply to the skeletal muscles

Skeletal muscles are motor, sensory and trophic (autonomic) innervation

Motor (efferent) innervation of skeletal muscles of the trunk and limbs are the anterior horn motor neurons of the spinal cord, and muscles of the face and head - from the motor neurons of certain cranial nerves. In doing so, each muscle fiber is suitable or a branch of a motor neuron axon, or the entire axon. In the muscles, providing fine coordinated movements (muscles of the hand, forearm, neck), each muscle fiber is innervated by a single motoneuron. In the muscles, which serves mainly to maintain posture, tens and even hundreds of muscle fibers receive motor innervation from one motor neuron, through its axon branching.

Motor fiber going to the muscle fiber, penetrates the endomysium and basal plate and falls into the terminal, which, together with the adjacent site specific myosymplasts form axo-muscle synapses and motor plaques. Under the influence of a wave of depolarization of nerve impulses from the nerve terminal is transmitted to plasmolemma myosymplasts extends further along the T-tubules and triads in the tank is transferred to the terminal sarcoplasmic reticulum, causing the output of calcium and start the process of reducing the muscle fiber.

Sensitive (afferent) innervation of skeletal muscle is psevdounipolar spinal ganglia neurons, through a variety of receptor endings dendrites of these cells. Receptor end of skeletal muscle can be divided into two groups:

Specific receptor devices unique to skeletal muscle: muscle spindles, Golgi tendon organ, non-specific receptor or tree form, distributed in the loose connective tissue endomysium, and epimizium.

Muscle spindles - a rather intricate encapsulated devices. Each muscle contains from several to several tens or even hundreds of muscle spindles. Each muscle spindle contains not only nerve elements, but also the specific muscle fibers 12.10 - intrafusal surrounded by a capsule. These fibers are parallel to the contractile muscle fibers (extra-

fusal) and receive not only sensitive, but also specific motor innervation. Muscle spindles irritable as tensile given muscle, caused by contraction of the muscles-antagonists, and in its reduction.

Tendon organs are specialized encapsulated receptors, including several of tendon fibers, surrounded by a capsule, which are distributed among the terminal dendrite branching psevdounipolar neuron. With the reduction of muscle tendon fibers closer together and squeeze the nerve endings. The tendon organs perceive only the degree of reduction of the muscle. Through muscle spindles and tendon organs involving spinal centers provided automatism of movements (such as walking).

Trophic innervation is provided by the autonomic nervous system (sympathetic part of it) and is mainly mediated by vascular innervation.

Skeletal muscles are richly supplied with blood. In the loose connective tissue perimizium are rich in arteries and veins, arterioles, venules and arterioles-venular anastomoses. In the endomysium are only capillaries, mostly narrow (4.5-7 mm), which provide trophic muscle fibers. Muscle fiber, together with the surrounding capillaries and motor end up mion. In muscle, contains a large amount arteriolo-venular anastomoses, ensuring adequate blood supply for different muscle activity.

Cardiac striated muscle

Cardiomyocytes

Structural and functional unit of cardiac striated muscle tissue is a cell - cardiomyocyte. According to the structure and functions of the cardiomyocytes are divided into two main groups:

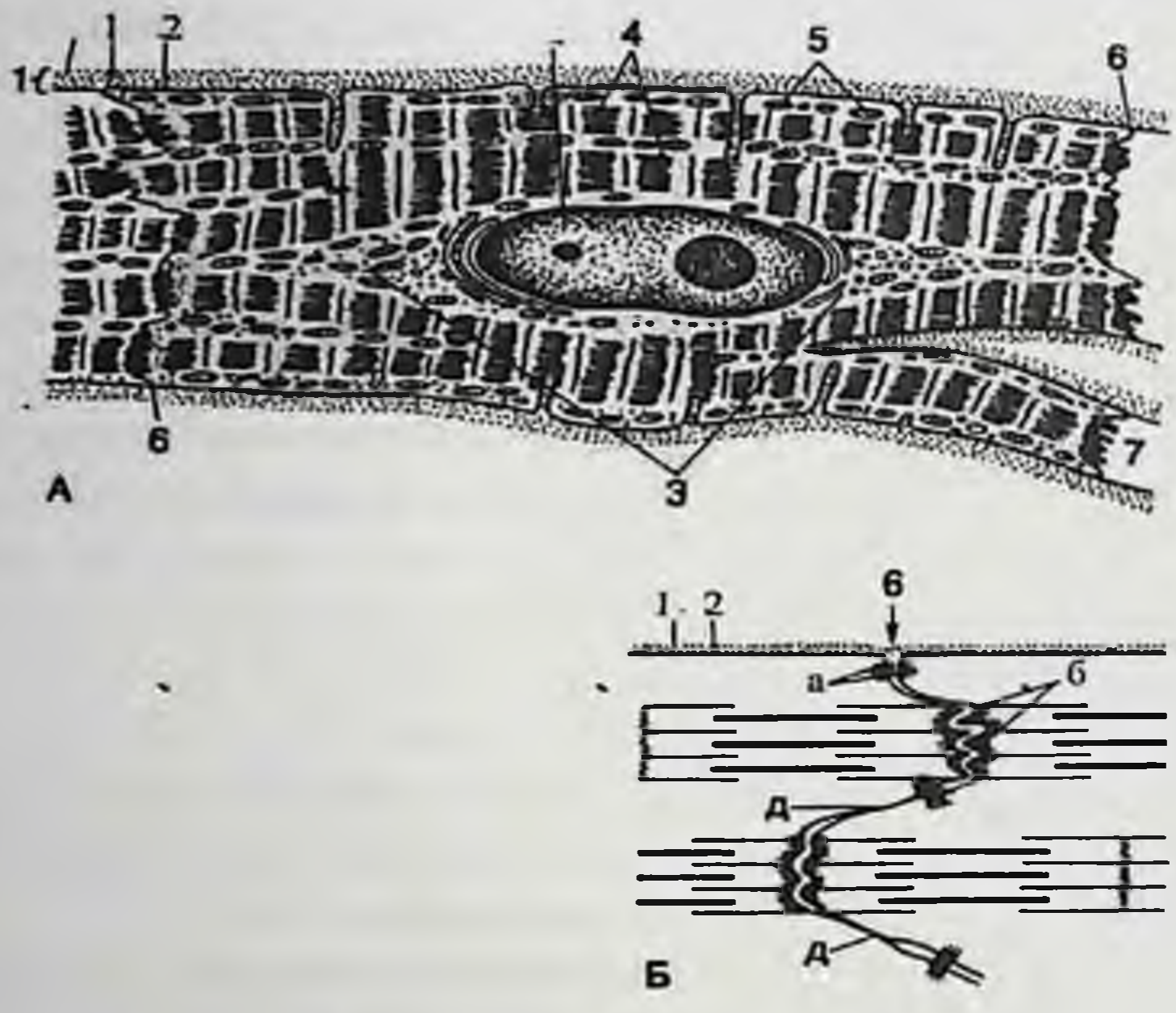
• Typical or contractile cardiomyocytes, forming together, myocardium;

• atypical cardiomyocytes forming the conducting system of the heart and, in turn, subdivided into three types.

Cardiomyocyte contractile is almost rectangular cage 50-120 microns in length, a width of 15-20 mm, the center of which is localized usually one core. Covered on the outside of the basal lamina. In cardiomyocyte sarcoplasm at the periphery of the nucleus are myofibrils, and between them are located near the nucleus and in a large number of mitochondria. In contrast to skeletal muscle, the myofibrils of cardiomyocytes are not separate cylindrical formation, and in essence a network of anastomosing myofibrils myofilaments as some sort of split off from one myofibril and continue diagonally to the other. In addition, the light and dark discs adjacent myofibrils are not always located at

the same level, and therefore transverse striations in cardiomyocytes is not expressed as clearly as in skeletal muscle fibers. Sarcotubules covering myofibrils, an expanded anastomosing tubules. Terminal tanks and no triad. T-tubules are available, but they are short, wide, and formed not only deepening plasmolemma but basal lamina. The mechanism of reduction in cardiomyocytes does not differ from that of skeletal muscle fibers (Figure 96).

Contractile cardiomyocytes, end-jointed to each other to form functional muscle



Picture-100. **Structure typical of cardiomyocytes.**
A) declining - cardiomyocyte. B) intercalated disk: 1-basement membrane; 2-sarcolemma; 3-core; 4-myofibril; 5-motohondry (sarcosome); 6-intercalated disk: a) desmosome; b) interdigitatsiya.

fibers, between which there are numerous anastomoses. With this out of the individual cardiomyocytes formed network - functional sintitsy. The presence of slit-like contacts between cardiomyocytes provides simultaneous and friendly at the beginning of their decline in the atria and then the ventricles.

Contact area of the adjacent cardiomyocytes are called intercalated discs. In fact, no additional structures (discs) between cardiomyocytes not. Intercalated discs - a place contact tsitolemmy adjacent cardiomyocytes, which include simple desmosomal and slotted contacts. Usually

in the intercalated disk distinguish the transverse and longitudinal parts. In the cross-pieces are extended desmosomal connection. In these places the inside of the actin filaments attached plasmolemma sarcomeres. In the longitudinal slit-like fragments are localized contacts. Through intercalated disks provide both mechanical and metabolic (mainly ionic) bond cardiomyocytes.

Contractile cardiomyocytes of the atria and ventricles are somewhat different from each other in morphology and function. Thus, atrial cardiomyocytes in the sarcoplasm contain fewer myofibrils and mitochondria, they hardly expressed the T-tubules, and instead under plasmolemma identified a large number of vesicles and caveolae - analogues of the T-tubules. In addition, in the sarcoplasm of atrial cardiomyocytes in nuclear poles localized specific atrial granules consisting of glycoprotein complexes. Standing out from the atrial cardiomyocytes in blood, these substances affect the level of blood pressure in the heart and blood vessels, as well as prevent the formation of blood clots in the atria. Therefore, atrial cardiomyocytes than contractility, possess and secretion. In ventricular cardiomyocytes are more pronounced contractile elements, and secretory granules are absent.

The second type of cardiomyocytes - atypical form cardiomyocytes conducting system of the heart, consisting of: sine-atrial node, atrioventricular node, atrioventricular bundle (bundle branch block), trunk, right and left legs, terminal branches of the legs - Purkinje fibers.

Atypical cardiomyocytes provide generation biopotential their holding and transfer on contractile cardiomyocytes.

The morphology atypical cardiomyocytes differ from the typical number of features: they are larger (length 100 mm, thickness 50 mm) in the cytoplasm contains few myofibrils, which are disordered and therefore atypical cardiomyocytes have transverse striations; cytolemma not form the T-tubules, in the intercalary drives between these cells and no desmosomes slit contacts.

Atypical cardiomyocytes various parts of the conducting system differ in structure and function and can be divided into three main types:

- P-cells (pacemakers) - pacemakers (I type);
- transitional cell (II type);
- cell bundle of His and the Purkinje fibers (III type).

Type I cells (P-cells) are the basis of sine-atrial node, and a small amount contained in the atrioventricular node. These cells are able to

self-generate a certain frequency biopotentials and transfer them to the transitional cells (II type), and the last transmit impulses to the cells of type III, from which biopotentials transferred to the contractile cardiomyocytes.**Sources of cardiomyocytes** - myoepithelial plates, which are certain areas of visceral splanchnotome sheets, and more specifically from the coelomic epithelium of these sites.

Innervation of the heart muscle

Biopotentials contractile cardiomyocytes derived from two sources:

-Conducting system of the heart (especially from sine-atrial node);

-Of the autonomic nervous system (from its sympathetic and parasympathetic parts).

Regeneration of cardiac muscle tissue

Cardiomyocytes recovered only by intracellular type. Cardiomyocyte proliferation was observed. Cambial elements in the cardiac muscle lacking. With the defeat of large areas of the myocardium (eg, myocardial infarction) restoration of the defect is due to the proliferation of connective tissue and scarring (plastic regeneration). Naturally, the contractile function in these parts is missing. Lesions are accompanied by a rhythm disturbance of the heart contractions.

Smooth muscle tissue

The overwhelming majority of the smooth muscle tissue of the body (internal organs and blood vessels) has mesenchymal origin.

Structural and functional unit of the smooth muscle tissue of internal organs and blood vessels is a myocyte. Is the most commonly spindle cell (20-500 microns in length, with a diameter 8.5 mm), covered on the outside of the basal lamina, but meet and process myocytes. In the center elongated nucleus, which are located at the poles common organelles: granular endoplasmic reticulum, a plate complex, mitochondria. The cytoplasm contains a thick (17 nm) of myosin and thin (7 nm) actin myofilaments, which are generally parallel to each other along the axis of the myocyte, or form A and I drive, which explains the lack of cross-striation myocytes. In the cytoplasm of muscle cells and the inner surface plasmolemma are numerous dense bodies, which are attached to actin, myosin, as well as intermediate filaments. Cytolemma forms small depth - caveolae, which are regarded as analogues of the T-tubules. Under plasmolemma localized numerous vesicles, which together with thin cytoplasmic tubules are part of the sarcoplasmic reticulum.

The mechanism of reduction in myocytes, in principle, similar to the reduction of sarcomeres in myofibrils in skeletal muscle fibers. He is due to the interaction of actin and sliding along myosin myofilaments. For such cooperation is also needed energy in the form of ATP, and the presence of calcium ions biocapacity. Biopotentials come from efferent autonomic nerve fiber endings directly on myocytes or indirectly from neighboring cells through slit contacts and transmitted via caveolae to the elements sarcoplasmic reticulum, causing the egress of calcium ions into the sarcoplasm. Under the influence of calcium ions develop mechanisms of interaction between actin and myosin filaments, similar to those that occur in the sarcomere of skeletal muscle fibers, resulting in a sliding movement of these myofilaments and dense bodies in the cytoplasm. In myocytes, except actin and myosin filaments are more intermediate, which at one end attached to the cytoplasmic dense bodies, and others - to attach to the calves on plasmolemma and so is the effort of interaction of actin and myosin filaments in the myocyte sarcolemma, and this is achieved by shortening it.

Myocytes surrounded the outside of loose fibrous connective tissue - endomysium and related to each other side surfaces. Thus, in close contact neighboring myocytes basal plate interrupted. Myocytes plasmolemm contact directly and in these places are slotted contacts through which the ionic bond and the transfer of biocapacity from one myocyte to another, which leads to the simultaneous and friendly reduction. Chain myocytes combined mechanical and metabolic coupling is functional muscle fiber. In the endomysium are capillaries that provide trophic myocytes, and in strata of connective tissue between the beams and layers of myocytes in perimizii are larger vessels and nerves, as well as vascular and nerve plexus.

Efferent innervation of the smooth muscle tissue by the autonomic nervous system. In this case, the terminal branches of the axons of the efferent autonomic neurons, passing over the surface of several myocyte make them small varicose thickening that some sag plasmolemm and form synapses. When you receive nerve impulses in the synaptic cleft allocated neurotransmitters (acetylcholine and norepinephrine), and determine the myocyte membrane depolarization and subsequent reduction. Through slit contacts biopotentials pass from one to another myocyte, accompanied by the excitation and contraction, and those of smooth muscle cells, which do not contain nerve endings. The excitation and contraction of myocytes usually are long and provide a tonic

contraction of smooth muscle of blood vessels and hollow organs, including the smooth muscle sphincter. These organs are numerous receptor endings in the form of bushes, trees or diffuse fields.

Regeneration of the smooth muscle tissue in several ways:

-By intracellular regeneration hypertrophy in the amplification of functional load;

-By mitotic division of myocytes during inflammation (reparative regeneration);

-Through differentiation from cambial elements - from adventitial cells and myofibroblasts

The clinical significance

Myasthenia gravis) is anfight autoimmune disease that is characterized by increasing muscle weakness caused by the decrease in the number of functional but active acetylcholine receptors on sarkolemms at the neuromuscular junction. This decrease is caused by circulating antibodies that bind to receptors between nerve and muscle. The body tries to correct this condition, and with the affected segments of the membrane receptors are trapped inside sarkoplazm, we digested and replaced by newly formed lysosomal receptors. These recipes, however, once again lose their sensitivity to acetylcholine due to the interaction with the same antibody, and the disease continues to progress

The practical part

Compilation of logical structures, the study of drugs and smooth cross-striated muscle tissue and a sketch of the principles of their structure in the albums.

The objects under study: 1.Gladkaya muscle tissue of the small intestine. 2.Skeletnaya transversely striped muscle tissue.

Sample test items

1. What is the specific inclusion of the substance of muscle fibers of skeletalmuscle tissue?

a) glycogen;
b) melanin;
c) lipids;
d) myoglobin.

2. What are the components of the sarcomere?

a) half of disk I, drive A and drive another half I;

b) the disk drive A and I;
c) a disc and a half disc I;
d) disc 1 and a half drive AD Half A disk, the disk I and another half drive A.

3. What proteins is part of the myofibrils?

a) myosin;
b) actin;
c) keratin;
d) collagen.

4. In what way is the spread of excitation along the muscle fiber?

a) by tsitolemmy;
b) by sarkotubulyarnoy system;
c) by cytoplasmic granular network;
d) in tsitolemmy and sarkotubulyarnoy system;
e) by microtubules.

5. What are the signs of skeletal muscle tissue?

a) formed cells;
b) cores are arranged along the periphery;
c) they consist of muscle fibers;
d) has only intracellular regeneration;
e) develops from myotome.

6. Which of the following is NOT an organelle found in cardiomyocytes?

a) organelles common values;
b) tonofibrils;
c) neurofibrils;
d) myofibrils.

Approximate refereed report on "Age characteristics of muscle tissue"

5.9. Nervous tissue

I. Goals and Objectives:

To investigate the function of development and nerve tissue structure

II. Questions for self-control students:

1. The concept of nervous tissue.

2. Sources of neural tissue.
3. Classification and types of nerve tissue.
4. Neuron.
5. Types of neuronal function.
6. The nerve endings.
7. Age characteristics of nervous tissue.
8. The clinical significance.

The theoretical part

Nervous tissue

The value of the nerve tissue in the body is determined by the basic properties of nerve cells (neurons neurocytes) irritable, get excited, generate momentum and pass it on. Nervous tissue regulate the activity of tissues and organs, their relationship and connection with the environment.

Nervous tissue is composed of neurocytes performing a specific function, and neuroglia ensuring the existence and the specific function of nerve cells and performing basic, food chains, dividing, secretory, and protective functions. Feature of the nervous tissue is the complete absence of intercellular substance.

Development of nervous tissue

Nervous tissue develops from the dorsal ectoderm thickening - the neural plate. Edge of the plate and lifted thicken as the neural folds, between the neural groove. Then the neural folds and merge, with the neural plate into the neural tube closes and separates from the overlying epidermal ectoderm it. Some of the cells of the neural plate is located between the epidermal ectoderm and the neural tube, in the form of loose clusters of cells - neural crest. Cephalic crest cells involved in the formation of the nuclei of the cranial nerves, the second source of which are the neural placode. In the trunk region crest cells divide into two flow cells. One of them, the surface is distributed between the ectoderm and mesoderm and gives rise to the pigment cells of the skin. Another goes deep and ventrally, passing between the somites and the neural tube, and between mesenchymal cells, which are evicted from the somites.

These cells form neurons of spinal ganglia and ganglia of the autonomic nervous system and neuroglia - lemmotsits. Placodes called neural ectoderm thickening on the sides of the head. They are involved in the formation of ganglion 5, 7, 9, 10 pairs of cranial nerves.

Neural tube in the early stages of embryogenesis is a pseudostratified neuroepithelium presented ventricular and neuroepithelial cells. Morphologically similar, ventricular cells are heterogeneous in their ability to differentiate into various cell types of the mature nervous tissue. Some of them give rise to neuroblastoms, other glial cells: ependimocyts, astrocytes. Glial cells throughout their life, as opposed to neurocytes retain high proliferative activity. As the differentiation of neuroblast changes submicroscopic structure of its nucleus and cytoplasm. At the core there are different parts of the electron density in the form of grains and fibers. The cytoplasm revealed a large number of canals and tanks endoplasmic reticulum, reduces the number of free ribosomes and polysomes, well developed Golgi complex reaches. Specific signs of early specialization of nerve cells should be considered as the appearance in the cytoplasm of thin fibrils - beams neurofilaments and microtubules. Number of neurofilaments in the process of specialization increases. Neuroblast body gradually becomes pear-shaped, and from its pointed end is beginning to develop otrostokakson. Neuroblasts into mature nerve cells - neurons. Between neurons establish synaptic contacts

The structure of the neurons neurocytes

Neurons, or neurocytes, different parts of the nervous system is significantly different from each other according to the functional value and morphological features.

Depending on the function of neurons are divided into:

- **Receptor** (sensitive, afferent) - generate a nerve impulse in response to various external or internal environment;

- **Intercalary** (associative) - provide various connections between neurons;

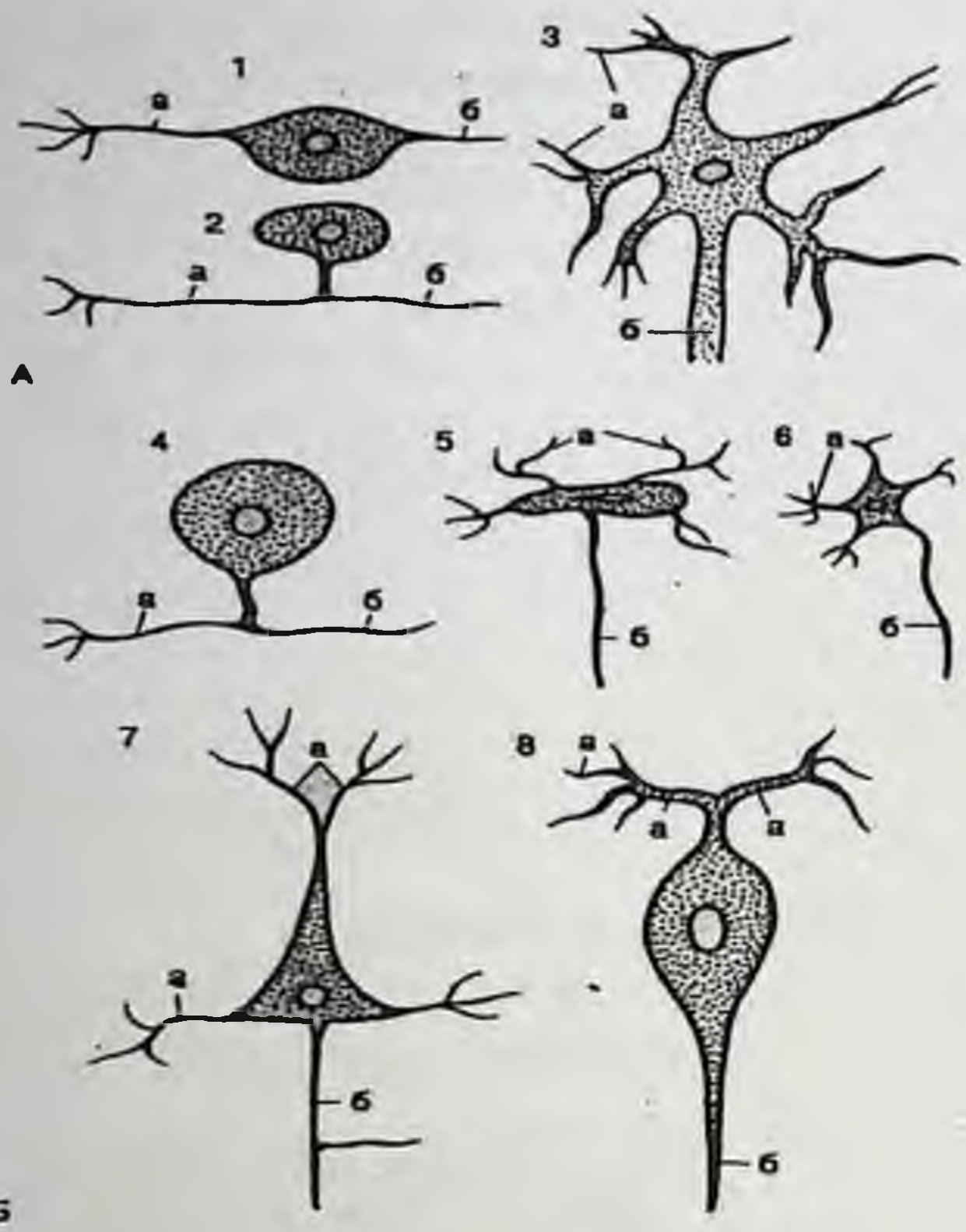
- **Effector** (efferent, motor) - convey excitement on the fabric of the workers, encouraging them to take action.

The characteristic feature of mature neurons is that they have branches. These processes provide a nerve impulse to the human body from one part to another, sometimes very remote and because of their length vary within wide limits - from a few micrometers to 1-1.5 m

According to the functional value of the processes of neurons are divided into two types. Some act as lead of a nerve impulse is usually the bodies of neurons are called axons or neuritis.

Neurite ends terminal unit or on another neuron, or working body tissues, muscles, glands.

The second type of nerve cells called dendrites. In most cases, they are highly branched, and this is determined by their name. Dendrites conduct impulses to the body of a neuron.



Picture-101. **Morphological classification of neurons. A) by the number of processes b) the structure of cells:** 1-psevdounipolar; 2-bipolar; 3-multipolar; 4-round; 5-spindly; 6-stellate; 7-pyramid; 8-bullet: a) dendrite b) axon.

According to the number of processes neurons are divided into three groups:

- Unipolar - cells with a single process;
- Bipolar - cells with two processes;
- Multipolar - cells having three or more (pic-101).

Multipolar cells are most common in mammals and man. Of the many processes of the neuron represented one of neurites, while the rest are dendrites

Multipolar cells are most common in mammals and man. Of the many processes of the neuron represented one of neurites, while the rest are dendrites.

Bipolar cells have two branches - neurite and dendrite. True bipolar cells in the human body are rare. These are some of the cells of the retina, the spiral ganglion of the inner ear, and others. However, the substance of his buildings to bipolar cells should be attributed a large group of afferent neurons in the so-called psevdounipolaric cranial and spinal ganglia. Psevdounipolaric they are called because neurite and dendrites of these cells begins with an outgrowth of the body, creating the impression of a single process, followed by a T-dividing it.

True unipolar cells, with a process - axons in the human body is not present.

Human neurons in most contain one core, located in the center, at least - eccentric. Binuclear neurons and the more multi-are extremely rare, such as neurons in the prostate and cervix. The shape of the nuclei of neurons round. According to the high metabolic activity of chromatin in their nuclei dispersed. The kernel has one, and sometimes two and three large nucleolus. In accordance with the high specificity of the functional activity of neurons, they have dedicated plasmolemma, their cytoplasm is rich in organelles. In the cytoplasm, a well-developed endoplasmic reticulum, ribosomes, mitochondria, Golgi apparatus, lysosomes, neyrotubuls and neurofilaments.

Cytolemma neurons, except for the function, which is typical for any tsitolemmy cells, characterized by the ability to carry out agitation. The essence of the process is reduced to the rapid movement of the local depolarization plasmolemma on its dendrites and axons to perikarion.

The abundance of granular endoplasmic reticulum in neurocytes corresponds to a high level of synthetic processes in the cytoplasm and, in particular, the synthesis of proteins required for borrowing their masses perikarions and processes. For axons without organelles that synthesize protein, typical DC cytoplasm of perikariones to terminals at 1-3 mm per day. It is a slow current, bearing proteins such as enzymes needed for the synthesis of neurotransmitters in the axon terminals. In addition, there is a fast current (5-10 mm per hour), conveying the main components required for synaptic function. In addition to current emissions from perikariona to the terminal axons and dendrites observed opposite (retrograde), the current through which a number of compo-

nents of the cytoplasm of the terminations back to the cell body. The transport of substances by spikes neurocytes involved endoplasmic reticulum, limited membrane vesicles and granules, microtubule cytoskeleton and aktinomiozin system.

Golgi apparatus in nerve cells is defined as the accumulation of different shapes of the rings, twisted yarn, pearls. Cell center often located between the nucleus and dendrites. Mitochondria are located in the body of the neuron, and in all the sprouts. Particularly rich in mitochondria in the cytoplasm neurocytes terminal apparatus processes, particularly in the synapses.

Neurofibrils. With silver impregnation of nerve tissue in the cytoplasm of neurons identified neurofibrils, forming a dense network perikarion cells and oriented parallel to the structure of dendrites and axons, including their finest terminal branches. Using electron microscopy, which correspond neurofibrilla neurofilament bundles 6-10 nm in diameter and neyrotubul (neyrotrubochek) with a diameter of 20-30 nm, located in perikarion and dendrites between chromatophilic clumps and oriented parallel to the axon.

Secretory neurons

Ability to synthesize and secrete biologically active substances, such as neurotransmitters, common to all neurocytes. However, there neurocytes, specialized mainly for that function - secreting neurons, such as the cell nucleus neurosecretory hypothalamic region of the brain. Secretory neurons have a number of specific morphological characters:

- Secreting neurons - a large neurons;
- In the cytoplasm of neurons and axons are different size granules secret - neurosecretion containing protein, and in some cases, lipids and polysaccharides;
- Many secretory neurons have a nucleus of irregular shape, which indicates their high functional activity.

Neuroscience

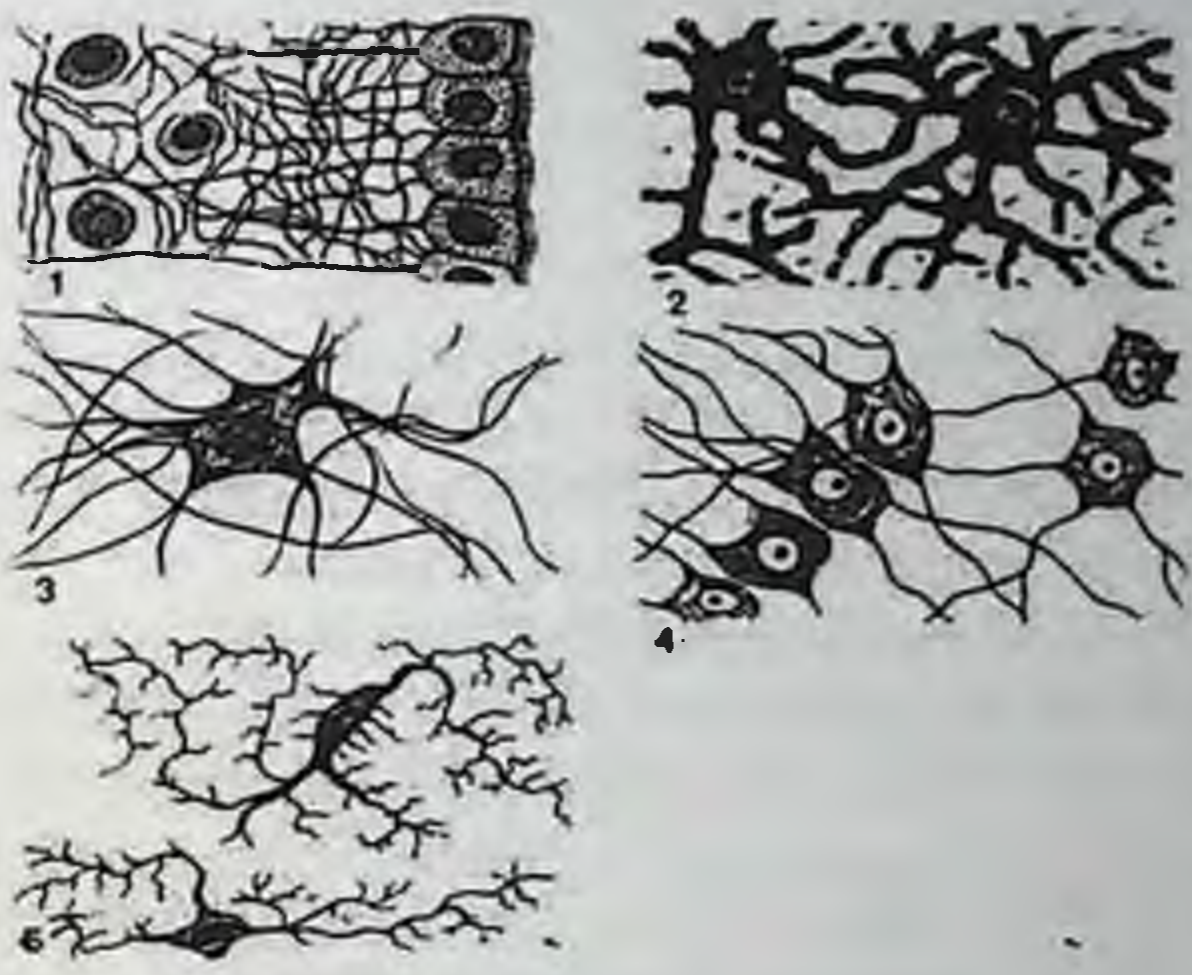
Classification of neuroglia: macroglia (gliocytes) ependimotsit, astrocytes, oligodendrocytes, microglia. (98-rice)

Ependimotsity form a dense layer of cell elements lining the spinal canal and all of the ventricles of the brain (Figure 99). Ependimotsity covering the choroid plexus of the ventricles of the brain, the cubic form. Babies they have cilia on their surface, which later reduced. The

main function is ependimotsites the formation of cerebrospinal fluid and the regulation of its composition.

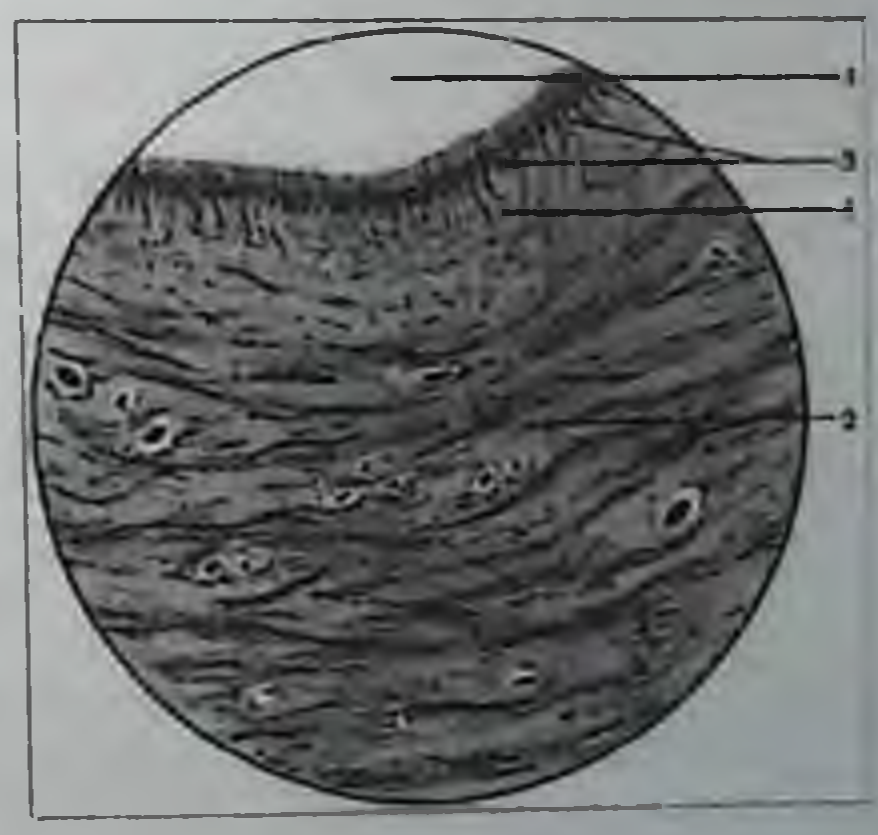
Astrocytes form a support unit of the central nervous system (Figure 100). They are small cells with numerous diverging in all directions spikes. There are two types of astrocytes:

- Protoplasmic
- Fibrous.



Picture-102. **Types of neuroglia** (glial cells) (by T.A.Radostinoy and L.N.Rumyantsevoy): 1-ependimogliotsits; 2-protoplasmic astrocytes; 3-fibrous astrocytes; 4-oligodendrogliotsity; 5-microglia (mikrogliotsits).

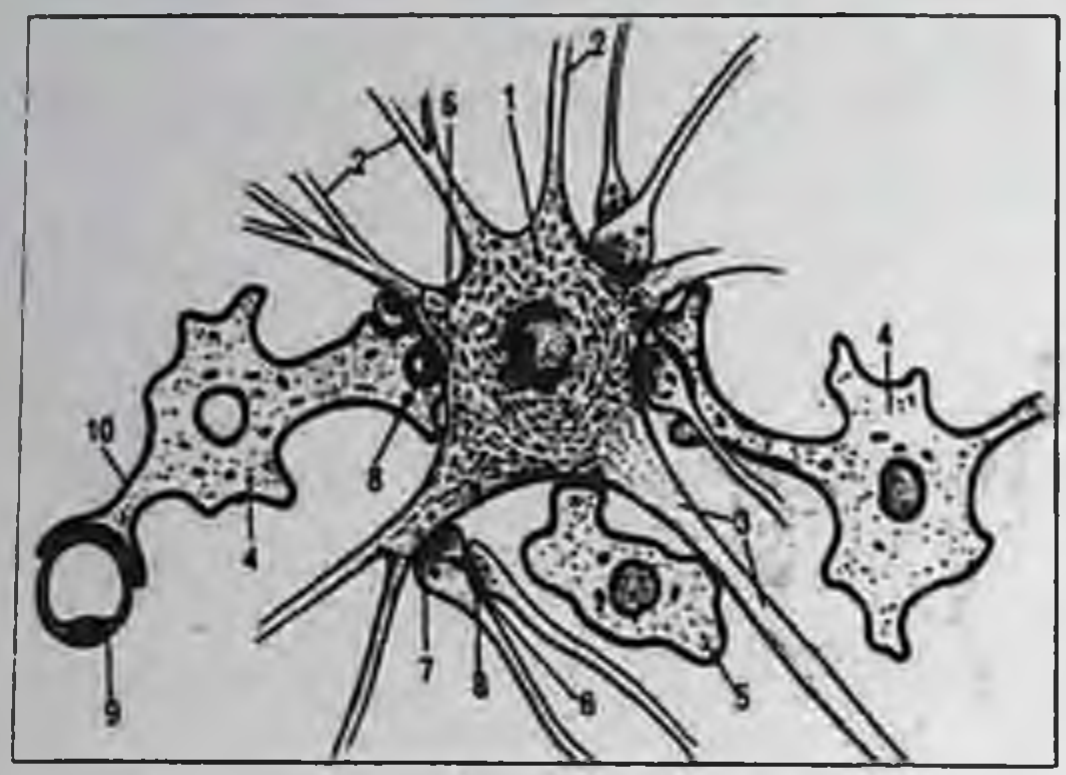
Protoplasmic astrocytes are located mainly in the gray matter of the central nervous system. They are characterized by a large round nuclei and numerous highly branched short processes. Protoplasmic astrocytes are dividing and trophic functions.



Picture-103. **Ependymal neuroglia.** 1-center channel; 2-gray matter of the spinal cord; 3-ependymal cells; 4-processes ependymal cells.

Fibrous astrocytes are found mainly in the white matter of the brain. These cells, long, processes that form the glial fibers, which together form a dense network - does

the product of the brain. Processes of astrocytes on the blood vessels on the surface of the brain and its terminal extensions form perivascular glial limiting membrane.



Picture-104. **Astrocytes**
(by G.R. Nobaku etc.).
1-the body of a neuron; 2-dendrite; 3-axon; 4-astrocyte; 5-aksoaksalny synapse; 6-oligodendrotsit; 7 - aksosomatic synapse; 8-aksodendritic synapse; 9-capillary; 10-foot prevaskularic astrocytes.

The main function of astrocytes - support neurons and isolation from external influences, it is necessary to implement the specific activity of neurons.

Oligodendrocytes - is the largest group of cells of the neuroglia. They surround the bodies of neurons in the central and peripheral nervous system, is composed of membranes of nerve fibers and nerve endings.

In different parts of the nervous system oligodendrocytes have a different shape and are represented by three species:

- Mantle cell, they form different structures in the nervous tissue;
- Lemmotsits, they surround nerve cell, creating covers of myelin structures (pic 105);
- End, they are located at the end of the process - end glial components, such as encapsulated nerve endings in the papillary dermis.

Microglia - the cells aliens, it is assumed that they have promonotsitic origin, that is, from the bone marrow. Microglia are glial macrophages, they are small, mostly forms capable of amoeboid movement. So on the surface of microglia, there are 2-3 larger process, which in turn are divided into secondary and tertiary branches. As part of the microglia are all organelles, but the most active lysosomal apparatus. During stimulation of microglial cells change their shape, appendages drawn, cells acquire specific, rounded. As such, they are called granular balls.

The nerve fibers

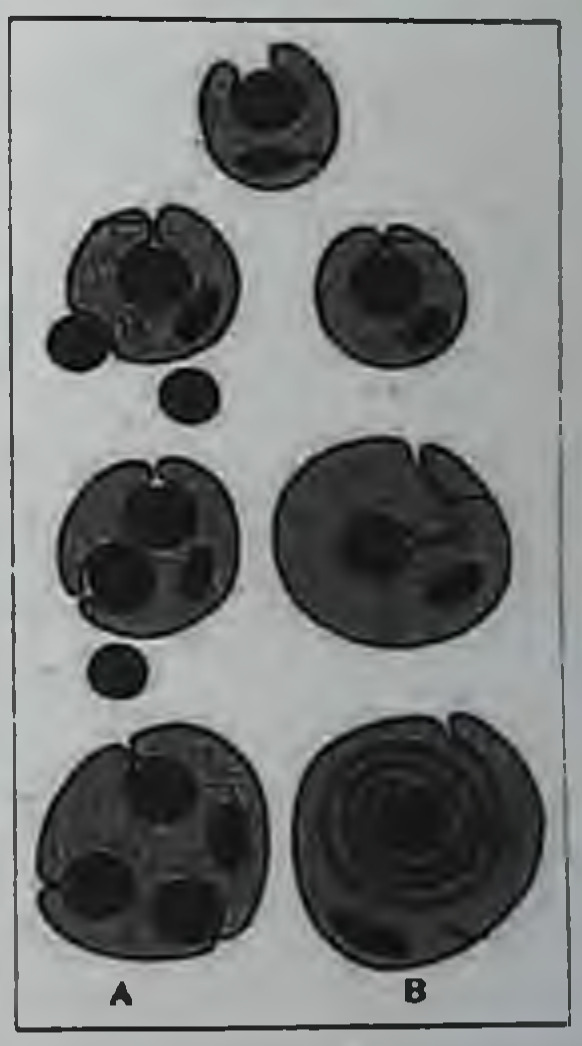
Nerve cell, usually covered with shells, called nerve fibers. In various parts of the nervous system membranes of nerve fibers are significantly different from each other in structure, so in accordance with the

characteristics of their structure, all nerve fibers are divided into two main groups: **the myelin and amyelinate**. Both are made up of the nerve cells, which is at the center of the fiber and is therefore called axons, and the shell formed by oligodendroglial cells, which are called neyrolemmotsitami (Schwann cells).

Myelinated nerve fibers are found in both the central and the peripheral nervous system. They are much thicker amyelinate nerve fibers. Cross-sectional diameter of between 1 and 20 microns. They also consist of axons, "dressed" sheath neyrolemmotsits, but the diameter of the axons of this type of fiber is much thicker and harder shell.

In myelinated fibers formed to distinguish between two layers of membranes: the inner, thicker myelin layer and an outer, thin, consisting of cytoplasm and nuclei neyrolemmotsits - neyrolemm.

Myelinated fiber is a uniform cylinder in which a certain distance from each other are bright-line incision myelin. At intervals there are areas of fibers, devoid of myelin layer - nodal interceptions - nodes of Ranvier. Intercepts correspond to the boundary adjacent neyrolemmotsits. The length of fibers, enclosed between adjacent interceptions, called cross-site segment, and its shell is represented by a glial cell (101, 102, 103.104, Fig.). In the development of the myelin fiber axons, plunging into neyrolemmotsit, bends its surface, forming a deep furrow, which generate mezakson.



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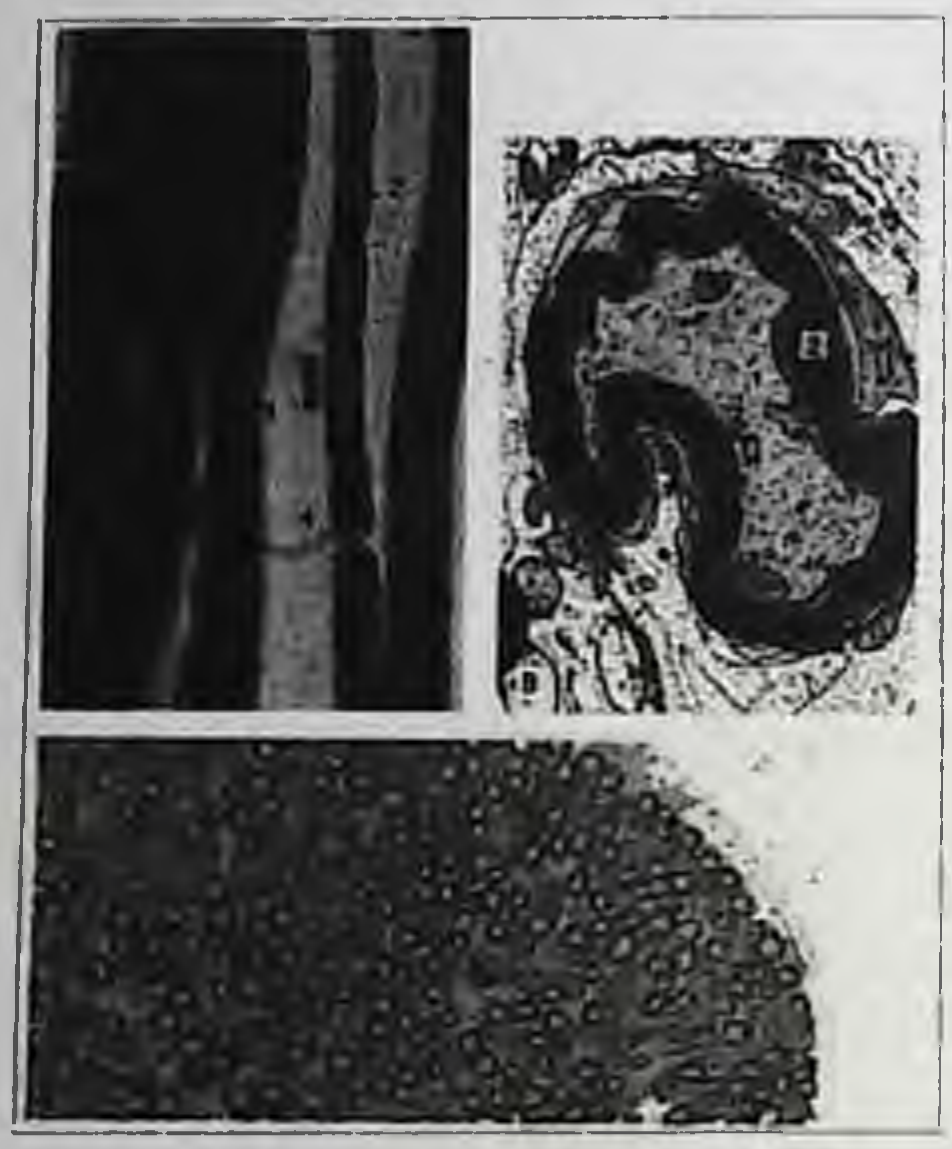
With further development mezakson extended concentrically superimposed on the axial cylinder and forms a dense layered around the area - a layer of myelin. Outer layer (neyrolemm) called peripheral zone of nerve fibers containing Pushback here neyrolemmotsits cytoplasm (Schwann cells) and their nuclei.

Axons of nerve fibers consists of neuroplasm - cytoplasm of a nerve cell that contains longitudinally oriented neurofilaments and neyrotubuly. In neuroplasm axons are mitochondria, which are more close to the interception and especially a lot of machines in the terminal fibers. On the surface of the membrane is coated cylinder axis - axolemma providing nerve impulse. The pulse rate myelin fibers than amyelinate. Thin fibers, and myelin-poor amyelinate fibers conduct nerve impulses at a rate of 1-2 m / s, while the thick myelinated fibers at a rate of 5-120 m / s/.



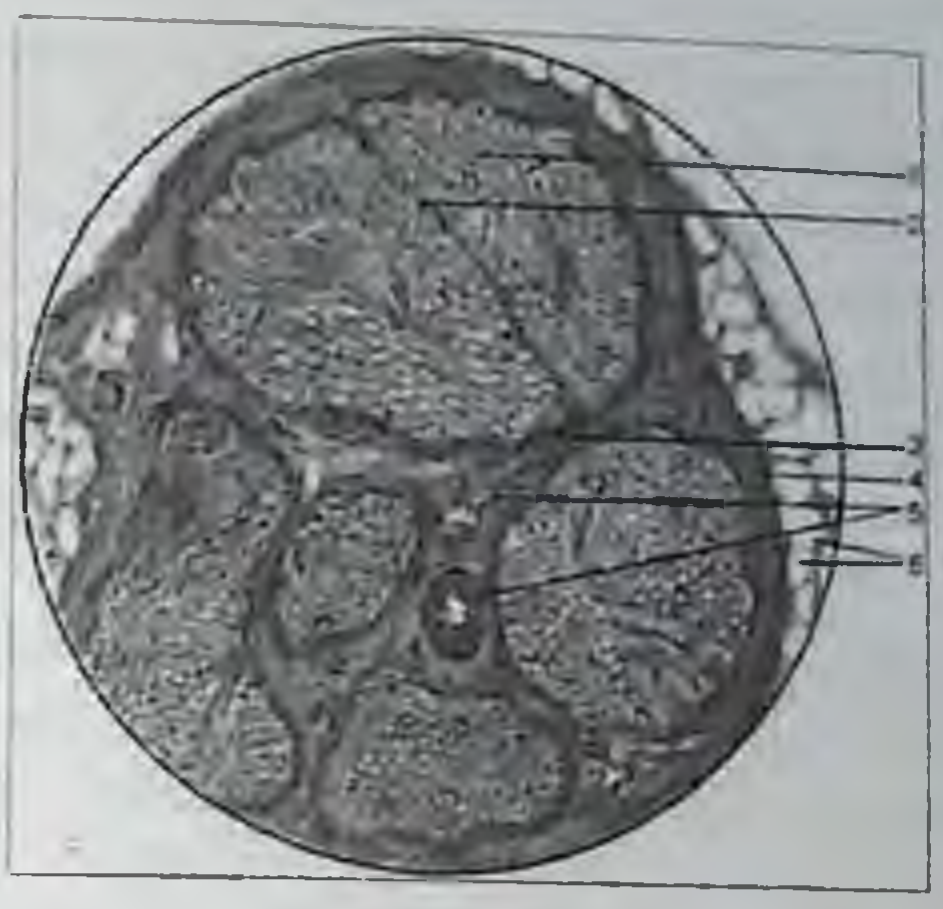
Picture-106. **Myelinated fiber. The formation and structure of the myelin sheath of:** A, B-nerve fiber.
B-structure of myelin fibers:
1-cytoskeleton; 2-myelin sheath;
3 nodes of Ranvier.

The top is covered with nerve connective tissue sheath-epimiziem (epineurium), which is rich in blood vessels, multiple fiber bundle perimiziem (perinevriem). Perimizy enters the fibers and forms-endomysium endoneurium (103-rice).

Remak's fiber located primarily in the autonomic nervous system. Oligodendroglial cells amyelinate membranes of nerve fibers, situated close to form strands, which at a certain distance from each other prominent oval nuclei. In the nerve fibers of the internal organs, as a rule, in that heavy is not one but a number (10-20) of the axons belonging to different neurons.

They can, leaving a single fiber, move to an adjacent, such fibers containing multiple axons, called fiber cable type. Electron microscopy amyelinate nerve fibers can be seen that as the immersion of the axons in the last strand lemmotsits wear them as a clutch. Lemmotsitov shell

with flex, tightly cover the axons, and bound up on them, have deep wrinkles, and at the bottom of which are individual axons.

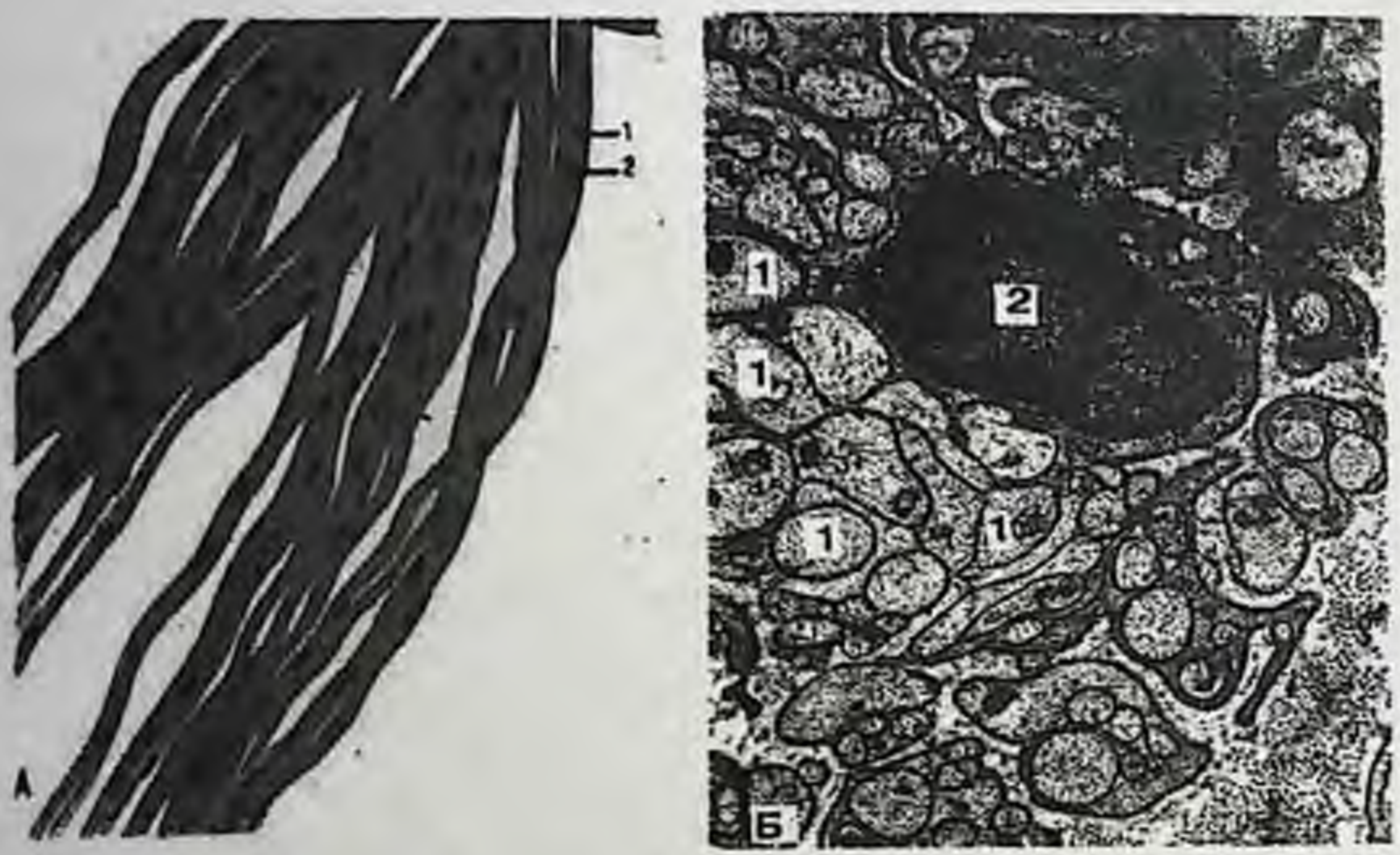


Picture-106. **Myelin (myelinated) nerve in cross-section.** 1-myelinated nerve fibers; 2-endoneurium; 3 –perinevry; 4-epineurium; 5-blood vessels; 6-fat cells.

Picture-107. **Oligodendro-gliacyte and myelin formation.** 1-oligodendrogliotsit; 2-nerve fiber; 3-cytoplasm oligodendrogliotsit; 4-akson; 5-perechvat Ranvier.

Convergence in the areas of membrane folds neyrolemmotsit form dual membrane - mezakson, which, as it were suspended axial cylinder. Neyrolemmotsits very thin shell, so no mezakson, or boundaries of the cells under a light microscope can not be considered, and the shell amyelinate nerve fibers in these conditions is detected as a homogeneous bundle cytoplasm, "dressing" of the axons. On the surface of each nerve fiber is covered with a basement membrane.

In amyelinate fiber (PIC108), a wave of depolarization of the membrane is around plasmolemm without interruption, and in myelinated fibers occurs only in the intercept. Thus, for myelinated fibers characteristic saltatory conduction of excitation, that is leaps. Between interceptions on axolemm an electrical current, the speed of which is higher than the passage of a wave of depolarization.



Picture-108. **Remak's fiber.** A) general view
B) cross-section of: 1-axon. 2-core lemmotsites.

Regeneration of neurons and nerve fibers

Neurons are irreplaceable cell population. They are characterized only intracellular physiological regeneration, is in continuous change of the structural proteins of the cytoplasm.

Processes of neurons in the peripheral nerves and thus have the ability to regenerate if damaged. In this case, the regeneration of nerve fibers preceded the phenomenon of degeneration. Neyrolemmotsits peripheral fiber segment in the first day becomes more active. In the cyto-

plasm neyrolemmotsits increases the number of free ribosomes and polysomes, endoplasmic reticulum. In the cytoplasm neyrolemmotsites a significant amount of spherical layer structures of various sizes. Myelin layer as a separate zone neyrolemmotsit disappears. Within 3-4 days neyrolemmotsits significantly increased in volume. Neyrolemmotsits rapidly multiply, and by the end of the 2nd week of myelin and axons particles dissolve. In resorption products involved as glial elements and connective tissue macrophages.

Axons of the central segment of fibers form a club-shaped ends of the expansion - the bulb growth and growing into the Ribbon located neyrolemmotsits peripheral nerve segment and grow at a rate of 4.1 mm per day. Slowing the growth of nerve fibers in the terminals. Later there myelination of nerve fibers and restoration of terminal structures.

The nerve endings

All nerve fibers end terminal devices, which are called nerves.

According to the functional value of the nerve can be divided into three groups:

- Effector (effectors);
- Receptor (affektornic or sensitive) (pic. 110)
- End machines, generators interneuron synapses, neurons are communicating with each other.

Effector nerves are two types:

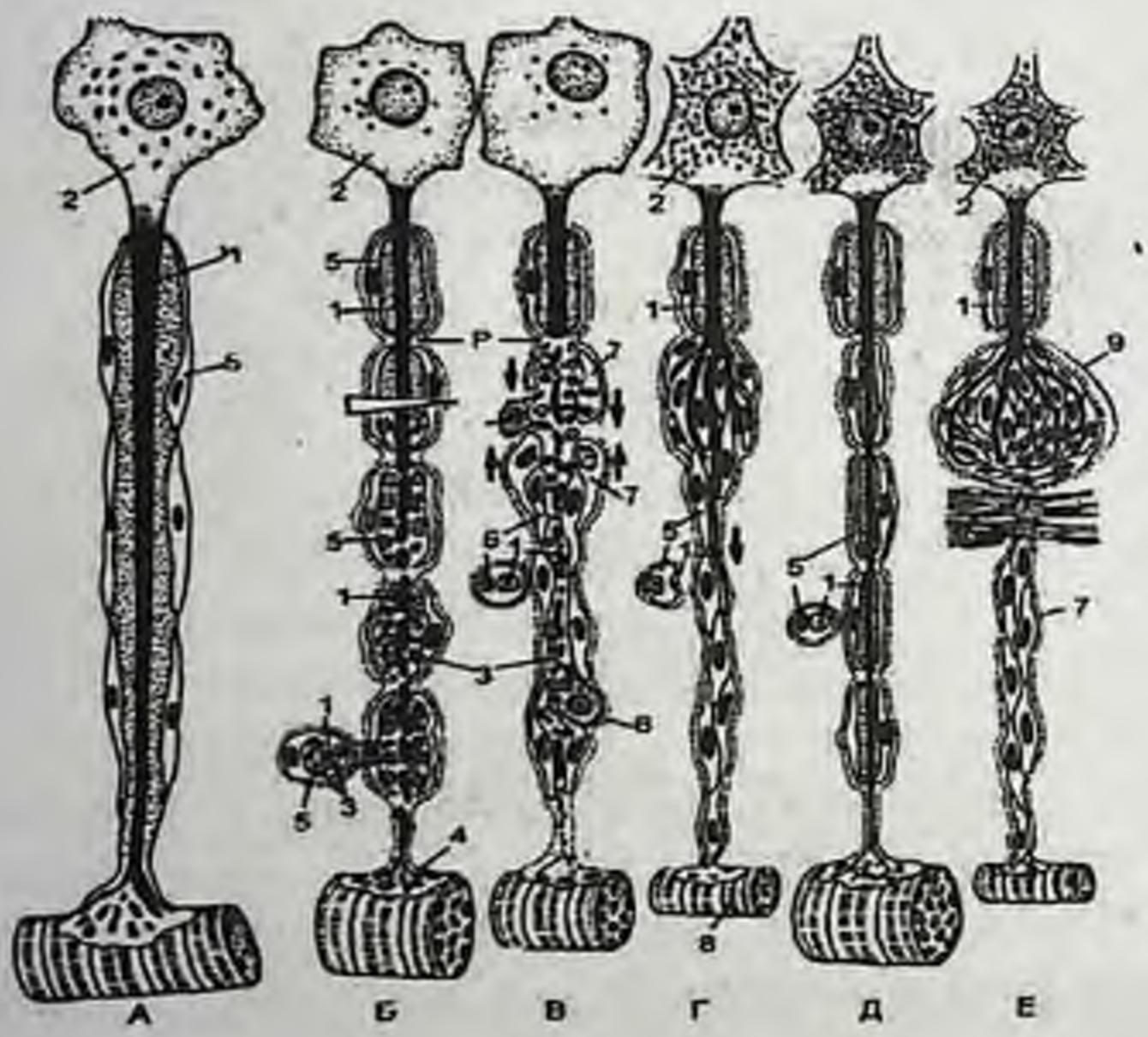
- Motor
- And secretory.

Motor nerve endings - this terminal devices of motor axons of cells of somatic or autonomic nervous system. With their participation nerve impulse is transmitted to the fabric of working bodies. Motor endings in striated muscles called neuromuscular endings (motor plaque). They represent the end of the axon cell motor nuclei anterior horn of the spinal cord or motor nuclei of the brain. Neuromuscular end consists of a terminal branch of the axons of the nerve fibers and specialized area of muscle fibers. Myelinated fiber going to the muscle fiber loses myelin layer and immersed in a muscle fiber, involving entail its plasmolemm. Connective tissue elements in this transition is the outer layer of the muscle fiber membrane. Plasmolemm terminal branches of the axon and the muscle fibers are separated by synaptic cleft width of about 50 nm (107-rice).

In the end of the muscle fiber has a typical cross-striation and is characterized by an abundance of mitochondria, the accumulation of

round or slightly oval nuclei. Sarcoplasm with mitochondria and nuclei together form the postsynaptic part of the synapse. Terminal branches of the nerve fibers in the synapse characterized by an abundance of mitochondria and numerous presynaptic vesicles containing typical for this kind of endings neurotransmitter - acetylcholine. When excited by acetylcholine enters through presynaptic membrane into the synaptic cleft to the postsynaptic cholinergic receptors (muscle) membrane, causing its excitation (wave of depolarization).

Postsynaptic membrane of motor nerve terminal contains the enzyme, which destroys the mediator and limited to its validity. Motor nerve endings in smooth muscle tissue built easier. Here, thin axon bundles or single terminal, followed between muscle cells form a beaded extension (varices) containing cholinergic and adrenergic presynaptic vesicles. **Secretory nerve** endings have a simple structure and ends in iron. They represent the end bud, or lenticular expansion fiber synaptic vesicles containing mainly acetylcholine.



Picture-109. **A - normal nerve fiber. BV-damaged nerves fibers over 2 weeks. T-3 weeks after D-3 through the month. E-breaking growth of axons and scar formation:** 1-axis-tsilindr; 2-perikarion; 3-fragmentation of the myelin sheath and the formation of fat cells; 4-motor blyashka; 5-cells Shvanna; 6-mikrogliya; 7-mitosis in Schwann cells and the formation of Byungnera tape; 8-muscle fiber; 9-amputation neuroma.

Receptor nerve endings

The main function of the afferent nerve endings is the perception of the signals coming from the external and internal environment. Receptor - a terminal dendrite branching sensitive (receptor) of the nerve cell.

Classification of receptors

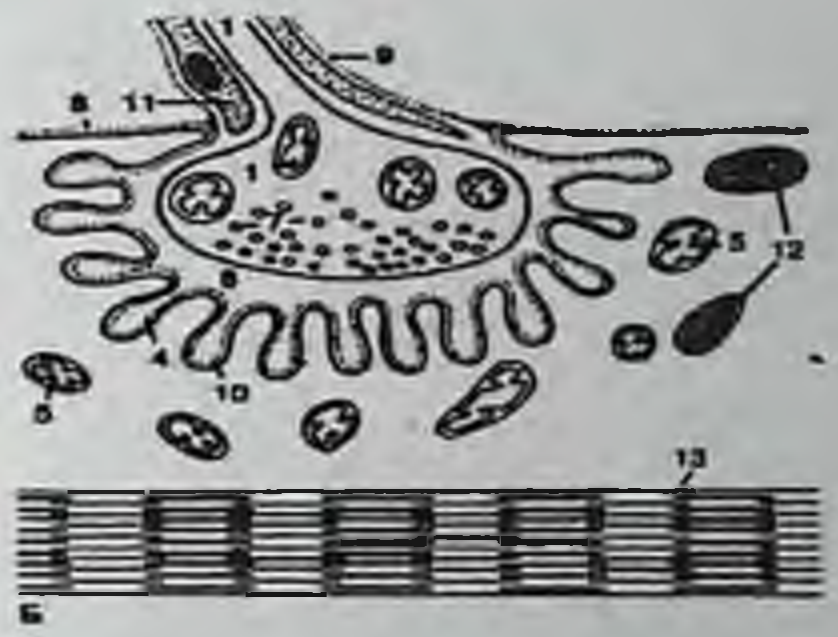
By origin:

- Neurosensory - neural source of origin, is a receptor neurons - primary sensory;

- Sensoepitelial - have no neural origin, are specialized cells that are able to perceive irritation - secondarily sensitive, such as encapsulated and non-encapsulated nerve endings.

By localization: exteroceptor; interoreceptors; proprioceptors.

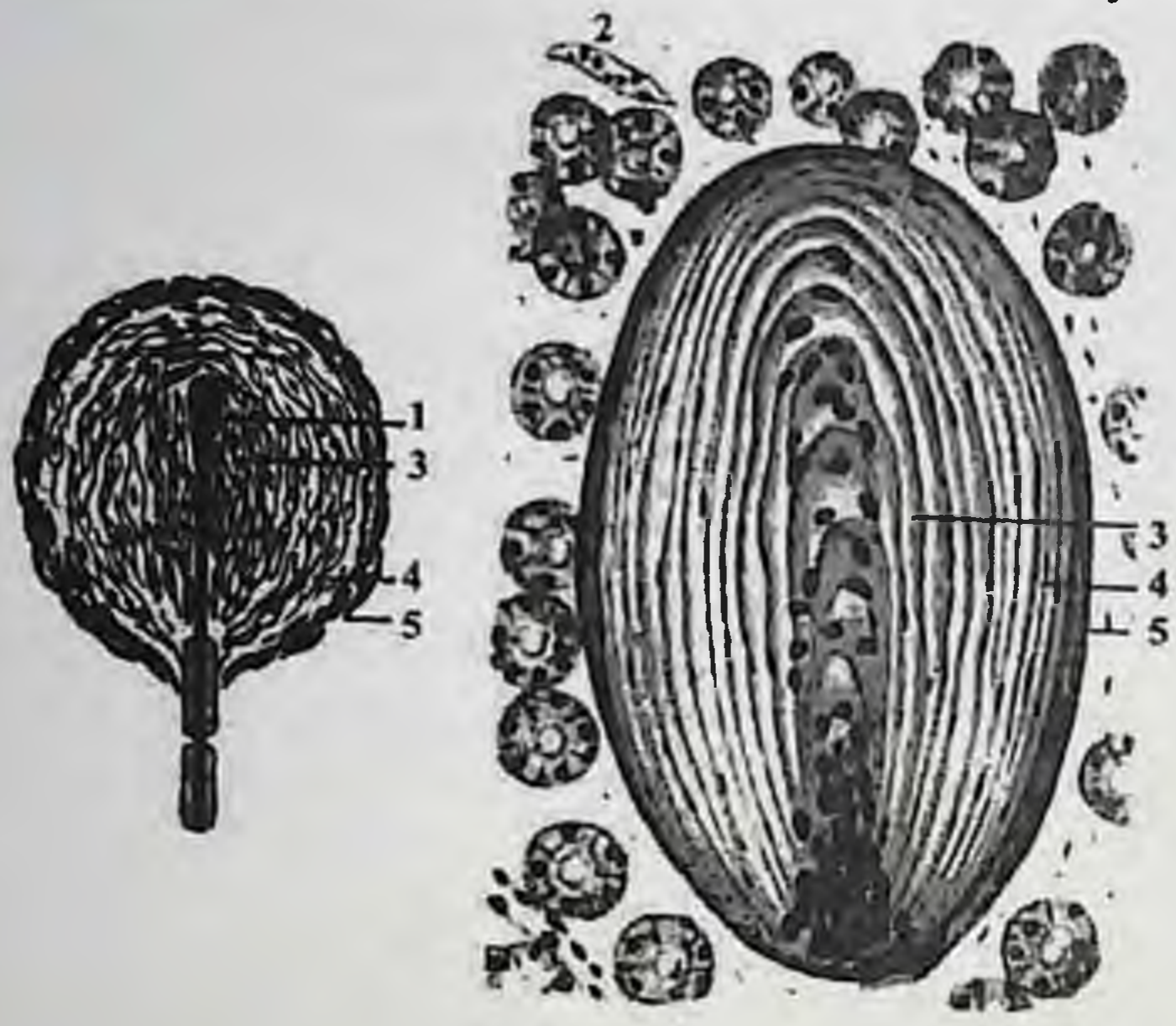
By morphology: free; non free (encapsulated: plate cells (PIC 111), Vater-Pacini, tactile corpuscles Meissen, Krause end bulb, Golgi tendon organs, non-encapsulated).



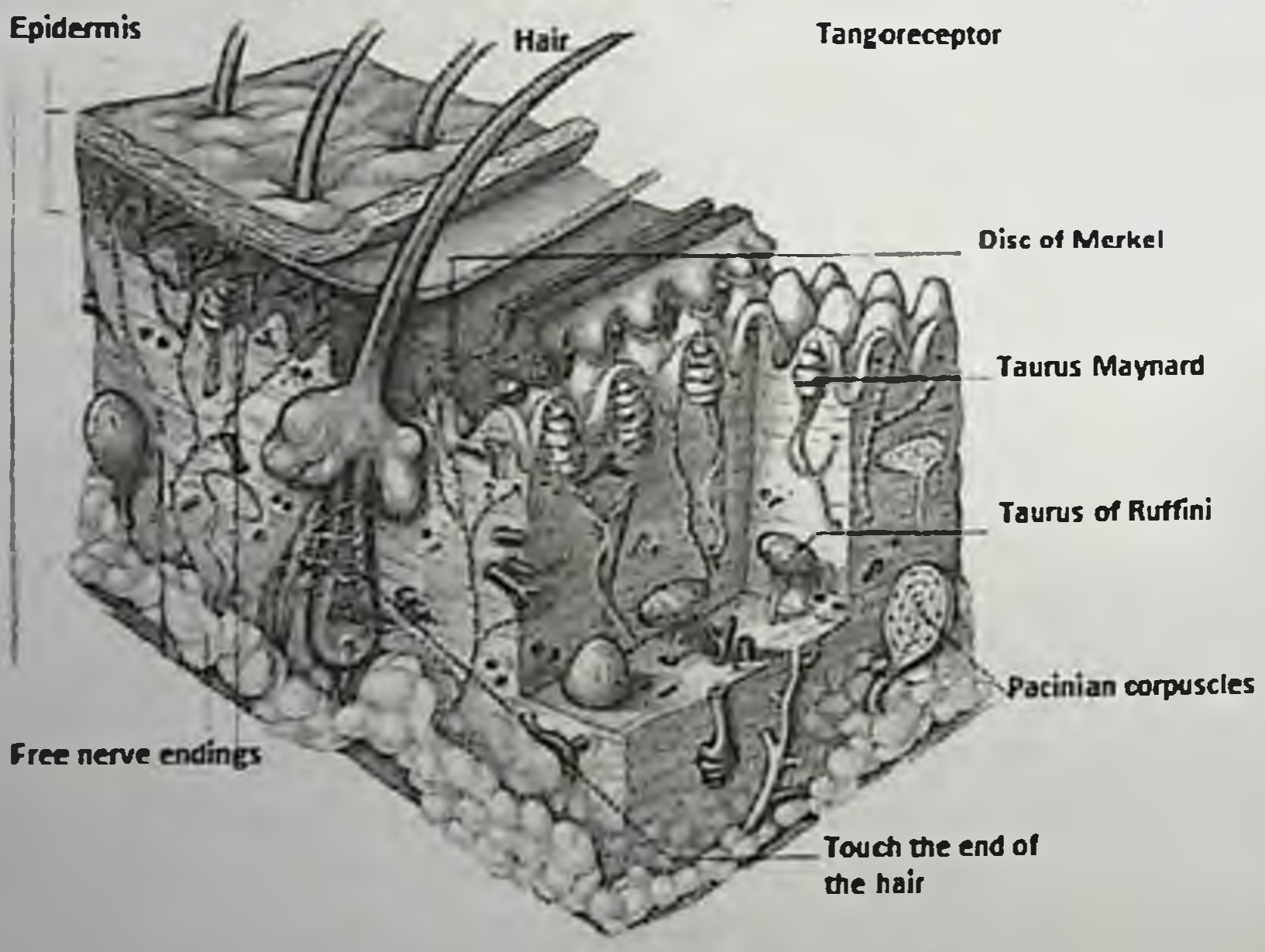
Picture-110. **Motoneuron and synapse in skeletal muscle. (by E.A.Shubnikovoy). A) general view B) Schematic synapse.**
1-motor neuron axon; 2-myelin; 3-muscle fiber; 4-sarcolemmal invagination; 5-mitochondrial; 6-synaptic cleft; 7-synaptic vesicles; 8-basement membrane of muscle fibers; 9-basement membrane of the nerve fiber; 10-basement membrane in the synaptic cleft; 11-lemmocyte; 12-core muscle fibers 13-miofobrilla.

Specificity of perception (by modality): thermoreceptors, baroreceptors, chemoreceptors, mechanoreceptors, nociceptors (pic 112).

By the number of perceiving stimuli: monomodal, polymodal.



Picture-111. **Capsular receptors.** 1-terminal part of dendrite; 2-blood vessel; 3-a inside the bulb; 4-outer bulb; 5-capsule.



Picture-112. **Receptor nerve endings**

Iinterneuron synapses

The polarization of a nerve impulse in the chain of neurons defined by their specialized contacts - synapses (109-rice).

Classification of synapses.

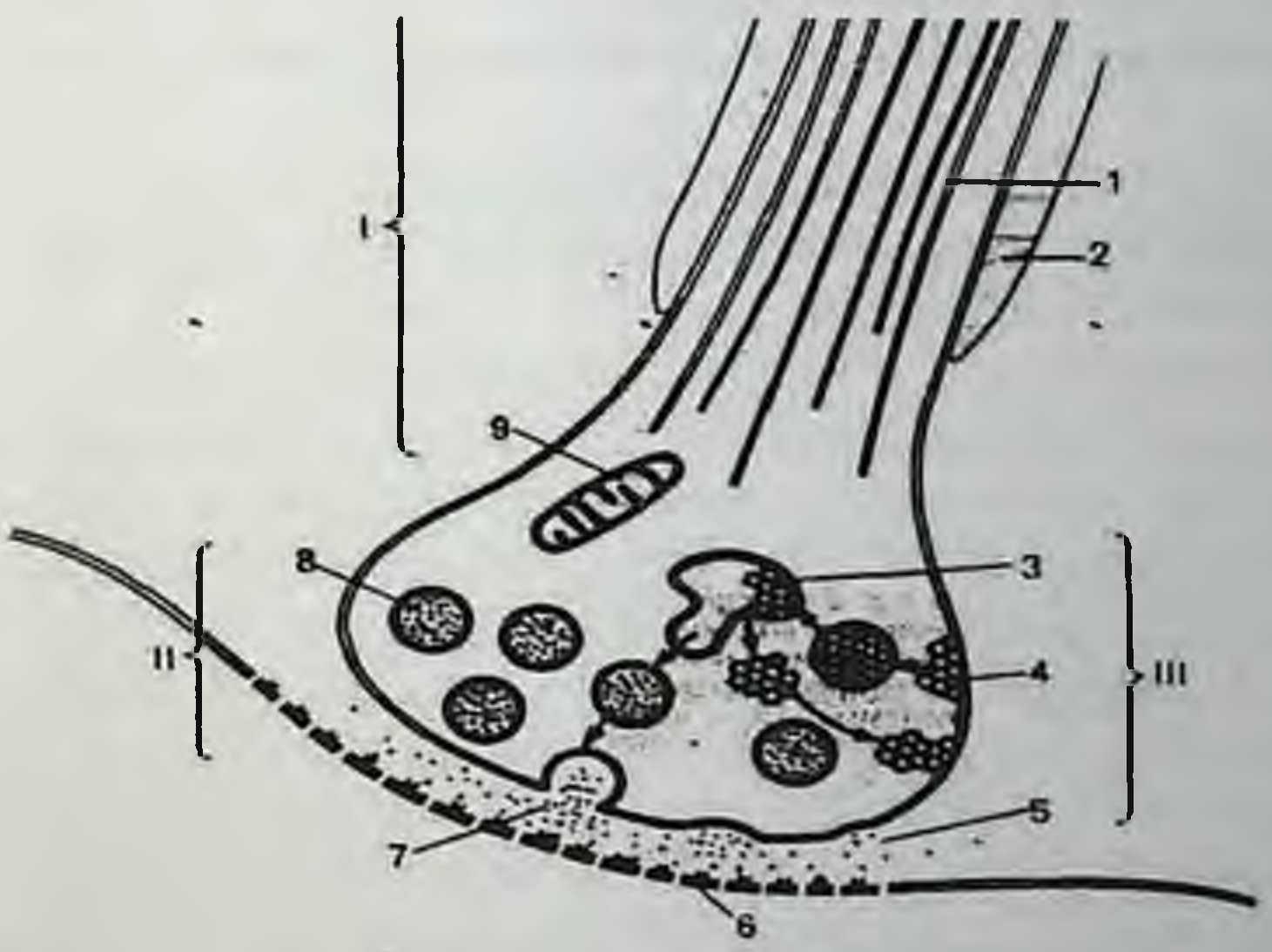
Mode of transmission:

Chemical - conduct nerve impulses in one direction;

Electrical - spend a nerve impulse in both directions.

By localization:

- Aksodendritic synapses;
- Aksoaksonal synapses;
- Aksosomatic synapses
- Somasomatic synapses;
- Dendrodendritic synapses.
- Purinergic synapses;
- Dopaminergic synapses.



Picture-113. **Cyclic changes in the synaptic vesicle. I nerve fiber synapse II part III presynaptic.** 1-microtubules (neyrotubuli); 2-myelin sheath; 3-development of tanks forming synaptic vesicles; 4 the formation of new synaptic membrane; 5-synaptic cleft; 6-postsynaptic membrane; 7- of synaptic vesicles; 8-exocytosis; 9-mitochondria.

According to the composition of the mediator:

- Adrenergic synapses - norepinephrine;
- Cholinergic synapses - acetylcholine;

- Peptidergic synapses;
- Purinergic synapses;
- Dopaminergic synapses

By function: - Exciting; - Braking.

Clinical significance

Local anesthetics are a guide - hydrophobic molecules that bind to sodium channels, inhibiting the transport of sodium and thus also the potential responsible for the appearance of the nerve impulse.

In multiple (scattered) scleroses, the myelin sheath is destroyed unknown mechanism with severe neurological consequences. In this disease, microglia phagocytes and destroy the myelin breakdown products through receptor-mediated phagocytes and liposomal activity. In addition, the AIDS dementia complex is due to an infection of the central nervous system caused by the human immunodeficiency virus type 1 (HIV-1). Numerous experimental data show that HIV-1 infects microglia cells. A number of cytokines, such as interleukin-1 and tumor necrosis factor-p (TNF (3), activate and enhance HIV replication in microglia.

Since nerves are widely distributed throughout the body, they are often damaged. By cutting the axon degenerative changes occur, after which comes the phase of repair.

In the damaged nerve fibers important differences chat changes in the proximal and distal segments. Proximal segment retains its connection with the tropic center (perikarion) and often regenerate. HYDRATED distal segment, separated ottela nerve cell degenerates

Axonal damage causes a number of changes in perikariones: chromatolysis, ie dissolution of Nissl substance and declineseat cytoplasmic basophilia, increased migration and perikarions core to its periphery. Proximal segment of the axon near the wound degenerate over a short distance, but once the macrophages remove detritus begins its growth. Macrophages produce IL-1, which stimulates the Schwann cells, which secrete a substance to provide the growth of the nerve.

The remainder of the nerve fiber, distal her fault as the axon (separated from its trophic center), and the myelin sheath is completely degenerate, and their remnants, except perineural connective tissue and membranes removed makrofagami. While there are these regressive changes, Schwann cells proliferate in the remaining strands of connective tissue or, giving rise to a solid cell columns. These series of

Schwann cells serve as the guiding elements to sprout axons, which are formed during the turnip-access fazy3.

Regressive changes after proximal axon segment HYDRATED grows and branches, forming several filaments, which continue to move in the direction of the speaker Schwann cells. Only those fibers that t through these columns of Schwann cells to grow and reach the effector organ

In the event that between the distal and maximum current segment has a considerable period, or when the distal segment of the study ¬ disappears completely (as, for example, amputation), appeared as a result of the growth of new nerve fibers may form a tumor, or a neuroma, which can become a source of spontaneous pain.

Loss of neurons in physiological conditions in adults is a mechanism of apoptosis and significantly faster in old age, leading to a loss of 20-40 % of the cells in certain parts of the brain. In degenerative diseases like Alzheimer's, Parkinson's and other activity increases apoptosis. AIDS-related deaths of neurological symptoms (up to 40, 50%) of neurons in the cerebral cortex.

In the human brain, the number of gliotsiits 5-10 times greater than the number of neurons and they are able to divide. In the damaged areas of the brain they multiply and form filling defects glial scars, gliosis, tumor-glioma. Last up 50 percent of intracranial tumors (L.V.Bykov 2003).

Practical part

Compilation of logical structures, the study drugs, and view multimedia on electron diffraction patterns of nerve tissue, and a sketch of the principles of the structure of the nervous tissue in the albums.

The objects under study:

1. The spinal cord.
2. Nerves.
3. Schemes glia.
4. The electron myelinated and unmyelinated nerve fibers and synapses

Sample test items

1. What applies to macroglia?

a) ependimotsity;

b) astrocytes;

c) oligodendrocytes;
d) the giant neurons of the cerebral cortex;
e) glial macrophages.

2. What function is performed by astrocytes?

a) barrier;
b) razgranichitelnuyu;
c) opornuyu;
d) sekretornuyu;
e) generate nerve impulses.

3. What gliocytes form a layer that resembles a single-layer prismatic epithelium?

a) ependimotsity;
b) protoplasmic astrocytes;
c) oligodendrocytes;
d) microglia.

4. Where are the ependimotsity?

a) lining the ventricles of the brain and the central canal of the spinal cord;
b) surround large neurons of the brain;
c) accompany nerve fibers;
d) surrounding blood vessels.

5. Where are the oligodendrocytes?

a) around perikaryons neurons;
b) around the processes of neurons;
c) lining the ventricles of the brain and channels;
d) around the blood vessels of the brain.

6. What is the function of microglia?

a) dividing the barrier;
b) tropic;
c) The protective. He participated in phagocytosis destruction of nerve tissue;
d) secretory.

Approximate refereed report on "Age-related changes of the nervous tissue"

VI-CHAPTER. PRIVATE HISTOLOGY

6.1. Nervous system

General characteristics

Nervous system is in the union of body parts into a unified whole (**integration**), provides the regulation of various processes, coordinate the functions of different organs and tissues of the body and interaction with the environment. Nervous system perceives diverse information from the environment and from the internal organs, processes it, and generates alarms, responses adequate to the stimulus.

Anatomically, the nervous system is divided into:

-Central nervous system, which includes the brain and spinal cord;

-Peripheral nervous system, which includes the peripheral ganglia (ganglion), nerves and nerve endings.

Physiologically (depending on the nature of the innervations of organs and tissues), the nervous system is divided into:

-Somatic (animal) nervous system, which regulates the function of predominantly voluntary movement;

-Autonomic nervous system, which regulates the activity of the internal organs and glands. Affecting the metabolic activity in various organs and tissues in response to changing conditions of their operation, and the environment, it provides adaptive-trophic function.

The autonomic nervous system is divided into interacting with each other divisions: the sympathetic and parasympathetic divisions, which are different localization centers in the brain and peripheral nodes, and the nature of the influence of the internal organs.

In the somatic and autonomic nervous system consists of units located in the central and peripheral nervous systems.

Functionally, a leading tissue of the nervous system is the nerve tissue, including neurons and glia. Accumulation of neurons in the central nervous system, usually called cores, and in the peripheral nervous system - nodes (ganglia). Bundles of nerve fibers in the central nervous system are called tracts in the peripheral nervous system, they form nerves.

Nerve center - a cluster of nerve cells in the central and peripheral nervous systems, in which between them is synaptic transmission.

They have a complex structure, richness and variety of internal and external communications and specialized to perform specific functions.

By the nature of the morphofunctional organization are distinguished:

- The nerve center of nuclear type, in which the neurons are no apparent order (autonomic ganglia, nuclei and spinal cord);

- The nerve center of the screen type, in which neurons that perform the same type of features in the form of the individual layers, similar to the screen on which are projected onto the nerve impulses (the cortex of the cerebellum, the neocortex of the brain, the retina of the eye). Within the layers and between them there are numerous associations.

In the nerve centers are processes of convergence and divergence of nervous excitement, the mechanisms of feedback.

Convergence - the convergence of different ways of nerve impulses to a smaller number of nerve cells. On neurons may be the end of the different cell types, which enables the convergence of influences from different sources.

Divergence - the formation of bonds of a single neuron with a large number of others, over which it has an impact, providing a redistribution of excitation pulses with irradiation.

Feedback mechanisms make it possible to adjust the amount of the neurons themselves available to them signals through connections with their axon collaterals intercalary cells. Last influence (usually braking) as the neurons, and the terminals of them converging fibers.

6.1.1. Brain and spinal cord

I. Aims and objectives:

1. To study the function and structure of the spinal cord;
2. To study the function and structure of the cerebellum;
3. Examine the function and structure of the cerebral cortex;

II. Sample questions for self-study:

1. The concept of the nervous system and its forms;
2. The spinal cord, cortex spinal cord;
3. The white matter of the spinal cord.
4. The brain stem;
5. The bark of the cerebellum;

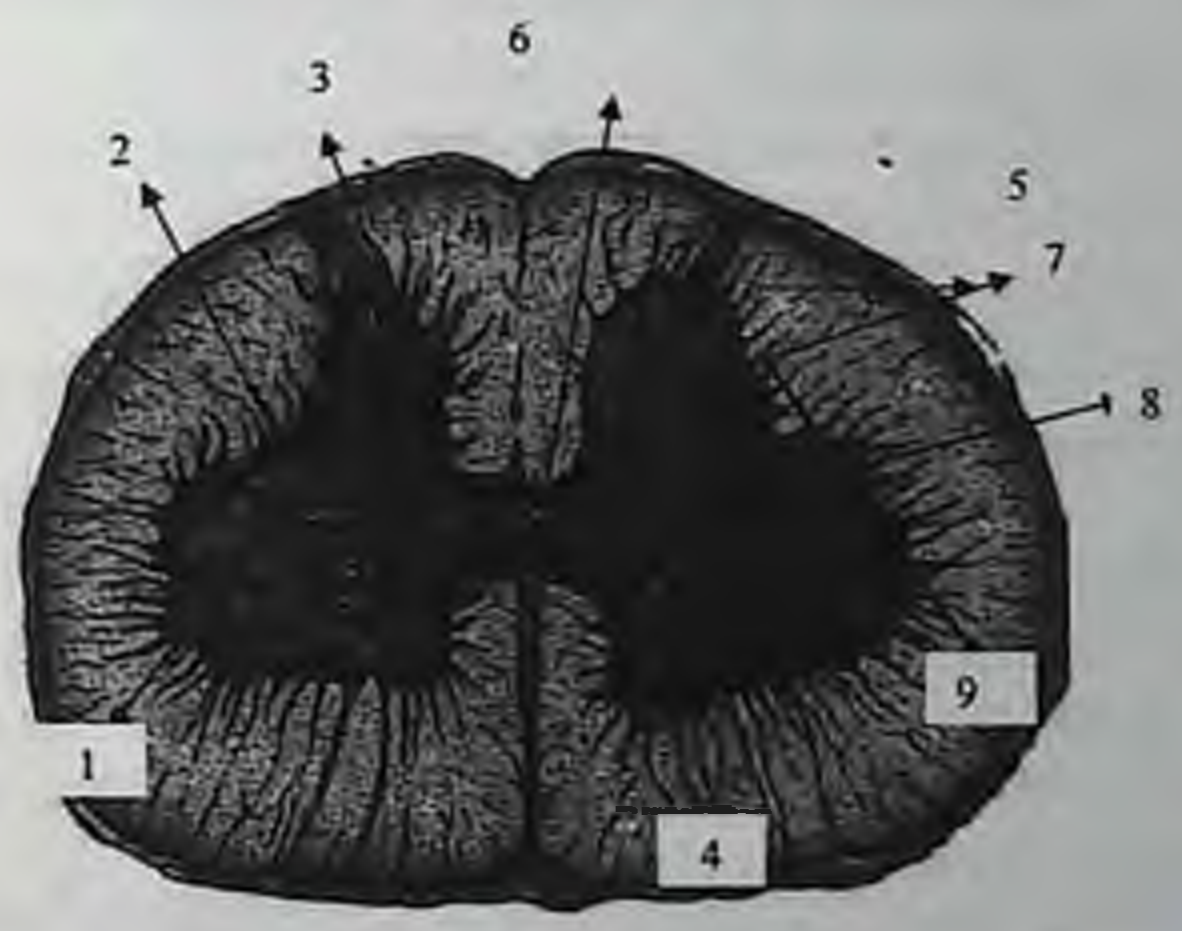
6. The white matter of the spinal cord;
7. The cerebral cortex, Cytoarchitectonics crust;
8. Mieloarhitektonika cortex;
9. CSF and its value;
10. The autonomic nervous system;
11. Development of the nervous system.
12. The clinical significance of the topic.

The theoretical part

Spinalcord

The spinal cord is located in the spinal canal and is given a rounded cord, enlarged in the cervical and lumbar spine, and penetrated central canal. It consists of two symmetrical halves, separated by a gap in front of the middle, behind the median furrow, and is characterized by segmental structure, with each segment connected pair of front (ventral) and a pair of rear (dorsal) roots.

In the spinal cord are distinguished: the gray matter located in the central part, the white matter, which lies on the periphery (pic 117).



Picture-117.
The structure of the spinal cord:
1-white substance;
2 gray matter;
3-posterior horn;
4-front horn;
5-lateral horn;
6 spinal canal.
7-beam neurons ;
8-associative neurons ;
9-motor neurons.

The gray matter is the transverse section of the form butterflies and includes dual front (ventral) side (lateral) horn (in effect a continuous poles running along the spinal cord). Horn gray matter of both symmetrical parts of the spinal cord are connected to each other in the central gray commissure (adhesions). In gray matter are bodies, dendrites, and (partially) the axons of neurons and glial cells. Between the bodies of neurons located neuropil - the network formed by nerve fibers and processes of glial cells.

Cytoarchitecture of spinal cord

Neurons are located in the gray matter in the form of (not always sharp) delineated clusters (nuclei), which switches the nerve impulses from cell to cell (in this regard, they are referred to the nerve centers of the nuclear type). Depending on the topography of the spinal cord axons of neurons are divided into:

-Radicular neurons whose axons form the anterior roots;

-Inner neurons, processes that end within the gray matter of the spinal cord;

-Beam neurons, processes which form the fiber bundles in the white matter of the spinal cord in the pathways.

Posterior horns contain multiple nuclei formed multipolar neurons of the small and medium size, in which the axons terminate psevdounipolar spinal ganglia cells that carry a variety of information from the receptors and fibers descending tract of lying above (supraspinal) centers .

In hind horns revealed high concentrations of neurotransmitters such as serotonin, enkephalin, substance P.

The axons of neurons:

- End in the gray matter of the spinal cord to motor neurons that lie in the anterior horns;

- Form of intersegmental connections within the gray matter of the spinal cord;

- Go into the white matter of the spinal cord, where they form the ascending and descending pathways, some axons goes over to the opposite side of the spinal cord.

Lateral horns are well defined at the level of the thoracic and sacral segments of the spinal cord, contain nuclei formed by the bodies of neurons that are related to the sympathetic and parasympathetic nervous systems. On the dendrites and cell bodies of these axons terminate:

- Psevdounipolar neurons that carry impulses from receptors located in the internal organs;

- Neurons centers regulating autonomic functions of the body are located in the medulla.

Axons of autonomic neurons, leaving the spinal cord in the anterior roots, form preganglionic fibers bound to the sympathetic and parasympathetic nodes. In neurons of the lateral horn key mediator is acetylcholine, reveals a number of neuropeptides - enkephalin, neurotensin, substance P, somatostatin.

Anterior horns contain motor multipolar cells (motor neurons) in all about 2.3 million combined in the nucleus of motor neurons, each of which usually lasts for a few segments. Distinguish between large (35-70 mm body diameter) alpha motor neurons and scattered among them smaller (15-35 microns) of gamma motor neurons.

On appendages and bodies of motor neurons are numerous synapses (up to several tens of thousands each) that provide them excitatory and inhibitory effects. Motoneurons terminate on:

-Axon collaterals psevdounipolar cells spinal units, forming with them monosynaptic reflex arc;

Neurons, axons, whose bodies lie in the posterior horn of the spinal cord;

Renshaw cells, axons, which form inhibitory axo-somatic synapses. The bodies of these small neurons located in the middle of the anterior horn and motor neuron axon collaterals innervated;

Fiber paths descending pyramidal and extrapyramidal systems, carrying impulses from the cerebral cortex and brain stem nuclei.

Gamma motor neurons, in contrast to the alpha motor neurons, have no direct connection with the sensory neurons of spinal units.

The axons of the alpha motor neurons give collaterals ending on the bodies of intercalary Renshaw cells, and leave the spinal cord in the anterior roots, going to mixed nerves to the somatic muscles, where they end neuromuscular synapses (motor plaques). More delicate axons gamma motor neurons have the same speed and form at the end of the intrafusal fibers of the neuromuscular spindles. Anterior horn cells of the neurotransmitter is acetylcholine.

Central spinal canal is in the center of the gray matter in the central gray commissure (Spike). It is filled with cerebrospinal fluid and lined with a single layer of cubic or prismatic cells ependyma, the apical surface is covered with microvilli and (partially) cilia and lateral bound complex intercellular connections.

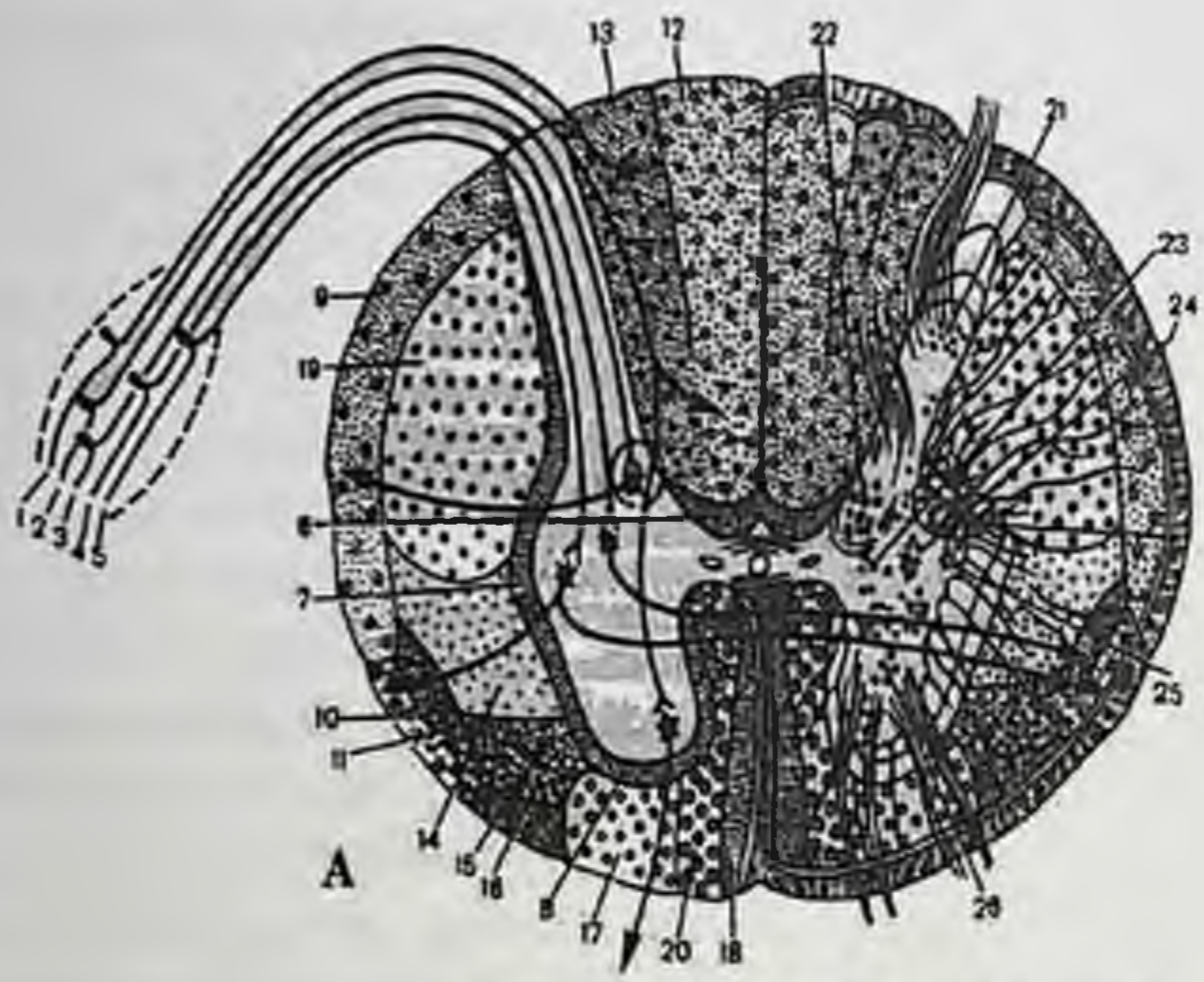
Pathways of the spinal cord

The white matter of the spinal cord gray surrounds and separates the anterior and posterior dorsal spines on the symmetrical, lateral, and ventral cord. It consists of a longitudinally-reaching nerve fibers (mainly myelin), forming a descending and ascending pathways (tracts). Last separated by thin layers of connective tissue and astrocytes (also found in contracts).

For each tract characterized by a predominance of fibers formed by the same type of neurons, so the paths differ substantially contained in

their fibers and neurotransmitters (like neurons) are divided into - monoaminergic, cholinergic, glutamatergic, glycinergic and peptidergic. Pathways include two groups:

- **Propriospinal;**
- **Supraspinal path.**



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Picture-118. **The structure of the spinal cord.A) section of the spinal cord and spinal ganglion:** 1, 2-reflex pathways of conscious proprioceptive sensation and touch; 3, 4 - reflex pathways of conscious proprioceptive impulses; 5-reflex pathways and thermal pain sensitivity; 6 rear beam own; 7-lateral beam own; 8-front own; 9-beam rear spinal cerebellar pathway; 10-front spinal cerebellar path; 11-spinal thalamic path; 12-gentle beam (beam Gaulle); 13-tapered beam (Burdach's column); 14-way; 15-rubrospinalny talamospinaly way; 16-vestibular-spinal way; 17-reticulo-spinal pathway; 18 tektospinalny-way; 19-cortico-spinal (pyramidal) side track; 20-corticospinal pyramidal front; 21-way custom kernel posterior horn of the; 22-breast; 23, 24-nucleus-nucleus of the intermediate zone; 25-lateral nucleus (sympathetic); 26-core anterior horn.

Propriospinal pathways are proper spinal pathways, which are formed by the axons of neurons, they form the link between its various departments. These pathways are mainly on the border of white and gray matter in the lateral and ventral cord.

Supraspinal pathways provide a link with the structures of the spinal cord and brain include cerebral spinal ascending and descending cerebro-spinal tracts.

Cerebral spinal tracts provide the transmission to the brain diverse sensory information. Part of the 20 channels of the axons of the cells formed by spinal units, while the majority is represented axons different neurons, whose bodies are located in the same or opposite side of the spinal cord.

Cerebro-spinal tracts provide connectivity of the brain with the spinal and include pyramidal and extrapyramidal system.

Pyramidal system established long axons of pyramidal cells of the cerebral cortex in humans and has about a million of myelinated fibers, which are at the level of the medulla oblongata mostly go to the opposite side and form the lateral and ventral corticospinal tract. Fibers of these tracts are projected not only to motor neurons, but also on the intercalary neurons of gray matter. Pyramidal system controls the precise voluntary movement of skeletal muscles, especially the legs.

Extrapyramidal system formed neurons whose bodies lie in the nuclei of the middle and the medulla oblongata and the bridge, and the axons terminate on motor neurons and neurons. It controls mostly skeletal muscle tone and muscle activity that maintain posture and balance the body.

Outdoor (surface) boundary glial membrane consisting of fused flattened processes of astrocytes, forms the outer boundary of the white matter of the spinal cord, separating the central nervous system from the peripheral nervous system. The membrane permeate the nerve fibers that make up the front and back roots.

Brain axis

The brain is made up of the brain stem, which is a continuation of the dorsal mantle formed hemispheres (includes elongated, rear, middle, and midbrain) and cerebellum. In the trunk of the gray matter of the brain is represented by numerous nuclei, surrounded by white matter: only in the caudal medulla is found continued anterior and posterior horns of the spinal cord, but in the cranial direction uniform clusters of neurons separated pathways, forming the nucleus. Moving away from

the trunk of ten pairs (3 to 12) of the cranial nerves, the nuclei of which are located within the medulla oblongata and the midbrain.

The nuclei of the brain stem are classified as:**sensory, motor, associative.**

Sensitive nuclei are homologous nuclei posterior horn of spinal cord - they are concentrated body and dendrites of multipolar neurons, the axons of which terminate psevdounipolar or bipolar cells that carry sensory information.

Motor nucleus contains motor neurons, whose axons terminate on the fibers of somatic muscles. To the motor nuclei are often referred and vegetative nucleus oblongata and the midbrain, containing bodies of neurons, whose axons form preganglionar fibers bound in parasympathetic ganglia in the 3, 7, 9, 10 pairs of cranial nerves.

Associative (switching) nuclei contain accumulations of associative multipolar cells, which provide the formation of neural circuits Multineuronal by switching the nerve impulses to the cerebral cortex and cerebellum, or vice cortex to the brain stem and spinal cord centers.**The white matter** of the brain stem has the same histological structure as in the spinal cord and consists of bundles of nerve fibers that form the ascending and descending tracts that connect different parts of the central nervous system. Along with features of topography and structure, individual nuclei of the brain stem and its different chemical pathways specific neurotransmitters.

A special department of the central nervous system has a specific organization and connecting its various levels, is the reticular formation.

Reticular formation is formed by a group of small, medium and large multipolar neurons with different patterns of branching of dendrites and axons containing various neurotransmitters and surrounded by a network of nerve fibers. It starts in the spinal cord and extends to the intermediate, reaching in the cranial direction to the rapid evolution. In this case, diffuse arrangement of its elements is replaced by a compact with the formation of the individual nuclei, the number of which, according to various classifications, ranging from a few dozen to hundreds.

The neurons of the reticular formation characterized by a large number of afferent connections coming from the sensory structures, and a wealth of efferent projections. Their processes are sent to the cerebral cortex, in different parts of the core barrel, the forebrain and cerebel-

lum, combining them into a single system (the integrative function of the reticular formation).

Extensive ascending projections, including directly into the cortex of the brain, provide the activating influence of the reticular formation in the higher centers of the nervous system. The set of descending projections of the reticular formation is considered as a system that inhibits the activity of the lower centers. The bulk of the projections presented reticulospinal tract fibers that inhibit the activity of motor neurons of the spinal cord. Attributed part of the reticular formation in the perception of pain, aggression, and sexual behavior. Key mediator in it are acetylcholine, norepinephrine, dopamine, serotonin.

Hypothalamus - a portion of the diencephalon, which contains the nucleus, a part of which combines special body neurons, specialized in the development of neurohormones. Last transported along the axons and secreted into the capillary network of the median eminence or neurohypophysis. Thus, not all communication between the central nervous system and target organs are made by nerve fibers.

Cerebellum

The cerebellum is located above the medulla oblongata and pons **and is a center of balance, maintain muscle tone, coordination, and control of complex and automatically executed motor acts.** It consists of two hemispheres with a large number of grooves and convolutions on the surface and a narrow middle part (the worm) and is connected with other parts of the brain in three pairs of legs. The gray matter of the cerebellum and cortex forms a nucleus, which lie at the back of his white matter.

The bark of the cerebellum is the nerve center of the screen type and is characterized by highly ordered arrangement of neurons, nerve fibers and glial cells. There are three layers, from outside to inside (Figure 115).

The molecular layer, which contains a relatively small number of small cells;

-Ganglionic layer formed by a row of large pear-shaped body cells (Purkinje cells);

-Granular layer, with more snug cells.

Molecular layer of the cerebellar cortex

Molecular layer contains the body shaped baskets and stellate cells (short-and Length of axons).

Shaped baskets cells are located in the inner part of the molecular layer. Their short dendrites form a connection with the parallel fibers in the outer molecular layer, and the long axon comes across gyrus, giving at intervals collaterals that descend to the bodies of the Purkinje cells, and branching out, cover them like baskets, brake forming axo-somatic synapses.

Stellate cells - small neurons whose bodies lie above shaped baskets cell phone. In short axons stellate cells dendrites form bonds with parallel fibers and branching axons form inhibitory synapses on the dendrites of Purkinje cells. In stellate cells may be involved in axon formation baskets around Purkinje cell bodies.

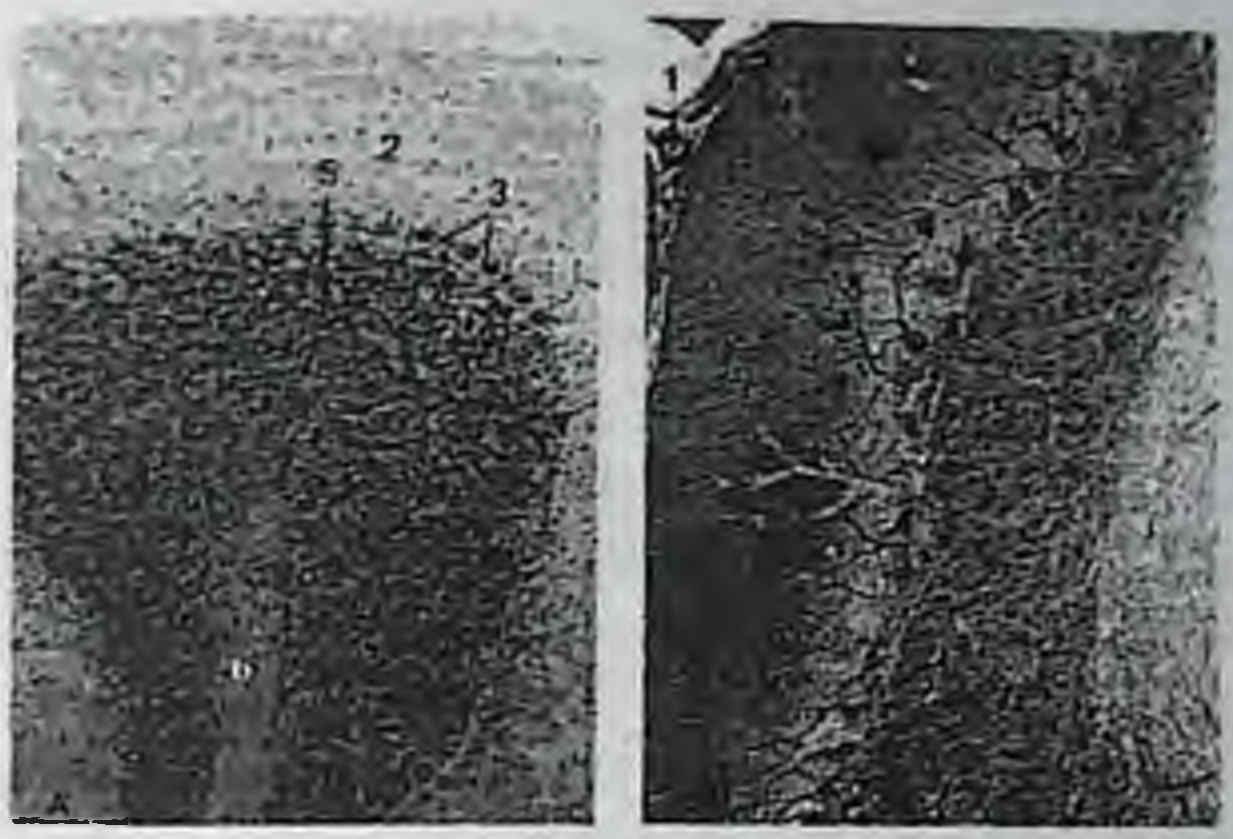
Ganglionic layer of cerebellar cortex

Ganglionic layer contains one row behind the Purkinje cells of the body (pear-shaped neurons) braided axon collaterals Shaped baskets cells ("baskets").

Purkinje cells (pear-shaped neurons) - large cells with a pear-shaped body, containing a well-developed organelles. From him in the molecular layer depart 03.02 primary (stem) of the dendrite branching intensity in the plane perpendicular to the cortex, with the formation of final (terminal) dendrites that reach the surface of the molecular layer. The dendrites are 60-100 thousand spines - contact zones of excitatory synapses formed by parallel fibers (axons of cells grains) and excitatory synapses formed by climbing fibers.

Axon Purkinje cells moving away from the bottom of her body, puts the myelin sheath, a granular layer permeates and penetrates the white matter, as the only efferent by its bark. In the course of the axon collaterals gives returning to the region of location of bodies of Purkinje cells and form inhibitory synapses on the bodies of neighboring Purkinje cells and Golgi cells. Purkinje cell number **decreases significantly** with age - by 20-40% to 70-90 years (compared with the number in40-50 year olds), which is probably the one of the causes of cerebellar function in the elderly.

The granular layer contains the cell bodies located close-grain, large cell grains (Golgi cells) and cerebellar glomeruli - the special rounded complex synaptic contact zones between the Moss family fibers, cell dendrites and axons of large grains cell grains.



Picture-119. **Cerebellum.** A-gyrus. B-cerebellar cortex.
1 soft shell; 2-molecular layer; 3-ganglionic layer;
5-granular layer; 6-white matter.

Cells of grain - the most numerous neurons of the cerebellar cortex. Neurons are small with poorly developed organelles and short dendrites, having a form of "bird's foot", which in the glomeruli of the cerebellum outlet mossy fibers form numerous synaptic contacts. The axons of cells grains are sent to the molecular layer, where the T-bar is divided into two branches, running parallel to the length of the gyrus (parallel fibers) to form excitatory synapses on the dendrites of Purkinje Corzine cells and stellate cells and large cell grains. Through dendritic tree of each Purkinje cell is 200-300 thousand parallel fibers, forming every cell 60-100 thousand synapses (not all fibers form synapses). The axon of each cell-grain forms a connection with the dendrites of Purkinje cells 250-500.

Large cell grain (Golgi cells) larger cells grains contain well developed organelles. Their axons within the glomeruli of the cerebellum form synapses on the dendrites of cells-grain and long dendrites ascend into the molecular layer, where the branches and form a connection with parallel fibers. Large cell grains have a depressing effect on cell activity of grains.

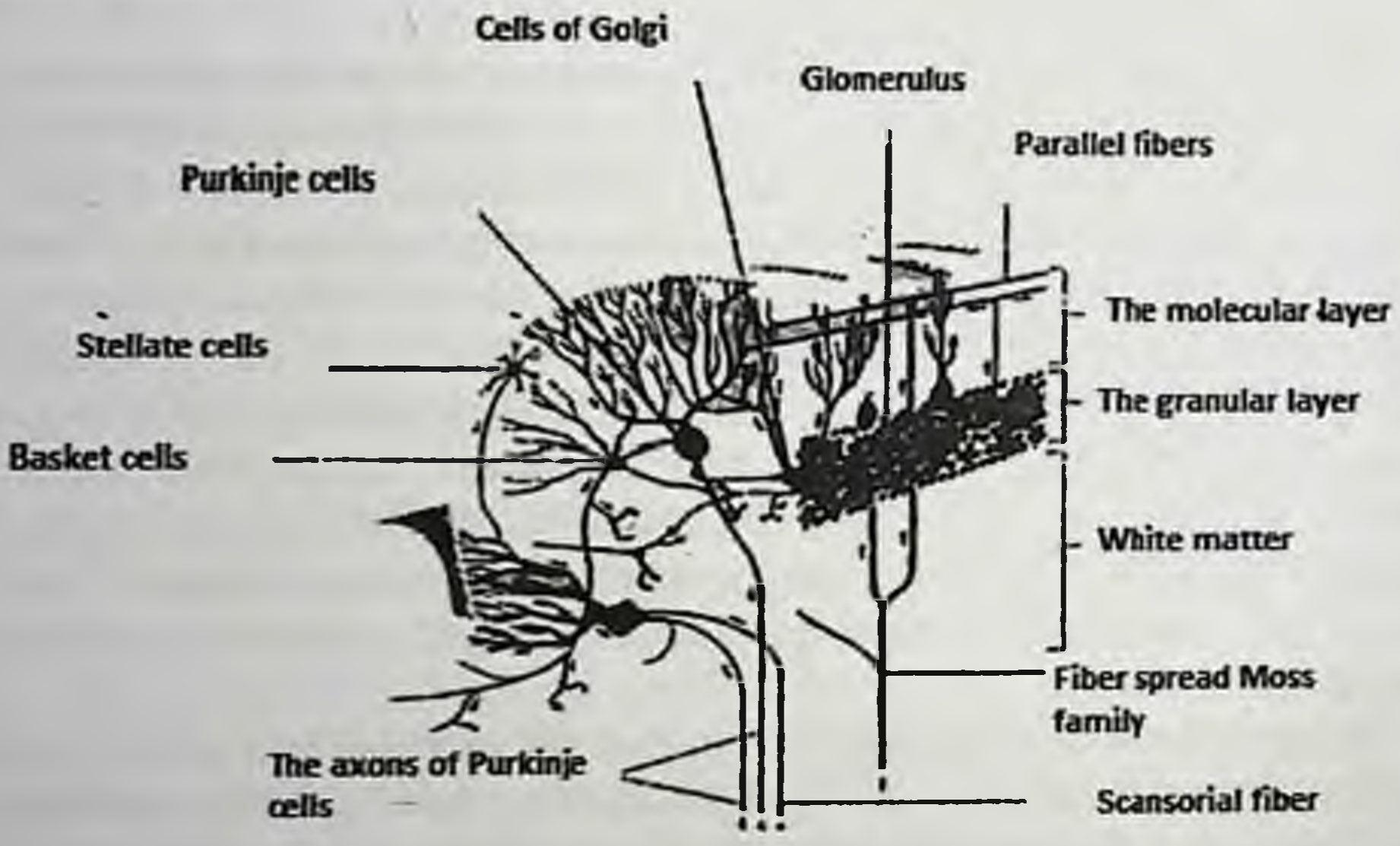
Afferent fibers of the cerebellar cortex include wide spread Moss (moss) and climbing.

Wide spread Moss (moss) fibers are in the cerebellum and spinal cerebellopontine paths and branch out ends with a (female) in special contact zones - cerebellar glomeruli and form synaptic contacts with the

dendrites of cells-grains, which also end in large cells and axons-grains . Cerebellar glomeruli outside is not completely surrounded by flat spikes astrocytes.

Climbing (Liano shaped) fibers in the cerebellum are olivo cerebellar tract and penetrate the bark of the white matter, passing through the granular layer to the ganglionic and travel along the bodies and dendrites of Purkinje cells, which they run out of excitatory synapses. Collateral branches of climbing fibers synapse on other neurons of all types, including cells of grain cells Golgi, stellate and basket cells. Each Purkinje cells normally contact one climbing fiber.

Efferent fibers of the cerebellar cortex are axons of Purkinje cells, which are in the form of myelin fibers are sent to the white matter, and reaches deep nuclei of the cerebellum and the vestibular nucleus neurons to which they form inhibitory synapses (Purkinje cells are inhibitory neurons).



Picture-120. **Diagram of the structure of the cerebellum.**
Showing interneuron relationship

Interneuron connections in the cerebellar cortex due to its wealth provide processing coming into her diverse sensory information (Figure 116). Exciting pulses arrive in the cerebellar cortex by mossy and climbing fibers. In the first case the excitation is transmitted to the dendrites of Purkinje cells directly, in the second - through the glomeruli of

the cerebellum - the dendritic cells, grains and more on their axons (parallel fibers). The latter form excitatory synapses on the dendrites also Corzine cells and stellate cells and large cell grains. Corzine axons shaped cells form inhibitory synapses. On the bodies of the Purkinje cells and axons of the stellate cells in their dendrites. Large axons of granule cells in the glomeruli of the cerebellum form inhibitory synapses on the dendrites cells grains. Formed in the cerebellar cortex inhibitory signals are transmitted to the nucleus of the Purkinje cells of the cerebellum and the vestibular nuclei, and through them eventually control the activity of the descending motor pathways. The main excitatory neurotransmitters in the synapses use glutamate and aspartate, in the brake - amma-aminobutyric acid.

Glial elements of the cerebellar cortex provides the functions of neurons located in all its layers and very diverse, and include oligodendrocytes (involved in the formation of myelin sheaths of nerve fibers), astrocytes, microglia. Astrocytes their flattened at the ends of shoots form perivascular limiting membrane (a component of the blood-brain barrier) and the membrane around the glomeruli of the cerebellum. A special type of astrocytes (cells or fibers Bergman) are located near the bodies of the Purkinje cells and their processes include cell bodies come to the surface of the molecular layer, forming a surface boundary glial membrane surround and support the dendrites of Purkinje cells

Cortex of the brain

Cortex of the brain is the highest and most difficult to organize the nerve center of the screen type, which allows the regulation of the activities of a variety of body functions and complex behaviors.

The bark is formed layer of gray matter thickness of 3-5 mm on the surface of the convolutions (30%) and in the depth of the furrows (70%) of the total area of 1500-2500 cm2 at about 300 cm3. Gray matter contains nerve cells (about 10-15 billion), nerve fibers and glia cells (over 100 billion). (107-rice)

Based on the differences and the structure of the density of cells (cytoarchitectonic), stroke fibers (mieloarhitektonic) and functional features of different parts of the cortex to produce its 52 mild delimited fields.

Cortical neurons - the multi-various sizes and shapes, including more than 60 species, among which are two basic types: pyramidal and not pyramidal.

Pyramidal cells - a specific type of cortical neurons to various estimates, 50-90% of all neurocytes crust. From the apical pole of tapered (on cuts - triangular) body, which faces the surface of the bark, leaves long (apical) dendritic spines covered, bound molecular layer of the cortex, where it forks. From the basal and lateral portions of the body deep into the crust and the sides of the cell body diverge 5-16 shorter side (lateral) **dendrites**, which branch out, spread within the same layer, where the body of the cell. From the middle of the basal surface of the waste body is long and thin axon, going to the white matter, which is at a distance of 60-90 m beginning to collaterals. Size of pyramidal neurons vary from 10 to 140 microns; distinguish giant, large, medium and small pyramidal cells.

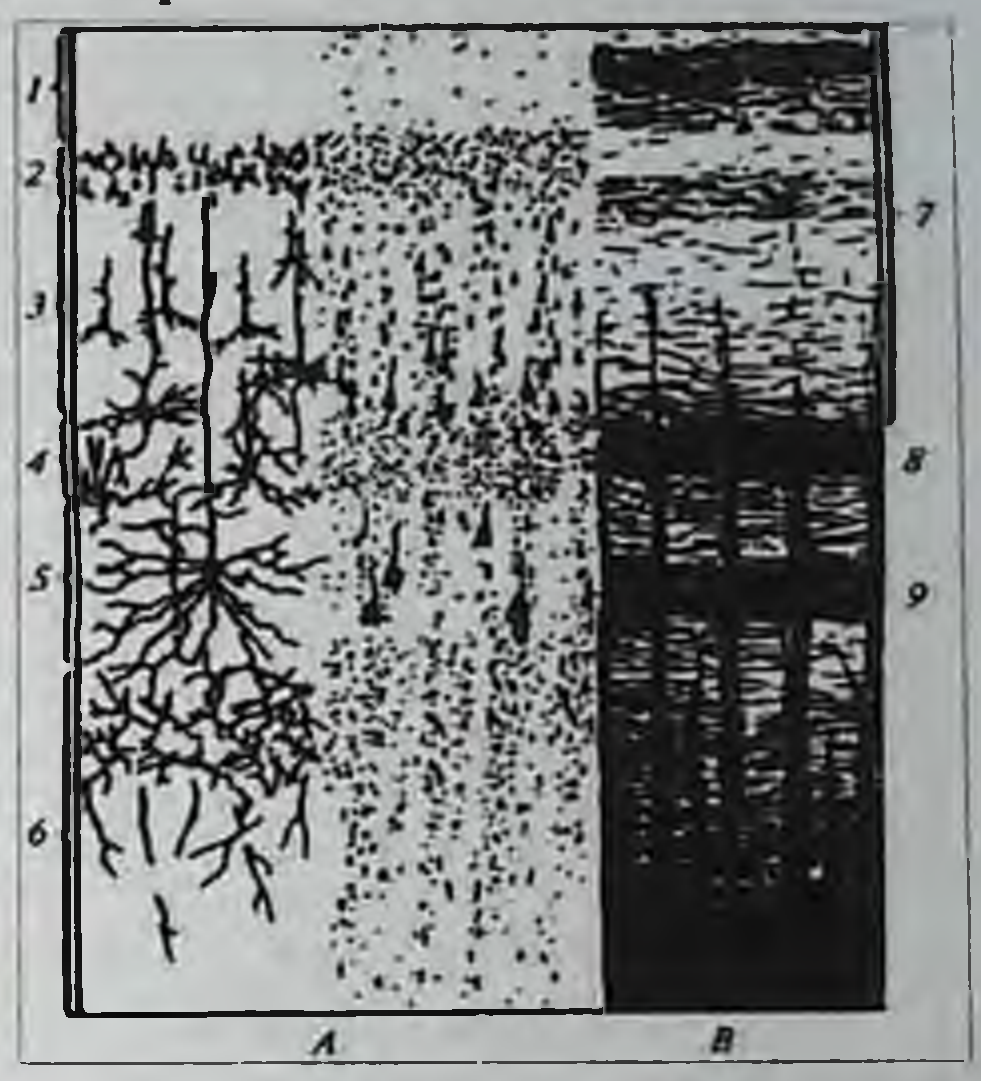
Not pyramidal cells are located in almost every layer of the cortex, treating incoming afferent signals and extend their axons within the cortex itself, transmitting impulses to the pyramidal neurons. These cells are very diverse and are predominantly species stellate cells. They include spinulose, star, aksonal cells, cells "candelabra", cells with double bouquet dendrites, horizontal cells Cajal, Martinotti cells, and others. The main function not pyramidal cells - the integration of neural networks in the cortex.**Cytoarchitecture** of the cerebral cortex of the brainCortical -neurons are not sharply demarcated layers (lamellae), which are designated by Roman numerals, and are numbered from outside to inside (Figure 117).

I. Molecular layer located under the pia mater, contains a relatively small number of small neurons - horizontal Cajal cells with long branching dendrites radiating horizontally from the spindle-shaped body. Their axons are involved in the formation of tangential plexus fibers of this layer. In the molecular layer, there are numerous dendrites and axons of cells located deeper strata of interneuron communication.

II. External granular layer consists of numerous small pyramidal and stellate cells, dendrites that branch out and take to the molecular layer and the axons, or go to the white matter, or form of the arc and also sent to the molecular layer.

III. Pyramidal layer varies considerably in width and most pronounced in the associative and sensorimotor cortical areas. It is dominated by the pyramidal cells, which increases the size of deep layer from small to large. Apical dendrites of pyramidal cells are sent to the molecular layer, and lateral form synapses with cells of this layer. These axons terminate within the gray matter, or sent in white. Apart

from the pyramidal cell layer contains a variety not pyramidal neurons. Layer has mostly associative functions, linking cells, both within this hemisphere, and with the opposite hemisphere.



Picture-121.

Cyto-and mieloarhitektonika cortical hemispheres of the human brain.

A-location cells (cytoarchitecture);

B-fiber arrangement (mieloarhitektonic);

1, 2, 3, 4, 5, 6-layers (plates of bark);

7-outer top layer of fibers;

8-band internal granular plate;

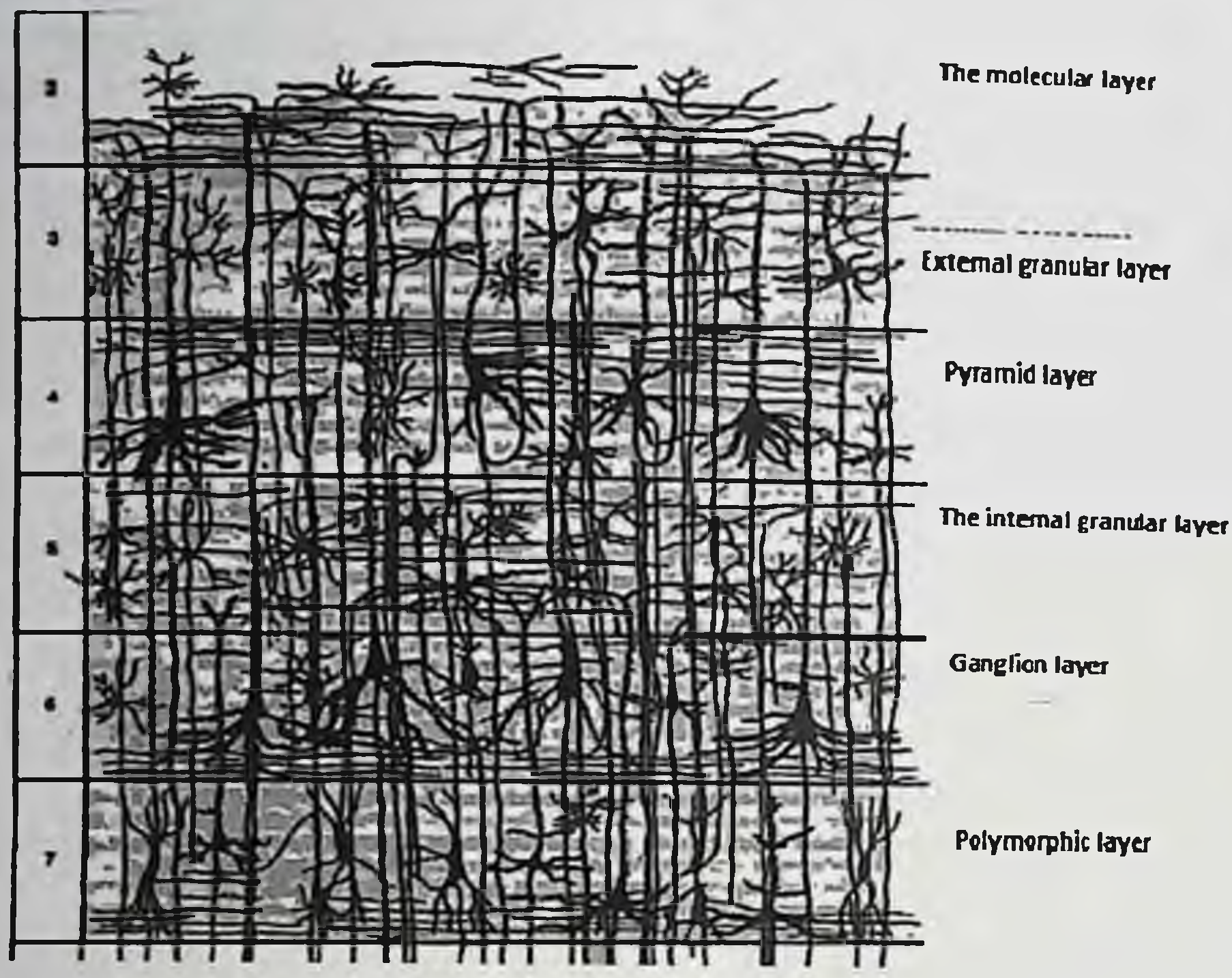
9 - strip inside pyramid plate.

IV. Internal granular layering a wide visual and auditory cortical areas, and in the sensorimotor area is virtually nonexistent. It consists of small pyramidal and stellate cells. In this layer, end most of the thalamic (spinulose) afferents. The axons of the cells of this layer is formed due to the cells above and the lower layer of the crust.

V. Ganglionic layer consists of large, and in the motor cortex (precentral gyrus) - giant pyramidal cells (Betz). Apical dendrites of pyramidal cells reach the I layer, forming there bouquets apical, lateral dendrites distributed within the same layer. Axons of giant and large pyramidal cells are projected onto the core of the brain and spinal cord, the longest of them as part of the pyramidal tract reach the caudal spinal cord segments. As for the majority of layer V cortical projection efferents.

In the 122 picture shows the relationship of cortical neurons

VI. Layer of polymorphic cells formed diverse in form neurons (fusiform, stellate, Martinotti cells). Exterior portions of the layer containing larger cells, internal - smaller and widely spaced. The axons of these cells go to the white matter in the efferent paths, and penetrate the dendrites to the molecular layer. Martinotti axons of small cells rise to the surface of the cortex and ramify in the molecular layer.



Picture-122.

Mieloarhitektonic and organization of the cortex

The nerve fibers of the cerebral cortex of the brain consist of three groups: the afferent, commissural and association;

efferent fibers.

Afferent fibers in the form of beams in the radial rays come into the crust from below the distal part of the brain, in particular, from the thalamus and geniculate bodies. Most of these fibers ends at layer IV.

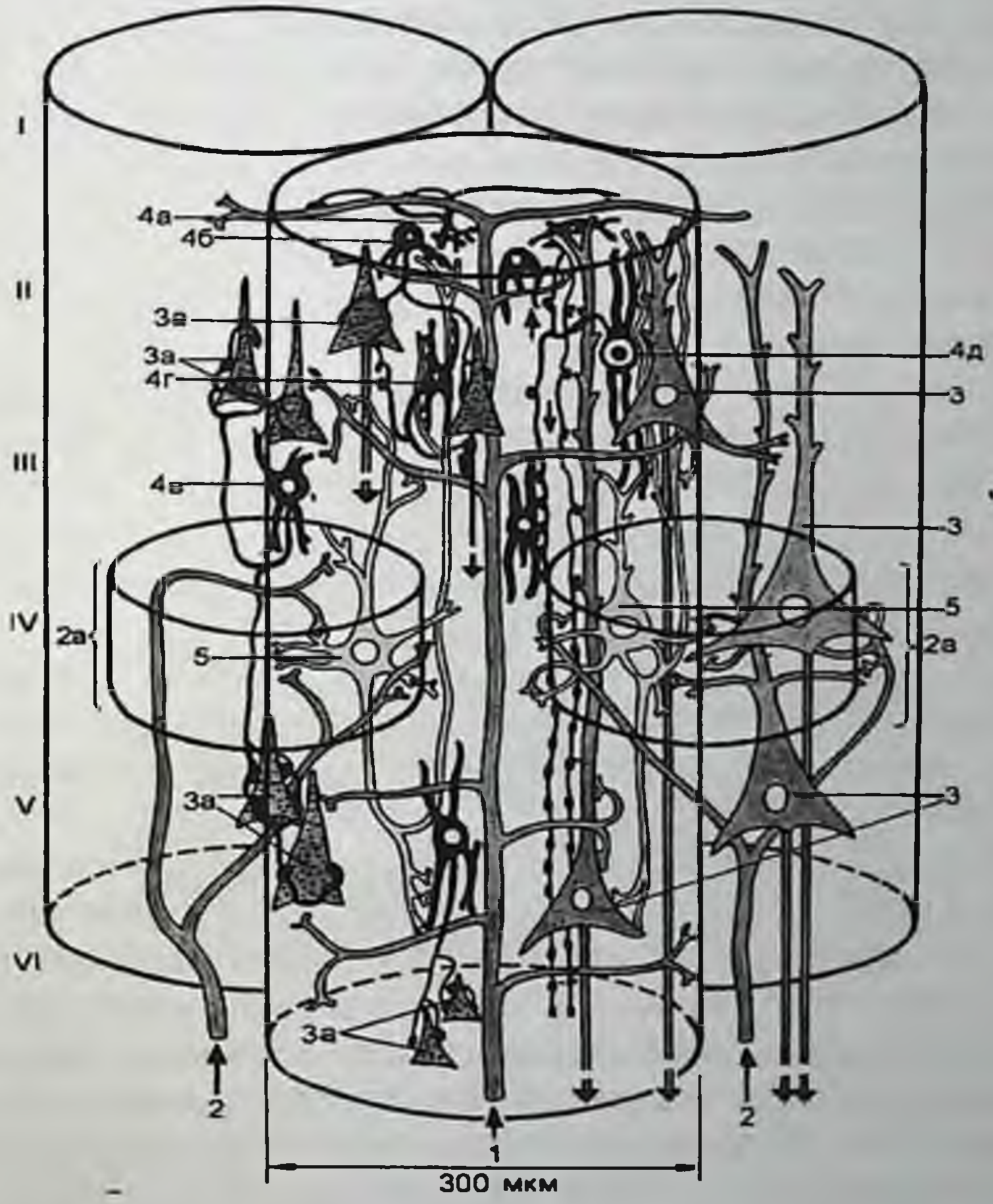
Associative and commissural fibers - in cortical fibers that connect between different cortical areas in the same or in different hemispheres, respectively. These fibers form bundles that run parallel to the surface of the cortex layer I (tangential fibers) in layer II (the strip spondylitis) in layer IV (the outer strip Bayyarzhe) and in layer V (internal strip Bayyarzhe). The latter two systems are the plexus formed by the final section of the afferent fibers.

Efferent fibers bind the cortex and subcortical formations. These fibers are in a downward direction in the radial beams (eg, pyramidal way).

Building types of the cerebral cortex

In some parts of the cortex associated with different functions, dominates the development of certain of its layers, which are distinguished on the basis of agranular and granular types of bark.

Agranular type of crust is typical for its motor centers and has the greatest development III, V and VI of the cortical layers in the poor development of II and IV (granular) layers. Such areas of the cortex are a source of descending pathways of the central nervous system. Granular type of crust is typical for the region of the sensory cortical centers.



Picture-123. **Modul brain. Afferent fibers (pink):** 1-cortico-cortical; 2-specific; 3-pyramidal neurons (blue); 4 inhibitory neurons and their synapses (black); 5-spiny satellite cells (yellow) excitatory pyramidal neurons.

It differs underdevelopment layers containing pyramidal cells, with a significant expression of granular (II and IV) layers.

Modular approach to the organization of the cerebral cortex of the brain

In the cerebral hemispheres of the brain are described repeating **blocks (modules) neurons,** which are regarded as its morphological and functional unit capable of relatively autonomous activity. They are in the form of cylinders or columns with a diameter of 200-300 mm (according to some estimates, up to 500 m or more), passing vertically through the entire thickness of the cortex. In the cortex of the human brain, there are about 3.2 million of these columns, each containing about **5,000 neurons**. Insidethe column is isolated as smaller mini-speakers, including the structure immediately surrounding the apical dendrites of pyramidal cells.

Column includes the following structures:

- Afferent pathways;
- A system of local bonds;
- Efferent pathways.

Afferent pathways. In the center column are about 100 excitatory cortical fibers - axons of pyramidal cells of the other speakers and the opposite hemispheres. They form the end of the column at all levels (including Martinotti cells, spinulose stellate cells of the lateral dendrites of pyramidal cells) and I go to bed, where they form the branches that go beyond it.

Specific afferent impulses thalamocortical fibers fed to the body and dendrites of pyramidal cells and stellate cells spinulose layer IV (the last in their axons to transmit them to the apical and basal dendrites of pyramidal cells).

System of local bonds formed neurons speakers, which include more than a dozen types of cells. Some of them have a brake function and predominantly regulates activity of pyramidal cells.Efferent pathways. The axons of pyramidal cells middle layer III speakers establish relationships mainly with the adjacent columns and rows in the opposite hemisphere, and the axons of large and giant pyramidal cell layer V, in addition, are sent to the subcortical centers, forming together with the axons of fusiform cells VI layer system efferent fibers of bark.

The white matter of the brain shows bundles of nerve fibers, which rise to cortical gray matter of the brain stem and down the trunk of the cortical centers of the brain gray matter.

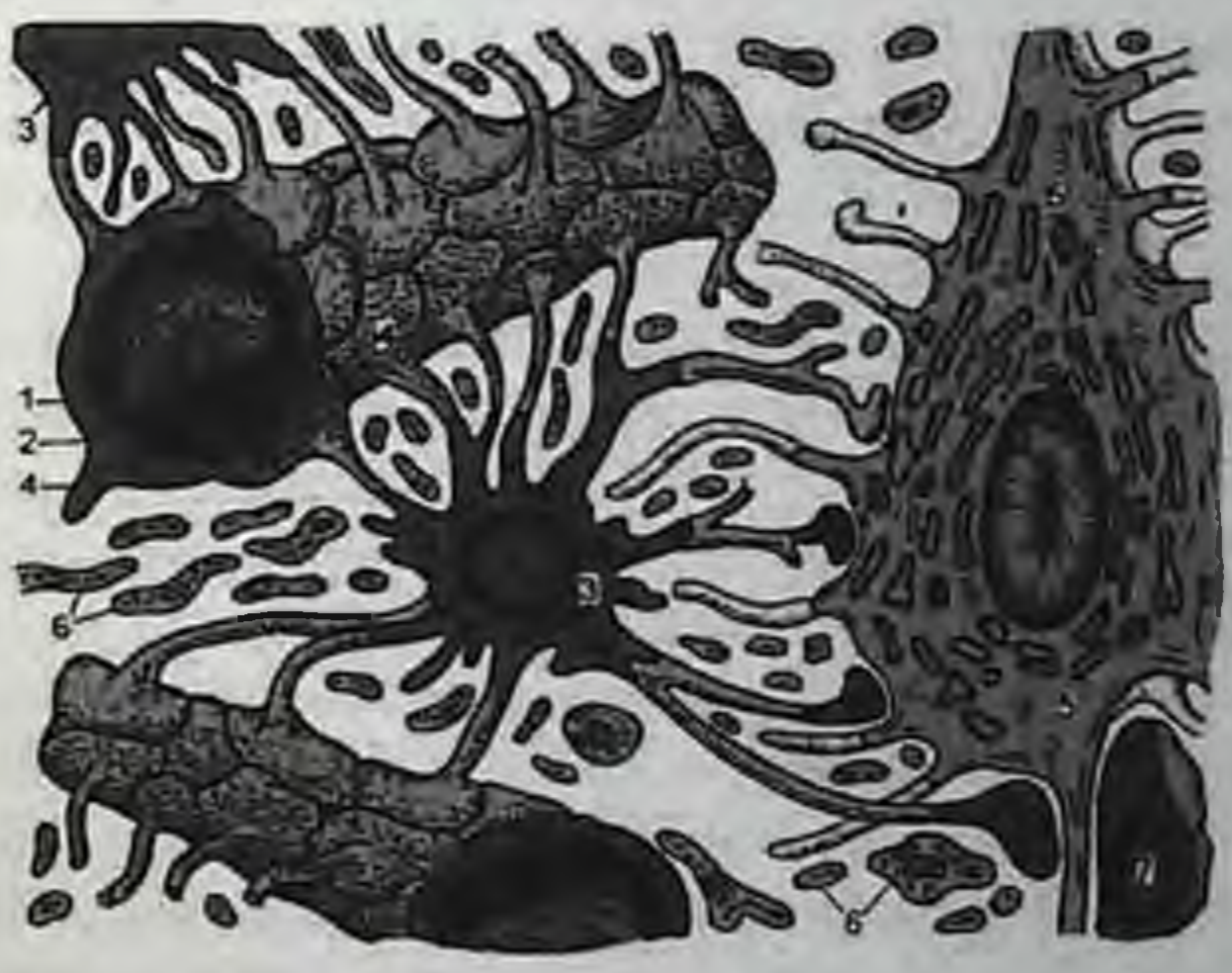
Glia of the brain. The brain contains all kinds macroglia (astrocytic, ependymal and oligodendroglial) and microglia.

Astrocytic glia provide the microenvironment of neurons, performs support and trophic functions in the gray and white matter, is involved in the metabolism of neurotransmitters. Astrocytes flattened plate-end portions of their processes form three types of glial border membranes:

perivascular; the surface; subendymal.

The blood-brain barrier

Perivascular limiting membrane surrounding the capillaries of the brain and are a part of the blood-brain barrier that separates the neurons of the central nervous system from the blood and tissues of the internal environment. The blood-brain barrier prevents the penetration of the central nervous system of blood-borne toxic substances, neurotransmitters, hormones, antibiotics (which makes treatment of infectious lesions of the brain and its membranes), supports the electrolyte balance of the brain, provides a number of selective transport of substances (glucose, amino acids) from the blood into brain.



Picture-124. **The structure of the blood-brain barrier:** 1-gemokapillyara endothelium; 2-basement membrane; 3-body astrocytes; 4-plate finishing processes of astrocytes; 5-neyron; 6-neuronal processes (neuropil); 7-oligodendrogliotsit.

The blood-brain barrier consists of the following components:

- The endothelium of blood capillaries (continuous lining) - the main component of the blood-brain barrier. Its cells are potent tight

junctions, whose formation is induced by contact with astrocytes. Endothelium prevents the transfer of some substances, contains specific transport systems for other metabolic changes and the third, converting them into compounds, unable to penetrate into the brain;

- Basement membrane of capillaries,
- Border perivascular glial membrane processes of astrocytes (pic-124).

Surface boundary glial membrane (edge glia) of the brain, is located under the meninges, forms the outer boundary of the brain and spinal cord, separating the tissue of the central nervous system from the meninges.

Subendymal (periventricular) Border glial membrane located beneath the ependyma and is part of the neuro-CSF barrier, which separates the neurons from the spinal fluid, also known as the liquor. This barrier is presented ependymal glia, its basement membrane (not always present) and the processes of astrocytes.

Ependymal glia forms the lining of the ventricles of the brain and is a member the blood cerebrospinal fluid barrier (between the blood and cerebrospinal fluid).

Oligodendroglia found in gray and white matter, it provides a barrier function, is involved in the formation of myelin sheaths of nerve fibers, regulates the metabolism of neurons, neurotransmitters grabs.

Microglia - specialized macrophages of the central nervous system, have considerable mobility. Activated by inflammatory and degenerative diseases. Performs in the central nervous system, the role of antigen-presenting dendritic cells.

Structure and function of the brain ventricles

Ventricles of the brain - the system of anastomosing cavities communicating with the central canal of spinal cord and subarachnoid space containing cerebrospinal fluid and lined by a single layer of ependymal layer of glial low prismatic cells or cubic shape with microvilli and cilia on the apical surface. In some areas ependimotsites have specific structural and functional features and participate in the development of spinal fluid and chemical signaling.

Choroid plexus of the ventricles of the brain - in the roof structure III and IV of the ventricles and part of the walls of the lateral ventricles, which provide 70-90% of the production of cerebrospinal fluid (10-30% are produced by tissue of the central nervous system and stand outside the ependyma choroid plexus). They are formed by branching

protrusions pia mater, which protrude into the lumen of the ventricles and are covered by special cubic horoidnymical ependimotsites.

Horoidnymical ependimotsites contain a large number of mitochondria, moderately developed synthetic apparatus, numerous vesicles and lysosomes. Their convex apical surface is covered with numerous microvilli, lateral form interdigitatsc and related complex compounds, and basal intertwined growths (basal labyrinth). On the surface of the choroid plexus ependyma move flattened Kolmer cells with well-developed lysosomal apparatus, which, obviously, are macrophages. Ependimotsites layer located on the basement membrane, which separates it from the underlying loose fibrous connective tissue of the pia mater, which contains numerous fenestrated capillaries and are found layered calcified bodies (nodules). Election ultrafiltration of blood plasma components with the formation of cerebrospinal fluid occurs from the capillaries into the lumen of the ventricles through the blood-CSF barrier. Found that ependymal cells are also capable of secreting certain proteins in cerebrospinal fluid and partially absorb substances from the cerebrospinal fluid (clearing it from the products of metabolism of the brain, drugs, particularly antibiotics).

Blood-cerebrospinal fluid barrier includes:

Cytoplasm-fenestrated capillary endothelial cells;

-Basement membrane capillary endothelium;

-Pericapillary space - a wide, free of loose fibrous connective tissue of the pia mater with a lot of macrophages;

- Basement membrane ependym;

- A layer of ependymal cells horoidnycal.

Cerebrospinal fluid circulates in the subarachnoid space of the ventricles of the brain and the central channel of the spinal cord. Its total volume in adults is 140-150 ml. It is produced in 500 ml per day, completely updated every 4-7 hours, and the composition is different from the serum - it has dramatically reduced the protein content and increased concentrations of sodium, potassium and chloride. Cerebrospinal fluid contains individual cells (no more than 5 cells in 1 mL). Absorption components of cerebrospinal fluid in the blood occurs in the villi spider plexus, jutting out into the subdural space on the extended center line of the brain, a small part of it is the ependym choroid plexus. Disruption of the normal ebb and absorption of cerebrospinal fluid leads to the development of hydrocephalus (characterized by expansion and compression of the ventricles of the brain and in utero and early

childhood - before closing the sutures of the skull as an increase in the size of the head).

The functions of cerebrospinal fluid:

- Protection (depreciation shock and concussion);
- The formation of hydrostatic shell around the brain and nerve roots and blood vessels, which are freely suspended in the surrounding cerebrospinal fluid (due to small differences in the density of cerebrospinal fluid and brain tissue), thereby decreasing the tension of the roots and vessels;
- Creation of an optimum liquid medium surrounding the organs of the central nervous system, in particular, the maintenance of constant ionic composition for normal activity of neurons and glia;
- Removing metabolites produced by the brain tissues;

Integrative - by moving the hormones and other biologically active substances.

Tannitsites - specialized ependymal cells in the lateral ventricle wall section III, infundibular pocket and the median eminence, which provide the link between the cerebrospinal fluid in the lumen of the ventricles of the brain and blood. They have a cubic or prismatic shape, their apical surface is covered with microvilli and individual cilia and basal leaves of the long arm, ending plate extension to blood capillaries. Tanitsites uptake from cerebrospinal fluid and transport them in their processes in the vascular lumen.

Meninges

The brain is protected by the bones of the skull and spinal cord - the vertebrae and intervertebral discs, and they are surrounded by three meninges (outside-in):

solid, arachnoid, soft, which fix these organs in the skull and vertebral canal and perform a protective, shock-absorbing functions, ensure the production and absorption of cerebrospinal fluid.

Dura (dura mater) formed a dense fibrous connective tissue with a high content of elastic fibers. In the spinal canal between it and the vertebral bodies have epidural space filled with loose fibrous connective tissue rich in fat cells, and contains numerous blood vessels. Hard shell of the brain tightly adherent to the periosteum of the skull, the epidural space is missing. On the side facing the arachnoid membrane, it is covered with layer of flat glial cells (meningoteliem). Hard shell of the brain forms a series of processes, which penetrate between the parts of the brain, separating them from each other. Between its folds are

lined with endothelium space filled with venous blood - sinuses (sinus) dura.

Arachnoid mater (arachnoidea) loosely adherent to the dura mater, from which it separates the narrow subdural space containing a small amount of body fluids other than cerebrospinal fluid. Arachnoid membrane formed by connective tissue rich in fibroblasts, and between it and the pia mater is filled with cerebrospinal fluid wide subarachnoid space, which is crossed by numerous thin branching connective tissue bands (trabeculae), extending from the arachnoid and woven into the meninges. In this space are the major blood vessels that feed the brain branches. On the surface facing into the subdural and subarachnoid space, arachnoid lined with a layer of flat glial cells that cover and trabeculae.

Arachnoid villi - (the largest of them - Pacchionian bodies - visible macroscopically) are areas through which substances from the cerebrospinal fluid back into the blood. They are outgrowths of avascular arachnoid brain mushroom-shaped, containing a network of slit-like spaces and stick out into the lumen of the sinuses of the dura mater. They spinal fluid is removed from the blood of a layer of glial cells and the endothelium of the sinus. The number and size of these villi increase with age.

Pia (pia mater), formed by a thin layer of connective tissue rich in small blood vessels and nerve fibers directly coated on the surface of the brain, repeating its relief and penetrating into the groove. On both surfaces (facing into the subarachnoid space and contiguous to the tissues of the brain) it is covered meningoteliem. Pia mater surrounding the vessels enter the brain, forming around the perivascular membrane, which in the future (with a decrease in the caliber of the vessel) is replaced by the Border perivascular glial membrane formed astrocytes. From the tissues of the central nervous system pia mater separates the outer limiting glial membrane and the basement membrane formed by astrocytes.

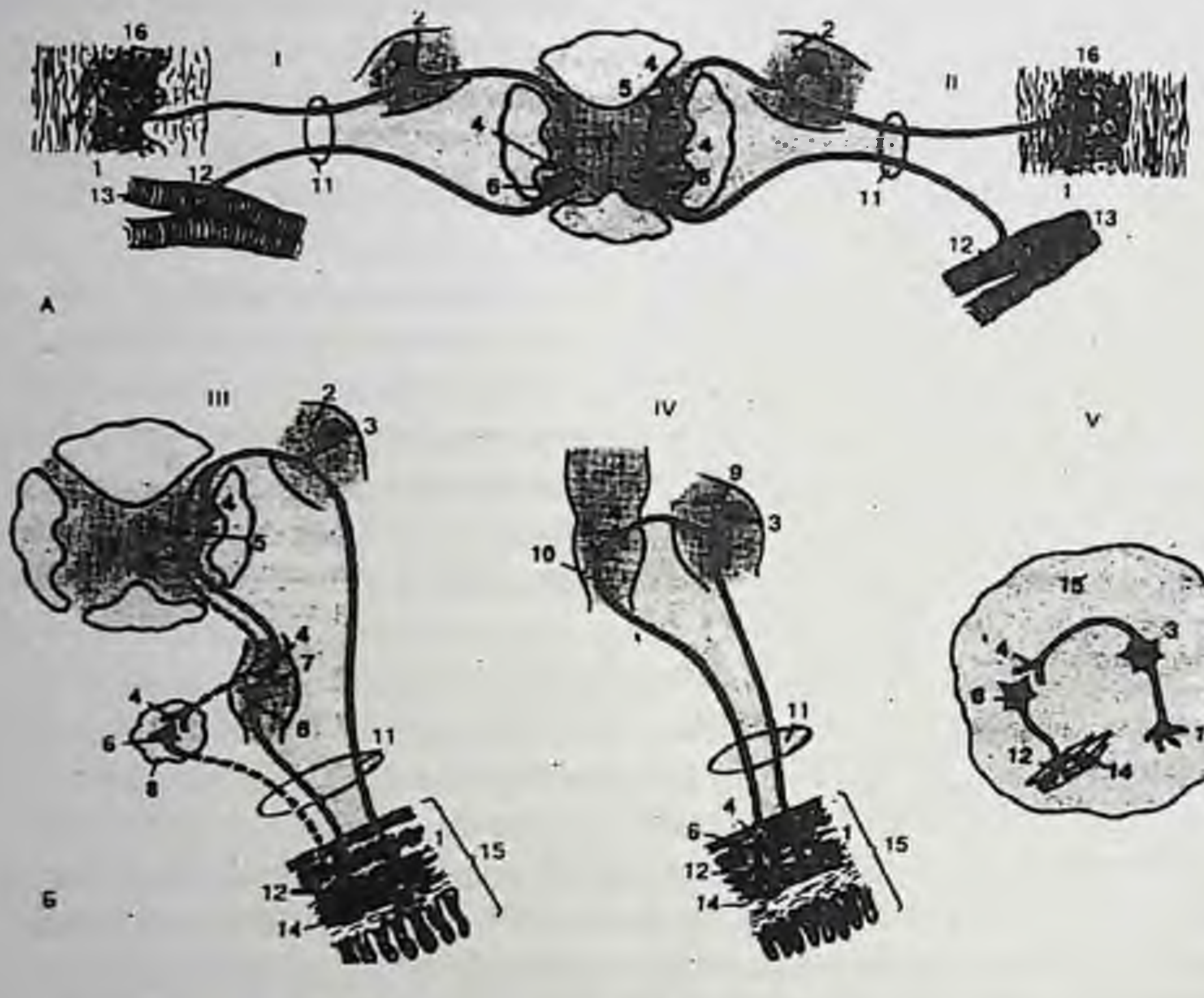
In the roof III and IV ventricles, and some sections of the walls of lateral ventricles of the brain pia with ependymomas involved in the formation of the vascular plexus that produce cerebrospinal fluid.

Reflex arc

The reflex arc is a morphofunctional unit of the nervous system, they are a chain of neurons that provide the reaction of working bodies response to stimulation of receptors.

In reflex arcs neurons connected to each other by synapses to form three links: receptor (afferent); therebetween associative (gusset), which in the simplest embodiment, the arc may be missing; effector.

At various parts of the arc have regulatory effects associated neurons overlying centers, resulting in reflex arcs have a complex structure. Reflex arcs in the somatic (the animal) and autonomous (vegetative) nervous systems have a number of features (pic-125).



Picture-125. **Types reflex.** A- somatic B- vegetative I-simple, II-complex, III-somatic, IV- parasympathetic, V- spot. 1-receptor; 2-spinal ganglia; 3-afferent neurons; 4- synapse; 5- associative neuron; 6- motoneuron (efferent); 7–8-vegetative ganglia of sympathetic trunk; 9-autonomic nervous plexus ganglion afferent vagus nerve; 10 medulla oblongata; 11-peripheral nerve; 12-efferent nerve ending; 13-wall of the inner body; 14-smooth muscle; 15-epithelium; 16-spinal cord.

Somatic (the animal) reflex arc

Receptor unit formed by afferent neurons psevdounipolyarnymi whose bodies are located in the spinal ganglia. The dendrites of these cells form the sensory nerve endings in the skin or skeletal muscle, and

the axons enter the spinal cord as part of dorsal root and sent to the posterior horns of his gray matter, forming synapses and dendrites on the bodies of neurons. Some branches (collaterals) axons of neurons are psevdounipolyarnyh (not forming ties in the posterior horns) directly into the anterior horns, which end in motor neurons (forming with them dvuhneyronnye reflex arc).

Associative link presented multipolar neurons, dendrites and the body are located in the posterior horn of the spinal cord and the axons directed to the anterior horns, transferring pulses to the body and dendrites of effector neurons.

Effector unit formed multipolar motor neurons, the body and dendrites of which lie in the anterior horns, and axons out of the spinal cord as part of the anterior roots are routed to the spinal ganglia and then as part of a mixed nerve - to skeletal muscle fibers to which their branches form a neuromuscular synapses (motor or motor, plaques).

Autonomous (vegetative) reflex arc

Receptor unit as in somatic reflex arc formed psevdounipolyarnymi afferent neurons, which lie in a body of spinal ganglia, but these dendritic cells form the sensitive nerve endings in tissues of internal organs, glands and blood vessels. Their axons enter the spinal cord as part of dorsal root and bypassing the posterior horns are directed to the lateral horn of the gray matter, forming synapses and dendrites on the bodies of neurons.

Associative link presented multipolar neurons, dendrites and the body are located in the lateral horns of the spinal cord and the axons (fibers preganglinarnye) leave the spinal cord as part of the anterior roots, going to one of the autonomic ganglia, where it ends in the dendrites and bodies effector neurons.

Effector unit formed multipolar neurons whose bodies are composed of autonomic ganglia and axons (postganglionic fibers), consisting of nerve trunks and branches are sent to the cells of working bodies - smooth muscle, glands and heart.

Nerve

Nerves (nerve trunks) connect the nerve centers of the brain and spinal cord receptors and working bodies. They are formed by bundles of nerve fibers, which are united by connective tissue components (shells): endoneurium; perineurium; epineurium. Endoneurium - thin layer of loose fibrous connective tissue surrounding the nerve fibers separate and bind them into a single beam. It contains a few cells and

fibers (mainly reticular), are small blood vessels. Perineurium - skin covering each bundle of nerve fibers on the outside walls and gave deep beam. It is formed by concentric layers of 2-10 flattened cells associated tight and gap junctions. Epineurium - the outer shell is a nerve that connects together the bundles of nerve fibers (the number of which depends on the diameter of the nerve, and ranges from one to several dozen). It is composed of dense fibrous connective tissue comprising fat cells, blood and lymph vessels.

Ganglia: sensory ganglia

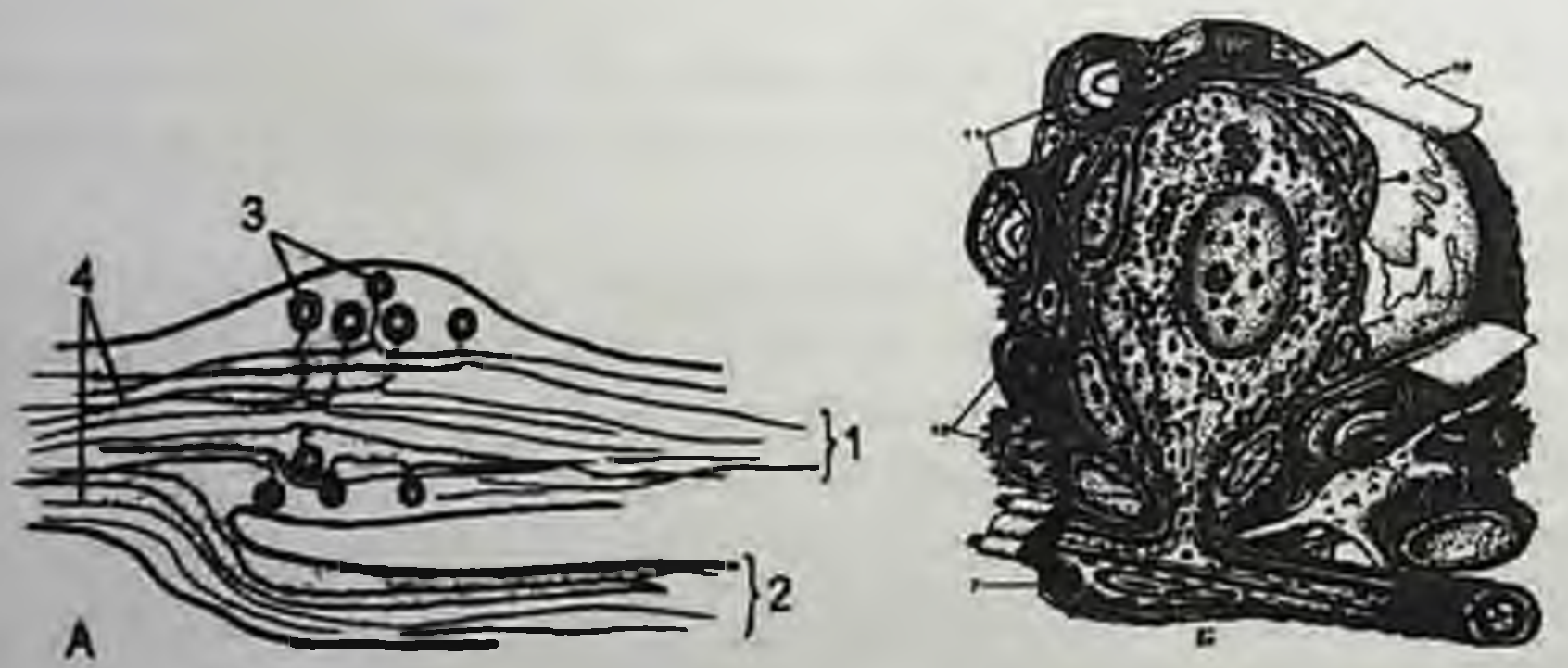
6.1.2. Ganglia (ganglia)

Cluster of neurons outside the central nervous system. They are divided into sensitive (sensory) and autonomous (vegetative).

Sensitive (sensory) ganglia contain psevdounipolyarnye or bipolar (in a spiral and vestibular ganglion) and afferent neurons located along the dorsal root of the spinal cord (spinal or spinal assemblies) and cranial nerves (5, 7, 8, 9, 10).

Spinal units

Cerebrospinal (spinal) node (ganglion) is spindle-shaped and covered by a capsule of dense fibrous connective tissue. On its periphery are dense clusters of bodies psevdounipolyarnyh neurons, and the central part is occupied by their processes and intervening thin layers endoneurium carrying vessels (pic-126).



Picture-126. **The structure of the spinal ganglion.** A longitudinal section of the ganglion and rootlets. 1-dorsal root; 2-front spine; 3-psevdounipolyarnye neurons; 4-(nerve fibers); 5-connective tissue capsule; 6-ganglion; 7-lemmotsit; 8 T-shaped branching process; 9-neyrolemmotsity ganglion; 10-basement membrane; 11-hemocapillars; 12-myelinated and unmyelinated fibers.

Psevdounipolar neurons are characterized by a spherical body and a bright nucleus with a visible nucleolus. Each neuron is surrounded by a layer adjacent to it flattened cells oligodendroglial (mantle glial cells or satellite cells) with small round nuclei; outside of the glial membrane with a thin connective tissue sheath. From the body of the neuron psevdounipolyarnogo departs process that separates the T-shape on the afferent (dendritic) and efferent (axonal) branches, which are covered by myelin sheath. Afferent branch ends at the periphery of receptors composed of efferent dorsal root enters the spinal cord.

Autonomous (vegetative) nervous nodes (Ganglia) can be placed along the spine (paravertebral ganglia) in front of him (prevertebral ganglia) in the wall of organs (heart, bronchi, digestive tract, bladder, and others) (intramural ganglia) and near the surface. Sometimes they take the form of small (from a few to a few tens of cells cells) clusters of neurons located in the course of certain nerves or lying intramural (mikroganglii). By vegetative nodes suitable preganglionic fibers (myelin) that contain cell processes whose bodies lie in the central nervous sisteme.Vegetativnye ganglia by function and localization are divided into: sympathetic, parasympathetic.

Sympathetic ganglia (para- and prevertebral) receive preganglionic fibers from cells located in the vegetative nuclei of the thoracic and lumbar segments of the spinal cord. Preganglionic fibers neurotransmitter is acetylcholine, and postganlionarnyh - noradrenaline (except sweat glands and some blood vessels, with cholinergic sympathetic innervation).

Parasympathetic ganglia lie in the organs themselves (intramural) and they are preganglionic fibers from cells located in the vegetative nuclei of the medulla and midbrain, and the lumbosacral spinal cord. The fibers leaving the central nervous system composed of 3, 7, 9, 10 pairs of cranial nerves and the anterior roots sacral spinal segments. Neurotransmitter pre- and postganglionic fibers is acetylcholine. In addition to his role of mediators in these ganglia play serotonin, ATP, maybe some peptides. In intramural nodes described three types of neurons (Figure 120):

- dlinnoaksonnye efferent neurons (cells Dogel type I) predominate. These are large or medium-sized efferent neurons with short dendrites and long axons, traveling outside the working body on the cells of which it forms a motor or secretory end;

-ravnootrostchatye afferent neurons (cells Dogel type II) have long dendrites and axons, stretching the limits of neighboring ganglion and synapse on cells of types I and III. These cells appear to belong to a receptor in the link local reflex arcs, which close without entering the nerve impulse to the central nervous system. The presence of such arcs confirms the continuation of the autonomic nervous system

functionally active afferent and efferent associative neurons transplanted organs (eg, heart);

- Associative cells (type III Dogel) - Local intercalary neurons that connect their processes several cell types I and II, morphologically similar to type II cells Dogel. Dendrites these cells do not extend beyond the node, but the axons are sent to other nodes on the cells forming synapses, type.

Picture-127. **Risk neurons and nerve fibers:** 1-long neuronal axons; 2-axon; 3-ravnootrastchatye neurons; 4-core glial cells.

Clinical significance

In traumatic brain injury as a result of damage to blood vessels, blood can accumulate under the periosteum (epidural hematoma) in the subdural space (subdural hematoma). Rupture blood vessels passing through the surface of the brain, causes bleeding into the subarachnoid space with the appearance of blood in the cerebrospinal fluid. Often affects the lining of the brain infectious process (meningitis), which may be complicated by the formation of adhesions in the subarachnoid space in violation of the outflow of cerebrospinal fluid and the development of hydrocephalus. Meningotely often becomes a source of benign prostatic tumor.

Nervous system tumors

Virtually all of the cells of the nervous tissue can give rise to tumors. From glial cells produce glioma, immature nerve cells give medulloblastom, and Schwann cells were schwannomas. Since neurons in adults do not share, they do not form tumors.

The practical part

Compilation of logical structures, the study of drugs in organs of the nervous system, and a sketch of the principles of electron structure of the spinal cord, cerebellum, cerebral cortex and autonomic ganglia to albums

The objects under study: 1. Spinal cord; 2. The cerebellum; 3. cortex; 4. autonomic ganglia.

Sample test items

1. Sources of development of the nervous system:

a) the neural tube;
b) ganglion plate;
c) the endoderm;
d) placode.

2. What is the difference front horn of the spinal cord dorsal horn?

a) has radicular neurons;
b) innervirut muscles of the body and limbs;
c) has intercalary neurons;
d) has connections with afferent neurons.

3. The bark of the cerebellum has a molecular layer...

a) pyramid ganglion;
b) granular;
c) mossy.

4. In the cerebral cortex nerve fibers are:

a) kommisuralny;
b) assotsiatitvny;
c) projection;
d) spino-thalamic.

Approximate abstract report on the theme: "Development and age characteristics of nervous tissue"

6.2. The sense organs

The organ of hearing and balance

I. Goals and Objectives:

1. The study of the function and structure of the organ of hearing.
2. The study of the function and structure of the organ of balance.

II. Sample questions for self;

1. General hararkteriststika senses;
2. Stronach outer and middle ear;
3. The structure of the inner ear; Snail;
4. Structures organ of Corti - the organ of hearing, its cellular composition;
5. Cytophysiology hearing;
6. Topography body balance;
7. Cellular composition ampullar scallop and macula;
8. The clinical significance of the topic.

The oretical part The sense organs

6.2.1. General characteristic

The sensor system provides a perception of the body of information on the state of the external and internal environment, as well as its processing and transformation into a sensation. All of these functions are performed by the analyzers and theiperipheral divisions - the senses. Analyzers - are complex structural-functional systems, connecting the central nervous system with the external and internal environment. They are part of the afferent reflex arcs. Each analyzer consists of three parts: peripheral, in which the perception of the stimulus;

intermediate or conductive represented pathways and subcortical structures;

center formed part of the cortex of the brain, where there is analysis and synthesis sensation; The sense organs are the peripheral parts of the analyzers.

Three types of sensory organs:

I type formed bodies of developing neuroectoderm. The receptor cells in these organs are the nerve cells are called primary sensory (primary sensory receptors). These bodies are the organs of sight and smell;

II Type sensory organs presented hearing, balance, taste. These organs perceive stimuli epithelial cells called sensoepitelial developing from cutaneous ectoderm. Sensoepitelial cells called secondarily sensitive (vtorichnochuvstvuyuschie receptors). They contact the dendrites of sensory nerve cells that transmit the perceived irritation to your neuron;

III Type senses presented encapsulated and non-encapsulated nerve endings. Their structure, as a rule, not an organ of the principle

(exception - encapsulated nerve endings). They are all the dendrites of neurons sensitive ganglia.

The organ of hearing and balance

The structure of the organ of hearing and balance are: external, middle, inner ear, which perceive sound, gravity, vibration stimuli, as well as linear and angular acceleration.

The outer ear consists of the shell, ear canal, eardrum.

Auricle formed an elastic cartilage covered with skin.

External auditory canal also provides elastic cartilage, which is a continuation of the cartilage ear and passing into the bone of the temporal bone. It is lined with bristly hair, skin and sulfur glands that produce earwax. The skin of the ear canal also contains sebaceous glands.

The tympanic membrane consists of two layers of collagen fibers, the outer layer of radial internal - circular and located between fibroblasts. Outside, covered with a thin epidermis, from the inside - the mucosa with single flat epithelium. With an eardrum with hammer handle spliced - one of the auditory ossicles.

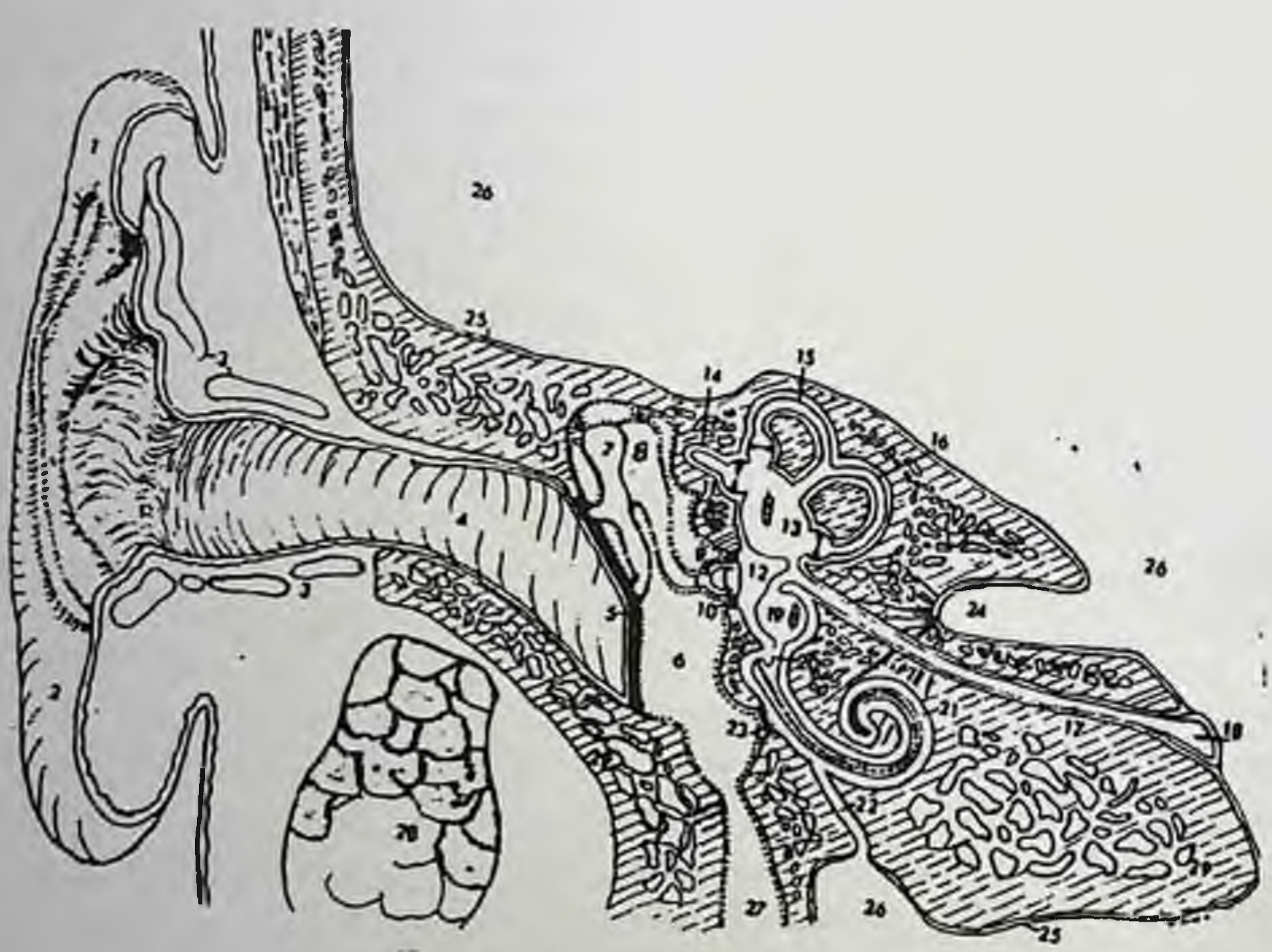
The middle ear consists of the tympanic cavity, auditory ossicles. **Auditory** tube.

covered with a single layer of barrel flat or cuboidal epithelium. The epithelium is the basement membrane, and the latter by a thin lamina propria, tightly connected with the periosteum. On the medial wall of the tympanic cavity formed bone wall of the inner ear, there are two openings or windows: oval and round. Oval window closes stapes base. It separates the tympanic cavity from the vestibular stairs snail. Round window closed fibrous membrane and separates the tympanic cavity from the tympani snails. **Ossicles** - the hammer, anvil and stirrup - formed lamellar bone, the articular hyaline cartilage-covered surfaces. Outside the stone covered with a single layer of squamous epithelium. They transmit auditory vibrations from the eardrum to the oval window and tympani. Associated with bone small striated muscle.

Auditory (Eustachian) tube connects the tympanic cavity with the nasopharynx. Formed bone wall covered with multilane ciliated epithelium, lying on his own record. Lamina propria contains simple mucous glands, as well as accumulation of lymphoid tissue that forms a tubular glands. Through the tube is regulated air pressure in the tympanic cavity. Pharyngeal opening pipe closed and opens only when swallowing, which balances the pressure on the eardrum.

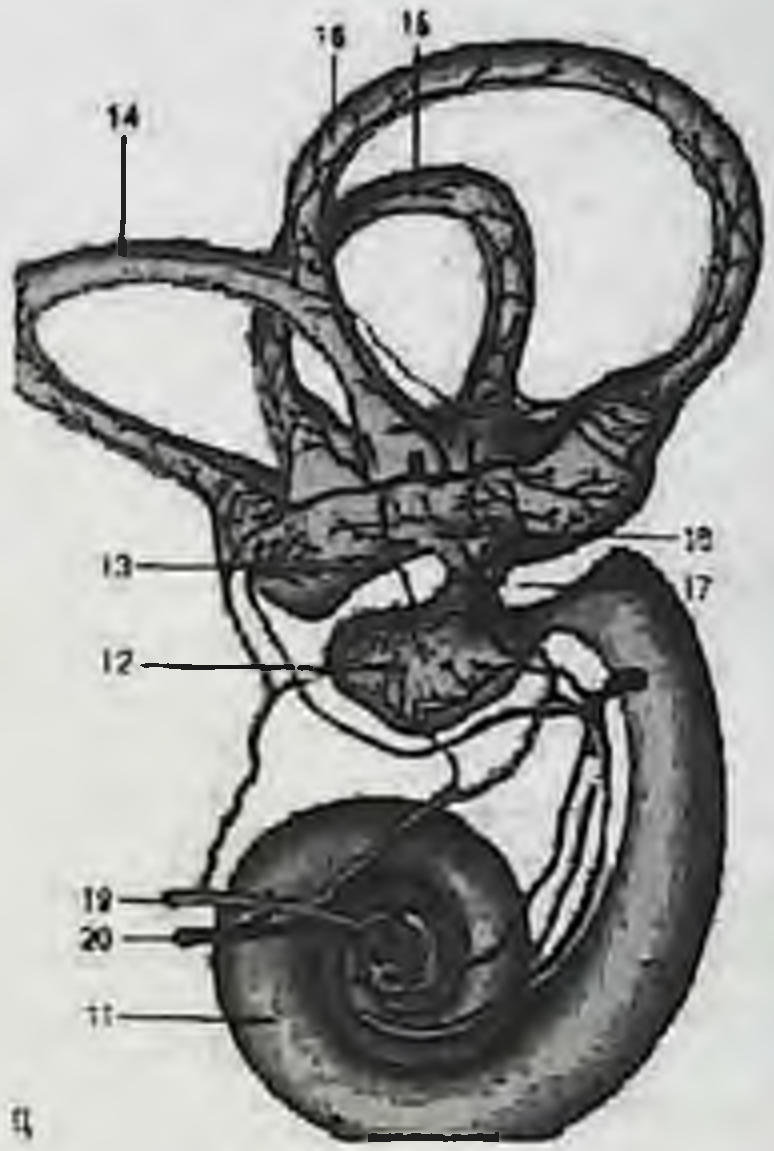
The inner ear is located in the pyramid of the temporal bone. Consists of **bone** and placed in it the membranous labyrinth. **Bony labyrinth** - a system of cavities, which include: the vestibule, the cochlea, the semicircular canals.

In the membranous labyrinth are the receptor cells of hearing and balance. They lie in special areas: the receptor cells of the organ of hearing in the spiral (Corti) organ (cochlea) and the receptor cells of the organ of equilibrium in an elliptical sacs (utricle), spherical sac (saccu-lus) and ampullar cristae in the semicircular canals. Membranous laby-rinth contains endolymph, and the space between the bone and the membranous labyrinth - perilymph. (128-img).



128-img. **The organ of hearing.** 1-auricle; 2-ear; 3-cartilage; 4-ear canal; 5-eardrum; 6-barrel; 7-hammer; 8-anvil; 9-stapes; 10-oval window; 11-facial nerve; 12-vestibular staircase; 13-dearest (patch); 14-lateral (horizontal) semicircular canal and ampullar scallops; 15-front (vertical) semicircular canal and ampullar scallops; 16-rear (vertical) semicircular canal and ampullar scallops; 17-endolymphatic duct; 18-sac; 19-spot bag; 20 connecting duct; 21-snail; 22-channel cochlear; 23-round box; 24-internal auditory bone; 25-solid; 26-cranial cavity; 27-auditory tube (Eustachian tube); 28-parotid gland; 29-temporal bone.

Development. Membranous labyrinth, which contains the organ of hearing and balance, is derived from the ectoderm. In this case, on the sides of the body to the head of the embryo formed paired thickening ectoderm - placode. They invaginates into the mesenchyme and become ear vesicles.

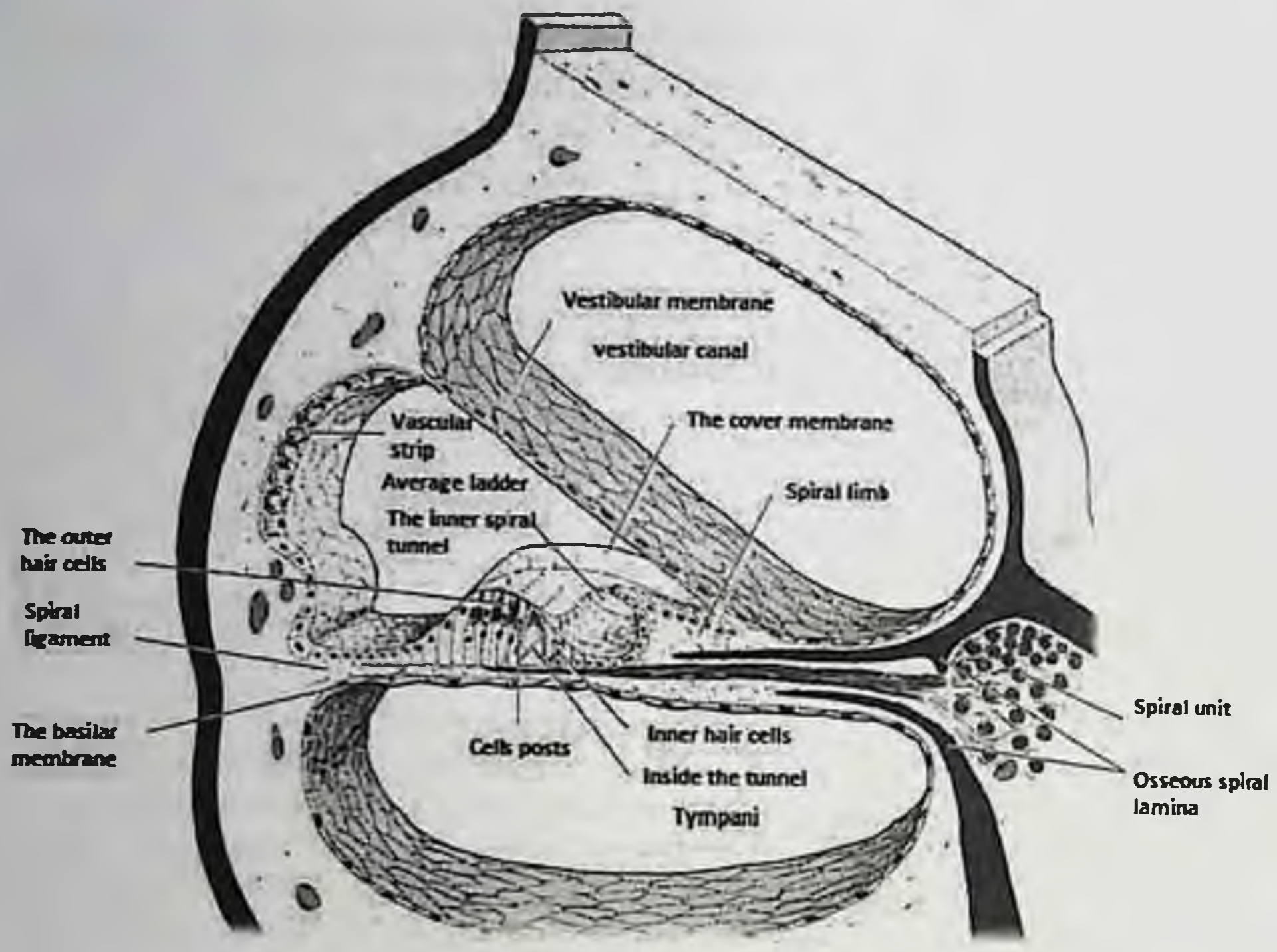


129-img. **The development of the inner ear. A-plokady auditory development** (step 9 somites). B-education auditory pit (stage 16 somites). C-development of otic vesicle (stage 30 somites). D-development of the membranous labyrinth. D-developed membranous labyrinth of the right ear.
1-ectoderm; 2 placode; 3-mesoderm; 4 dorsal aorta; 5.6-sip; 7-telencephalon; 8-ventral aorta; 9-auditory vesicle; 10-beginning of the development of vestibular; 11-snail; 12-spherical bubble; 13-elliptical bag; 14-upper longitudinal semicircular canal; 15-outer horizontal semicircular canal; 16-posterior semicircular canal; 17-mezhmeshkovy channel; 18-endoplasmic channel; 19-artery. 20-vienna.

Each bubble is lined with pseudostratified epithelium and filled with endolymph. Then bubbles are divided into two parts: the vestibular (utricle with the semicircular canals) and a bag of cochlear duct. Later snail grows in size and is separated from the pouch. The inner lining of the bubbles is differentiated under the influence of the auditory ganglion.

Organ of hearing

Hearing organ located in the cochlear duct of the membranous labyrinth for its entire length. A cross section of the channel has the shape of a triangle, facing the central bone rod snails. Cochlear canal has a length of about 3.5 cm, making 2.5 turns in a spiral around a central shaft of the bone ends and blind on top. The channel is filled with endolymph. Outside of the cochlear duct is space filled perilymph. These spaces are called ladders. Top is vestibular stairs, bottom - drum. Vestibular ladder separated from the tympanic cavity oval window, where the base is inserted stapes and tympani tympanic cavity is separated from the round window. Both stairs and surrounded by bone-channel cochlear bone snails.



130-img. **The structure of the cochlea**

The wall of the cochlear canal, facing the vestibular stairs, called the vestibular membrane. This membrane is composed of connective plate covered with a single layer on both sides of squamous epithelium. Side wall cochlear duct is formed spiral ligament, which has a vascular strip - pseudostratified epithelium to the blood capillaries. Vascular strip produces endolymph, provides transport to the organ of Corti of nutrients and oxygen to support the ionic composition of the endolymph, necessary for normal function of the hair cells.

The wall of the cochlear duct, which lies on the tympani, has a complex structure. **It is a receptor system - the organ of Corti**. The basis of this wall is the basilar membrane, covered by squamous epithelium tympani. The basilar membrane is composed of thin collagen fibers auditory strings. These strings stretched between the spiral bone plate extending from Modiolus snail and spiral ligament, which lies on the outer wall of the cochlea. Their length varies: at the base of the cochlea are shorter (100 m), and at the top to 5 times longer. Basilar membrane of the cochlear duct is covered Border basement membrane,

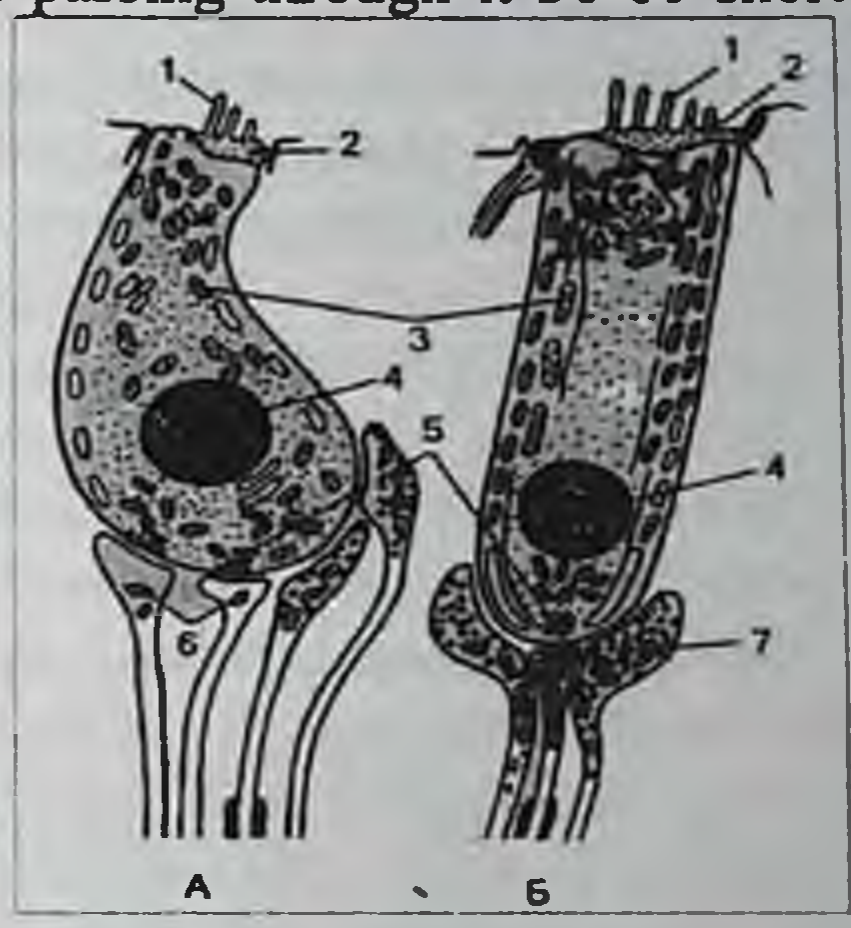
which has a spiral organ of Corti. It consists of receptor and supporting cells of different shapes (130-img).

The receptor cells are divided into:

- Domestic;
- The outer hair cells (131-img).

Inner cells are pear-shaped

Their nuclei lie in the extended bottom. On the surface of the apical part of the waist is the cuticle and passing through it 30-60 short stereocilia, linearly arranged in three rows. The hairs are fixed. The total number of inner hair cells is about 3500. They lie in a row along the spiral organ. The inner hair cells are in the pits of the internal reference phalanx cells.



131-img. **(A) internal and (B) the outer hair sensory epithelial:** 1-hair; 2- cuticle; 3-mitochondria; 4-core; 5-synaptic vesicles receptor cells; 6-bright nerve; 7-dark nerves.

Outer hair cells are cylindrical in shape. On the apical surface of these cells also have a cuticle through which

the stereocilia. They lie in rows. Their number in each cell 70. Its vertices stereocilia are attached to the inner surface of the cover (tectorial) membrane. This membrane is hanging over the body and the spiral formed by Holocrine secretion cells limb from which it departs. Outer hair cells are in the form of three parallel rows along the length of the spiral organ. They found a large number of actin and myosin filaments are embedded in the cuticle. Well developed mitochondria and smooth endoplasmic reticulum.

And innervation of the two different types of hair cells. The inner hair cells are generally sensitive innervation, whereas the outer approach mostly efferent nerve fibers. Number of outer hair cells is 12 000-19 000. They perceive the sounds of greater intensity, and the interior can perceive and faint sounds. At the apex of the cochlea hair cells make low, and at the base of it - high-pitched sounds. To the outer and inner hair cells are suitable dendrites of bipolar neurons of the spiral ganglion, which lies between the mouth of the skull spiral.

Supporting cells of the spiral organ differ in structure. There are several types of these cells:

- Internal and external phalanx;
- Internal and external cell poles;
- External and internal border cell Hensen;
- External support cells and Claudius cells Böttcher.

The name "phalanx cells" due to the fact that they have a thin finger-like processes, which are separated from each other sensory cells. Cell poles have a wide base, which lies on the basement membrane and the narrow central and apical parts. Latest interior and exterior cells are connected to each other, forming a triangular tunnel, through which the hair cells to the appropriate sensory neuron dendrites. External and internal border Hensen cells are respectively outside the outer and inner phalanx medially from the cells. Claudius support cells are outside of the outer border cells and Hensen cells lie on Böttcher. All these cells perform support functions. Botcher cells lie under Claudius cells and between them and the basement membrane.

Spiral ganglion is located at the base of the skull spiral extending from Modiolus, which is divided into two lips, forming a cavity for ganglion. Ganglion is built on the general principle of sensory ganglia. In contrast to the spinal ganglia are sensitive to form a bipolar neurocytes. Their dendrites through the tunnel approach to hair cells, forming them neuroepithelial synapses. The axons of the bipolar cells form the cochlear nerve.

Histophysiology hearing. The sounds of a certain frequency are perceived outer ear and are transmitted through the ossicles and oval window perilymph in the tympanic and vestibular stairs. In this case, starts to oscillate vestibular and basilar membrane, and hence the endolymph. As a result of the movement of the endolymph displaced sensory hair cells, because they are attached to the tectorial membrane. This leads to the stimulation of hair cells (Figure 124), and through them - bipolar spiral ganglion neurons that transmit auditory stimulation in the brain stem nuclei, and then the auditory area of the cerebral cortex.

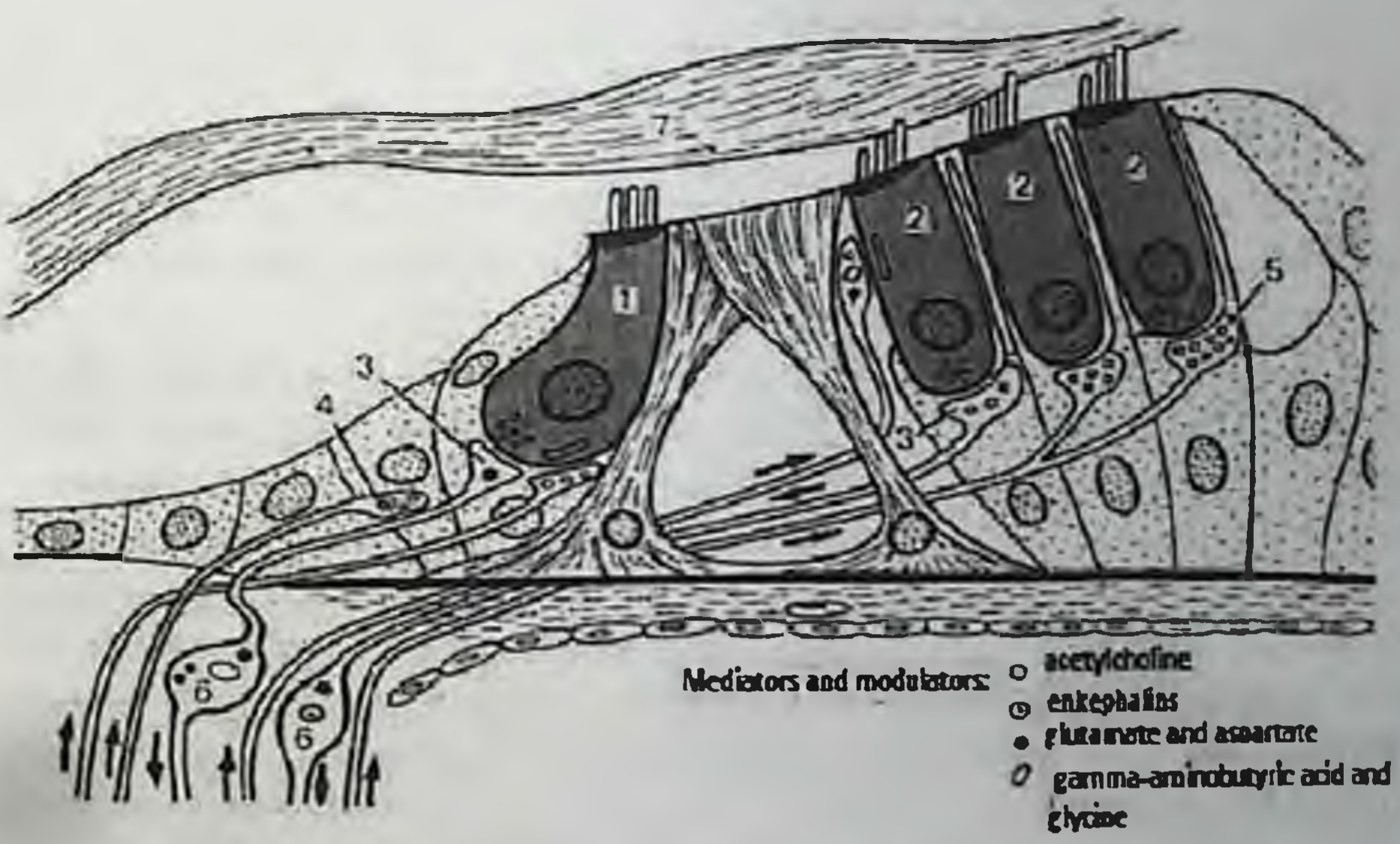
Neuronal composition analyzers hearing and balance as follows:

- Neuron - bipolar neurons of the spiral (the hearing organ) or vestibular (balance organ) ganglia;
- Neuron - vestibular nuclei of the medulla oblongata;

- Neuron in the thalamic axons of it goes to the neurons of the cortex
hemispheres.

Certain frequency sounds are perceived outer ear and are transmitted via the auditory ossicles and oval window in the perilymph, located in the tympanic and vestibular stairs. When this comes into vibrational motion vestibular membrane and the basilar, and hence the endolymph. By moving the shift endolymph hairs sensory cells, as they are attached to the tectorial membrane. This leads to the stimulation of hair cells (Figure 132), and through them - bipolar spiral ganglion neurons that transmit excitation in the auditory brainstem nuclei, and then in the auditory region of the cerebral cortex. Neuronal composition analyzers hearing and balance the following:

- Neuron - the bipolar neurons of the spiral (the organ of hearing) or vestibular (balance organ) ganglia;
- Neuron - vestibular nuclei of the medulla oblongata;
- Neuron in thalamic axon it comes to cortical neurons



132-img. **Innervation and mediator providing spiral body (schema).**
1-internal sensoepitelialnaya cell; 2-outdoor sensoepitelialnye cells; 3-receptors on sensoepitelialnyh cells; 4-efferent endings in the receptor neuron dendrites; 5-efferentnae sensoepitelialnyh end on the outer cells; 6-bipolar neurons of the spiral node; 7-tectorial membrane.

Organ of body balance

Body balance consists of a spherical bubble - bag or sacculus, utricle or elliptical bubble utricle and three semicircular canals. At the junction of these channels with an expansion of the utricle - ampoules. The pouch is connected to the channel cochlea. In vials are receptor sites in the form of scallops or cristae. In the utricle and sac receptor sites have the form of spots or maculae.In these areas the epithelium has a special structure, and all the rest of the vestibular membranous labyrinth is lined with a single layer of squamous epithelium.

The epithelium is composed of maculae 7000-9000 sensory hair epithelial cells and are located between the supporting cells. Above the surface of the epithelium is having a gelatinous consistency otolith membrane containing calcium carbonate crystals (otoliths or statoconia).

In the otolith membrane mounted hairs of receptor cells, which are bent at the displacement of the membrane. In this case, the hair cells are excited and transmit electrical impulses to the dendrites of bipolar neurocytes vestibular ganglion.

There are two types of hair cells:

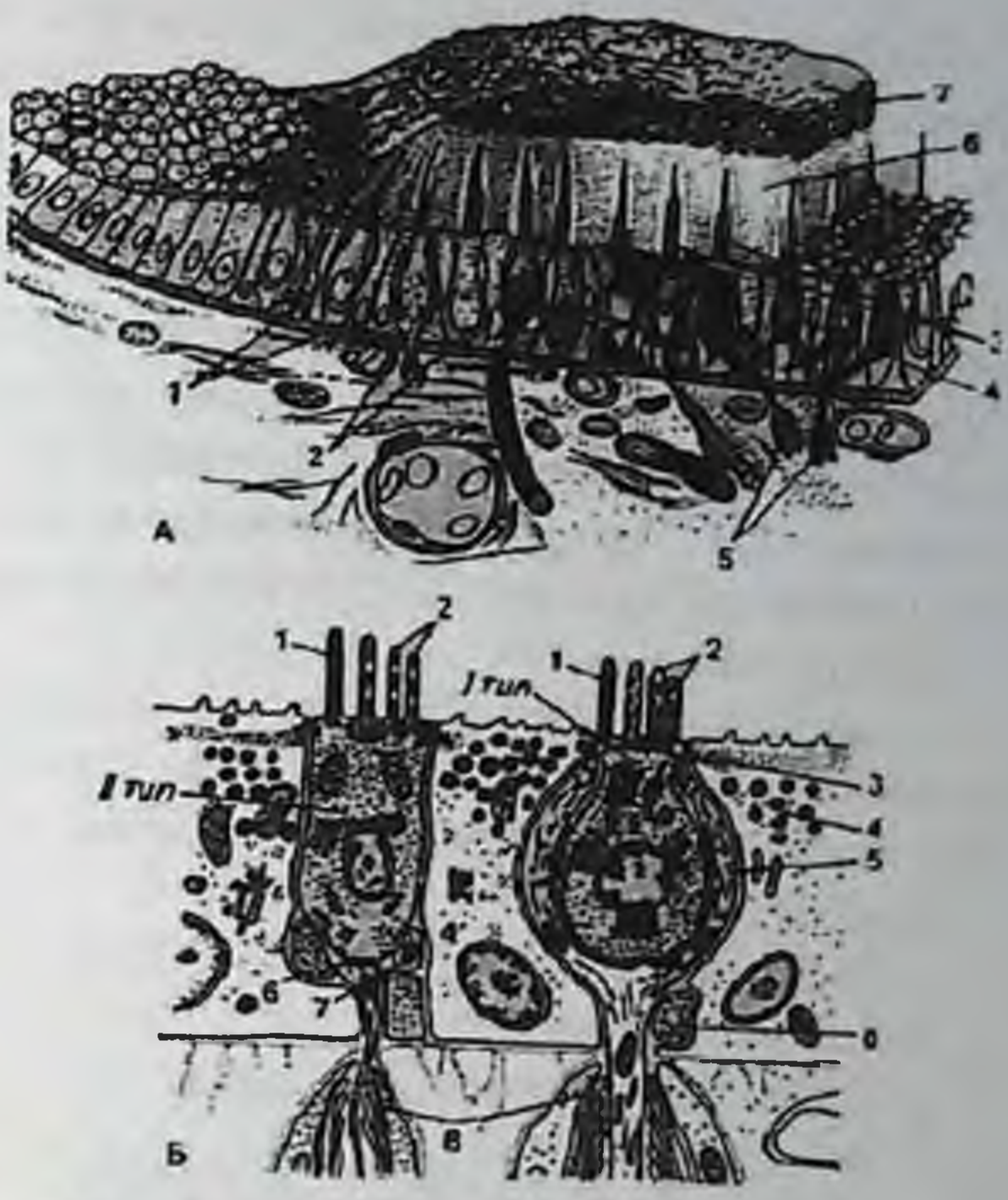
-**pyriform cells** have a wide base and narrow apical part. On the apical surface of the cuticle with a fixed 60-80 hairs - stereocilia. In addition, the cell surface is also moving a hair - kinocilium, which is eccentrically located cilium. Toward the bottom of each pear cells suitable nerve ending in a cup - cup-shaped nerve endings;

-**cylindrical cells** have a prismatic shape, and they end in the nerve endings of the dendrites of bipolar cells-point type. The rest of the structure of these cells is similar to the structure of pear-shapedx(133-img).

Also in the macula there is a third type of cell is the supporting cells, which have a prismatic shape and numerous microvilli on the apical surface. Its main function is Holocrine secretion components of the otolith membrane. Morphologically spots utricle and saccule differ little from each other.

However their function is different. Spot spherical sac perceives vibration fluctuations and gravity (gravity receptor).

Spot utricle only accept change in vertical position of the body relative to the gravitational field of the Earth, there is only gravity receptor.



133-img. **Macula.** A structure on the light-optical level: 1-support epithelial cells; 2 –senso-epitelialnyec ell; 3-hairs; 4-nerve; 5-nerve myelinated fibers; 6-gelatinous otolith membrane; 7-otoliths; B-structure on the ultramicroscopic level: 1-kinocilium. 2- stereocilia; 3-cuticle; 4-epithelial cell; 5-cup-shaped nerve ending; 6-efferent nerve ending; 7-afferent nerve ending; 8-myelinated fiber (dendritic).

134-img. **The structure of the scallop**

Scallops in ampullae of the semicircular canals were built in the same principle as the spots. They are part of the receptor hair (cylindrical or pear-shaped) and supporting cells (Figure 134). The total number of hair cells is 15 000-17 000. Instead of the otolith membrane is formed gelatinous substance dome. The dome is a product of secretion Holocrine supporting cells, he, unlike the otolith membrane contains no otoliths. In the dome loaded kinocilium and stereocilia. At movement of the head and the accelerated motion of the body is rejected due to movement of the dome of the endolymph in the semicircular canals.The main function of scallops - the perception of angular acceleration.

The practical part

Compilation of logical structures, the study of drugs in organs of hearing and balance, and a sketch of the principles of electron structure of the organs of hearing and balance to albums

Studied objects:

1. Organ of hearing (organ of Corti).
2. The body balance.
3. The electron neurosensory cells.

Sample test items

1. What is the difference primary sensory cells from secondary feelings?

a) there is one process;
b) it has three process;
c) c has two peripheral and central ridge;
d) has one perferichesky process

2. What is the difference of secondary sensory cells from the primary feeling?

a) there is one process;
b) it has three process;
c) has two peripheral and central ridge;
d) has one perferichesky process.

3. The bodies of balance located in:

a) in my dearest;
b) in spherical bag;
c) in the cochlea;
d) in the semicircular canals.

Approximate refereed report on "Histophysiology organ of hearing".

6.3. Organ of vision

I. Aims and objectives:

1. The study of the structure and function of the organ of vision.
2. The study of the function and structure of the olfactory organ.

II. Sample questions for self;

1. Overview of the senses.
2. The structure of the membranes of the body.
3. Dioptric apparatus of the vision.
4. Accommodative apparatus of the vision.
5. The receptor apparatus of the vision.
6. The structure of the retina trehneyronnoy.
7. Histophysiology view.
8. The clinical significance of the topic.

The theoretical part

6.3.1. Organ of vision

Body vision consists of the eyeball, the auxiliary apparatus (eyelids, lacrimal gland, oculomotor muscles).

Eyeball from the morphological point of view, is the body of the laminate type. It consists of three layers (Figure 135).

outer-shell-sclerain more opaque throughout, but in the anterior part of the eyeball moves in a transparent cornea;

the average layer - vascular, in turn, is divided into three parts: the choroid, ciliary body and iris;

an inner sheath: retina, optic part and blind part.

In addition, part of the globe include:

lens, vitreous humor, the fluid front and the back of the eye.

From a physiological point of view, the eye secrete several functional units:

- **Diopter or photorefractive device**: cornea, lens, vitreous body, the liquid chamber of the eye;
- **Accommodation apparatus**: Iris, lens, ciliary body;
- **Receptor system** - retina
- **Auxiliary machinery**: for ever; eyelashes; lacrimal gland; oculomotor muscles.

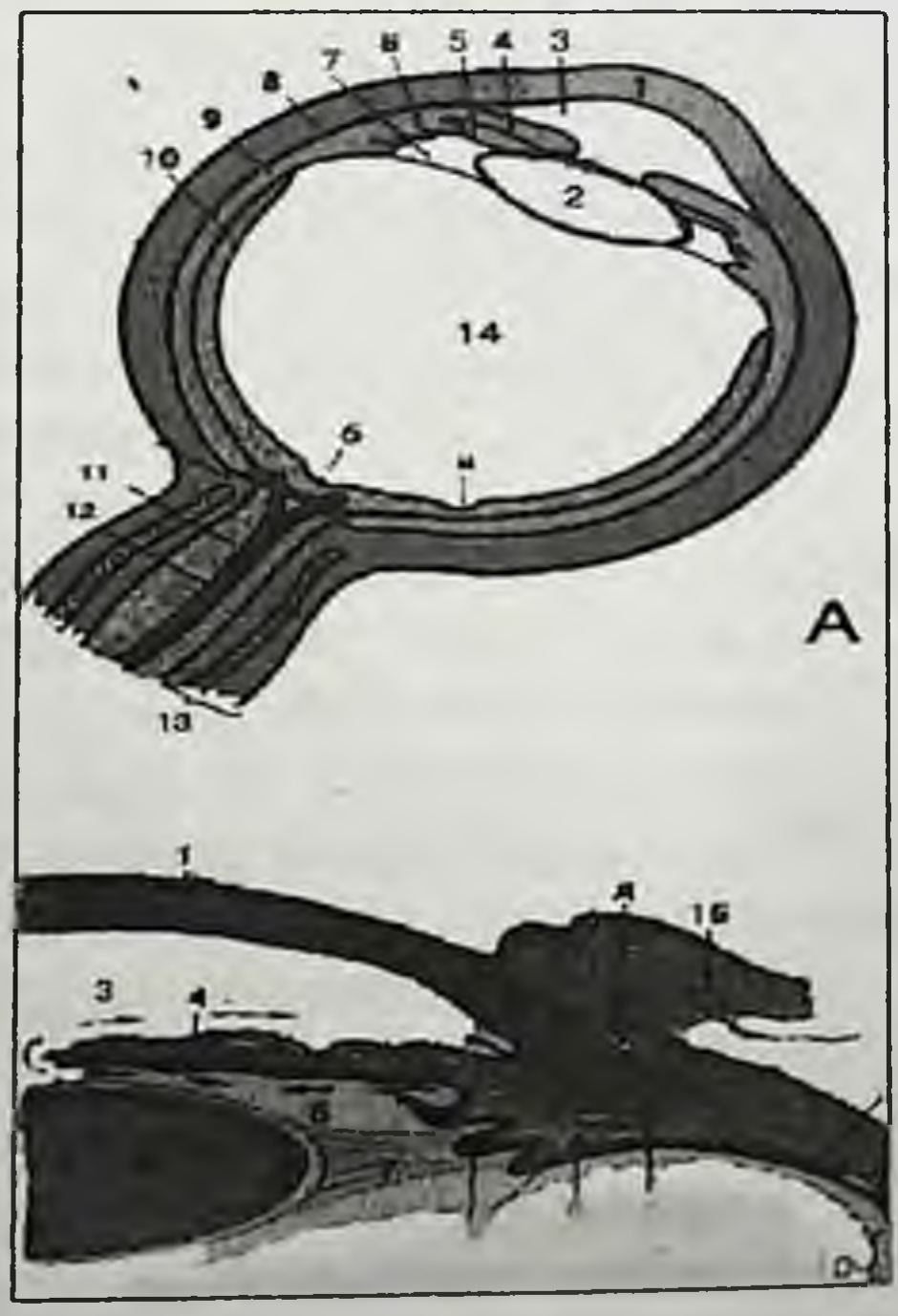
Development

Eyesight develops early enough from several sources. The retina and optic nerve develop from the front wall of the protrusion of brain-bladder, which has the form of eye bubbles. These vesicles by invagination become eye glasses. Of the outer wall of the optic cup is developing retinal pigment epithelium, from the inside - the actual retina. Edge of the optic cup serve to form the iris smooth muscle (muscle, narrowing and expanding the pupil) and ciliary body. The lens develops from the ectoderm, which forms the first boss - of lens placode and then lenticular bubble. Lenticular vesicle buds from the rest of the ectoderm and gradually moves into the cavity of the optic cup. Fused over it participates in the formation of ectoderm anterior corneal epithelium. Sclera, choroid, and its derivatives (iris, ciliary body) develop from the mesenchyme. Epithelium of conjunctiva, lacrimal glands develop from cutaneous ectoderm.

Dioptric apparatus of the eye

Cornea - the transparent part of the fibrous outer coat of the eye sclera. It consists of five layers (Figure 128):

- The outer epithelium is stratified squamous epithelium not keratinizing, which consists of three layers - the basal layer of the thorny and flat cells. In the epithelium contains a large number of free nerve endings, causing the high sensitivity of the cornea. Anterior epithelium of the cornea in the limb enters epithelium conjunctiva;



135-img. **The structure of the eye.**
A-structure of the eyeball;
B is the angle of the eye.
1-cornea; 2-lens; 3-lobby camera; 4-iris. 5-rear camera; 6-ciliary body; 7-ciliary band; 8- sclera; 9-choroid; 10-mesh layer; 11-vessels mesh layer; 12-optic nerve; 13-mater covering the nerve; 14-vitreous telo; 16-conjunctivitis. a-yellow spot, b-v-a blind spot processes ciliary body, g-ciliary muscle, d-venous.

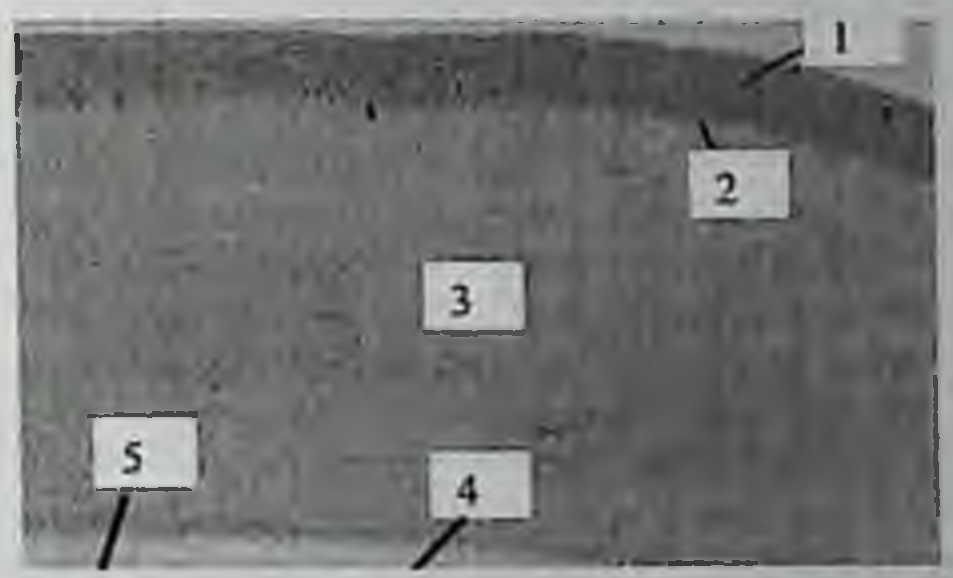
- Anterior border (Bowman) membrane. Formed, ordered, in a three-dimensional network, arranged collagen fibers. Plays the role of the basement membrane;

- Own stuff cornea. Established executed a dense fibrous connective tissue. It consists of parallel underlying collagen fibers, ground substance and located between the fibers fibrocytes. Place of transition is called the limb. It contains a large number of vessels, of which feed on the external part of the cornea. Food for the central departments is due to substances in the anterior chamber fluid;

- Rear Frontier (Descemet's) membrane has the same structure as the outer membrane;

- Rear epithelium - single layer squamous epithelium (often called the endothelium).

In the cornea has no proper vessels, food is due to the diffusion of substances from the anterior chamber of the eye and vascular limb. When inflammation of the blood vessels of the limb can penetrate the cornea own stuff, which creates its opacity (cataract). The cornea is richly innervated by the nerves lie not only in their own material, but also in the anterior epithelium (136-img).



136-img. **Corneas.**
1-keratinizing stratified squamous epithelium not; 2 basement membrane of the anterior cornea; 3-own stuff; 4-posterior limiting membrane; 5-posterior corneal epithelium.

Factors of transparency of the cornea:

- Perfectly smooth front surface of the epithelium, trauma, ulceration of the cornea, this smooth surface is disturbed, leading to the appearance of opaque areas;

- The lack of substance in their own vessels, inflammation, they can grow into it from a limb that breaks transparency;

- Low levels of the substance in its own water of the cornea, inflammation of the cornea (keratitis), an increase of water content, and the transparency of the cornea is lost (cataract);

- A high degree of order of arrangement of collagen fibers in the border membranes and their own substance of the cornea.

Vitreous body - is the main refracting media of the eye. In addition to this most important function of the vitreous body is involved in the metabolism of the retina, and also fixes the lens and prevents the (normally) retinal detachment of the pigment epithelium. It is represented by intercellular substance (99% of water and protein vitrein), which prevails, and single cells (fibroblasts, macrophages and lymphocytes).

Accommodative apparatus

The lens material is developed from the ectoderm, which turns under the influence of the optic cup in lenticular bubble. This bubble is separated from the ectoderm and sinks into the cavity of the optic cup. The front wall of the lens vesicle consists of a single layer of cubic epithelium, and the back of the form elongated cells called lenticular fibers. As they grow, the cavity bubble disappears. In the center of the primary lens fibers formed lenticular nucleus of the lens. In the future, due to proliferation of the cells in the equatorial, lenticular form secondary fibers.

The lens capsule is coated on the outside - a thickened basement membrane. Capsule contains glycoproteins and microfilament network, provides elasticity lens. At the front of the lens capsule remains under its single-layer epithelium. At the equator, its cells are capable of mitotic division (germ band). Once it is complete, these cells form new lenticular fibers. Epithelial cells also form the posterior lenticular fibers. Cytoplasm of lens fibers contain crystalline substance crystallin. In the center of lenticular fibers compacted, losing core superimposed on each other and form the nucleus of the lens.

Inside the lens no nerves and blood vessels that provide transparency. Lens inside the eye is maintained by the ciliary filaments (Zinn) ligament, which attaches to the capsule. Change the degree of tension of threads varying curvature of the lens, and then changes its refractive power. Providing excellent accommodation - the ability to clear vision of distant objects is different. In young people, the lens has high elasticity, which is gradually lost with age. This leads to a violation of seeing close objects (presbyopia). With aging may also violate lens clarity and capsules - there lenticular cataract.

The choroid is composed of three parts: the choroid, ciliary body (ciliary) body iris.

The main function of choroid - food retina. It is also involved in the regulation of intraocular pressure. Pigment contained in this shell, absorb excess light. A reduction of the ciliary muscle (part of the chor-

oid) can change the length of the optical axis of the eye, so that the choroid is involved in accommodation.

The iris is in front of the lens. Has the form of a plate, which is located in the center of the pupil. In iris allocate 5 layers (Figure 137).

-Anterior epithelium - the continuation of the rear of the corneal epithelium;

-Outer boundary layer contains loose fibrous connective tissue unformed with fibroblasts and melanocytes;

-Vascular layer also formed unformed loose fibrous connective tissue, contains blood vessels, melanocytes;

-Internal boundary layer has the same structure as the outer boundary layer;

-Internal or pigment epithelium layer.

137-img. **IRIS.** 1-single-layer squamous epithelium; 2-outer boundary layer of; 3-vascular layer; 4- internal boundary layer 5-posterior pigment.

In iris contains two muscles - the narrows and expands the pupil. These muscles are formed mionevral cloth and are: first - in the area of vascular about pupillary layer;

the second - in the vascular and partly internal boundary layers.

Muscle narrowing the pupil is innervated by the parasympathetic nervous system, muscle, extending the pupil - the sympathetic nervous system. In the attachment of the anterior surface of the iris to the sclera and ciliary body (the angle of the anterior chamber of the eye) are trabeculae that make up a bunch of the comb. Between the trabeculae are space through them is moisture outflow from the anterior chamber into Schlemm's canal, which in turn communicates with the venous sinus. Venous sinus located circularly around Shlemmov channel. Schlemm's canal and provide venous sinus outflow of intraocular fluid into the venous system of the eye. Narrowing of the channel in the pathology

leading to increased intraocular pressure, which in severe cases causes death of neurons of the retina and blindness.

Ciliates (ciliary) the body is composed of two parts:

- **Internal** - ciliary crown;
- **External** - ciliary ring.

The basis of the ciliary body of the ciliary muscle, formed by smooth muscle tissue. Its beams have a circular area in the inner parts of the radial and in the exterior. From the surface of the ciliary body depart ciliary processes, which are attached thread Zinn ligament. Relaxation of the ciliary muscle causes tension Zinn ligaments and flattening lens. Muscle contraction, on the contrary, causes relaxation Zinn ligament, and the lens due to its elasticity becomes more convex, its refractive power increases. Covering the ciliary processes of the two-layer cubic epithelium formed an inner layer and an outer layer of non-pigmented pigmented cells. The cells of each layer has its own basement membrane.

Retseptor apparatus.

The retina consists of a back (visual) and front (blind) parts. Blind portion of the retina consists of two layers of glial cubic epithelium. The border between the blind and the visual parts of the rough and called serrated edge. Visual (optical) part has a complex layered structure characteristic of the display of the nerve centers. The main part of the neural retina is a three-part series. It consists of a photoreceptor, bipolar and ganglionic neurons in the body, these neurons form three nuclear layer of the retina (inner and outer granular and ganglionic). There are also layers formed spines of neurons, interneuronal connections and glial elements of the layer of rods and cones, the outer and inner layers of mesh, the layer of nerve fibers, the two glial limiting membrane. In total there are 10 layers of the retina (Figure 138).

1. Pigment epithelial layer is located between the basal lamina of the choroid, on one hand, and the layer of rods and cones of the retina, on the other. Pigmentotsites forming layer lie on the basement membrane. Their bases located to choroid. Moving away from the tops of the cells in the form of processes, "beard", which also contain the pigment melanin, the ability to migrate here from the cell bodies. In the light of increased pigment, and he moved to the processes that surround the rods and cones of photoreceptor neurons, deeply penetrating between them. In this part of the pigment absorbs light and prevents overstimulation of photoreceptor neurons.

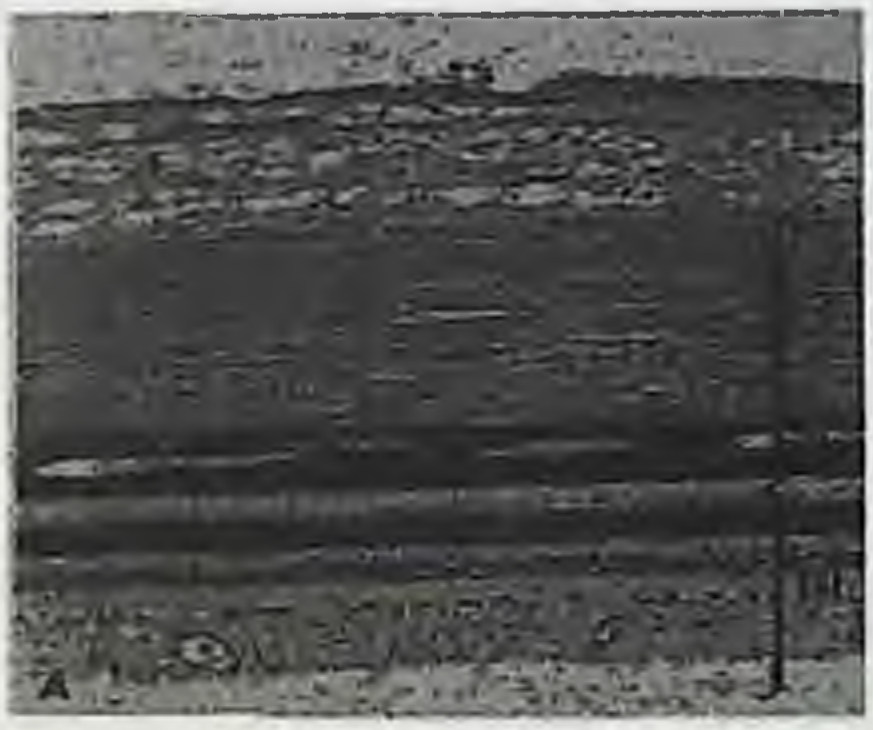
In the dark appendages disappear, and the pigment moves to the cell body, which probably excitation of photoreceptors.

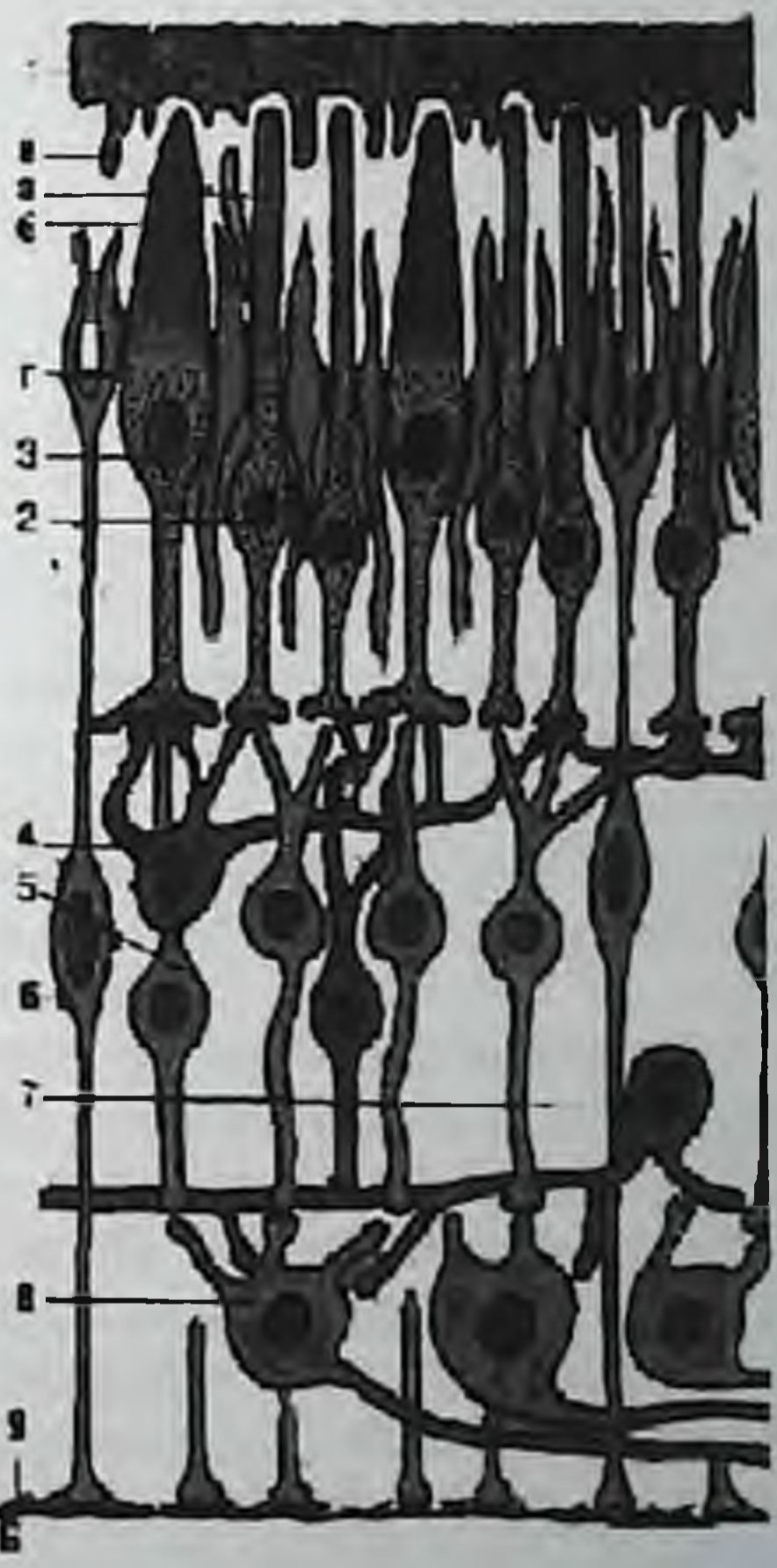
Pigment layer functions:

-Trophic function to the photoreceptor neurons, ensuring diffusion of nutrients and oxygen from the choroid;

-Protective function - protection of rods and cones primarily from excess light output, participation in blood aqueous barrier;

Phagocytosis, and digestion undergoing constant destruction exterior of neurons and, therefore, help in updating their drives.





138-img. **Back of the eye.**
A) general view. I choroid;
II sclera; III retina.
B) The retina and its layers.
C) longitudinal section of the retina.
I shell pigment; II layer fotoresensor;
III outer boundary layer;
IVouter nuclear layer;
V outer plexiform layer;
VIinner plexiform layer;
VIIinner nuclear layer;
VIIIganglionic layer;
IX layer of nerve fibers;
X inner boundary layer.
1-pigmentotsit; 2, 3-rods and cones are prominent processes
a) rodlike; b) cones are prominent;
c) scion prominent.

-Retinal biosynthesis (part of the visual pigment rhodopsin) and transport it to the photoreceptor neurons.

Layer of rods and cones formed dendrites of **photoreceptor neurons**, shaped or sticks or cones. Sticks isolated outer and inner segments. The outer segment is a large number of transverse double membranes arranged in stacks of flat membrane vesicles. They are called discs. In the outer segment disks contain the visual pigment rhodopsin, which consists of the protein opsin and an aldehyde of vitamin A - retinal.

Under the action of light energy splits rhodopsin, which leads to an increase in the permeability of the cell membrane for ions and an electrical potential. In the dark, rhodopsin regeneration occurs, accompanied by loss of energy of ATP. Drives sticks constantly updated. Their growth occurs in the proximal, from the newly-formed wheels are moved distally, "age" phagocytic cells of pigment epithelium. For tumors disc membranes need vitamin A, in which there is a lack of their destruction, and there is a "night blindness" - the inability to see at night.

Light perceiving apparatus of the eye

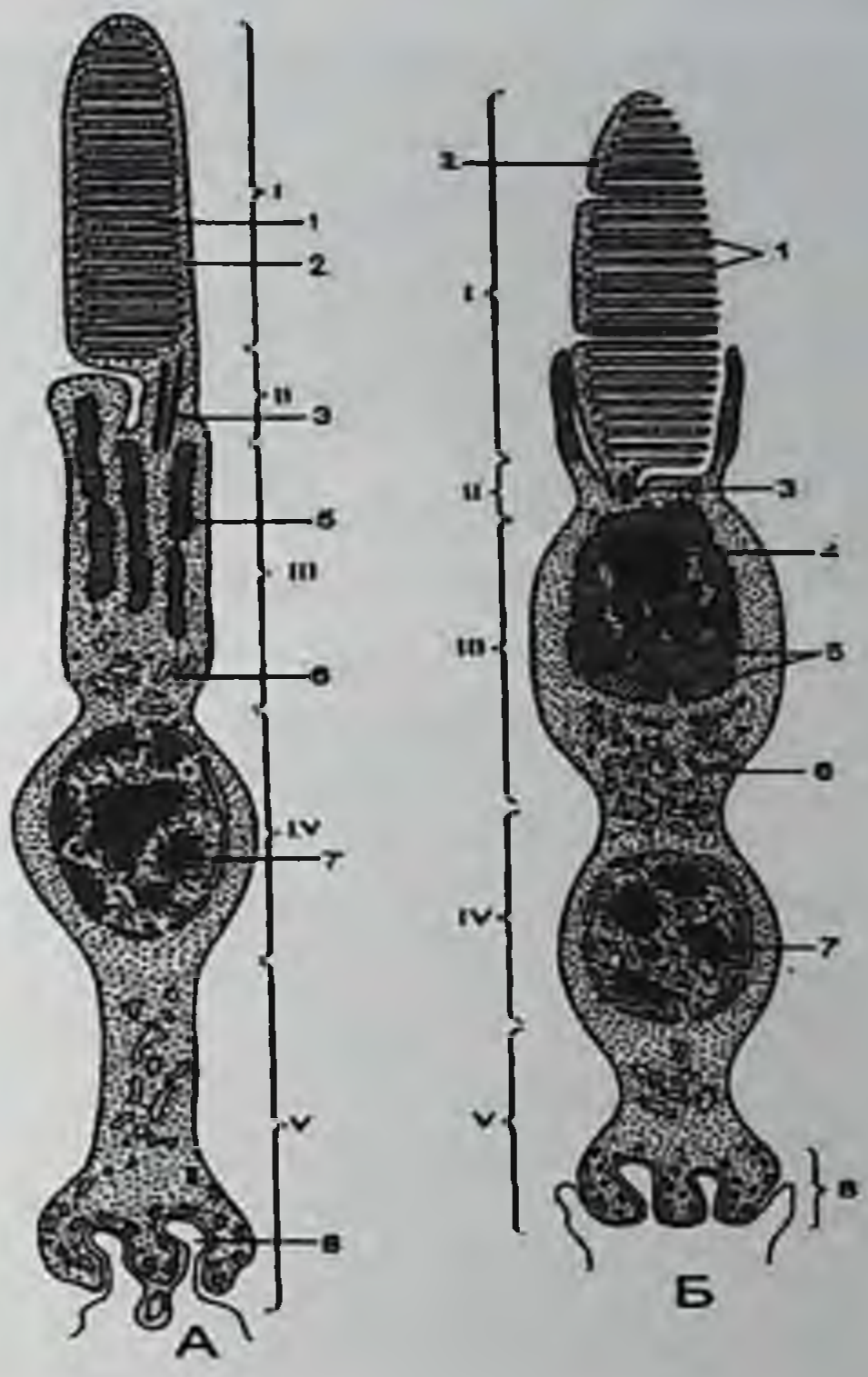
Sticks - black and white receptors night vision. Their number is about 130 million rods are located in the peripheral regions of the retina.

In flask outer segment structure is somewhat different from sticks. First, the outer segments are not isolated from the drive, and from the half-disc, formed by deep invaginations tsitolemm resembling a comb. Second, they are not cylindrical and conical. Third, the domestic segment has ellipsoidal inclusion is surrounded by mitochondria (139 - img).

In half-disc cones contain visual pigment iodopsin. This pigment decomposes under the influence of red, blue or green light. Fifth, the membrane cones are not subject to renewal. Cone inner segment has the same structure as in the rods, the difference lies in the fact that the core of cone cells larger than the rod-shaped core. The total number of cone neurons is about 7 million they are in the center of the retina. Their content is particularly high in the macula - the area better vision (132-rice). Cone cells respond to light of high intensity, providing daytime color vision.

Photoreception mechanism associated with the decay of rhodopsin molecules and iodopsin under the influence of light energy. This trig-

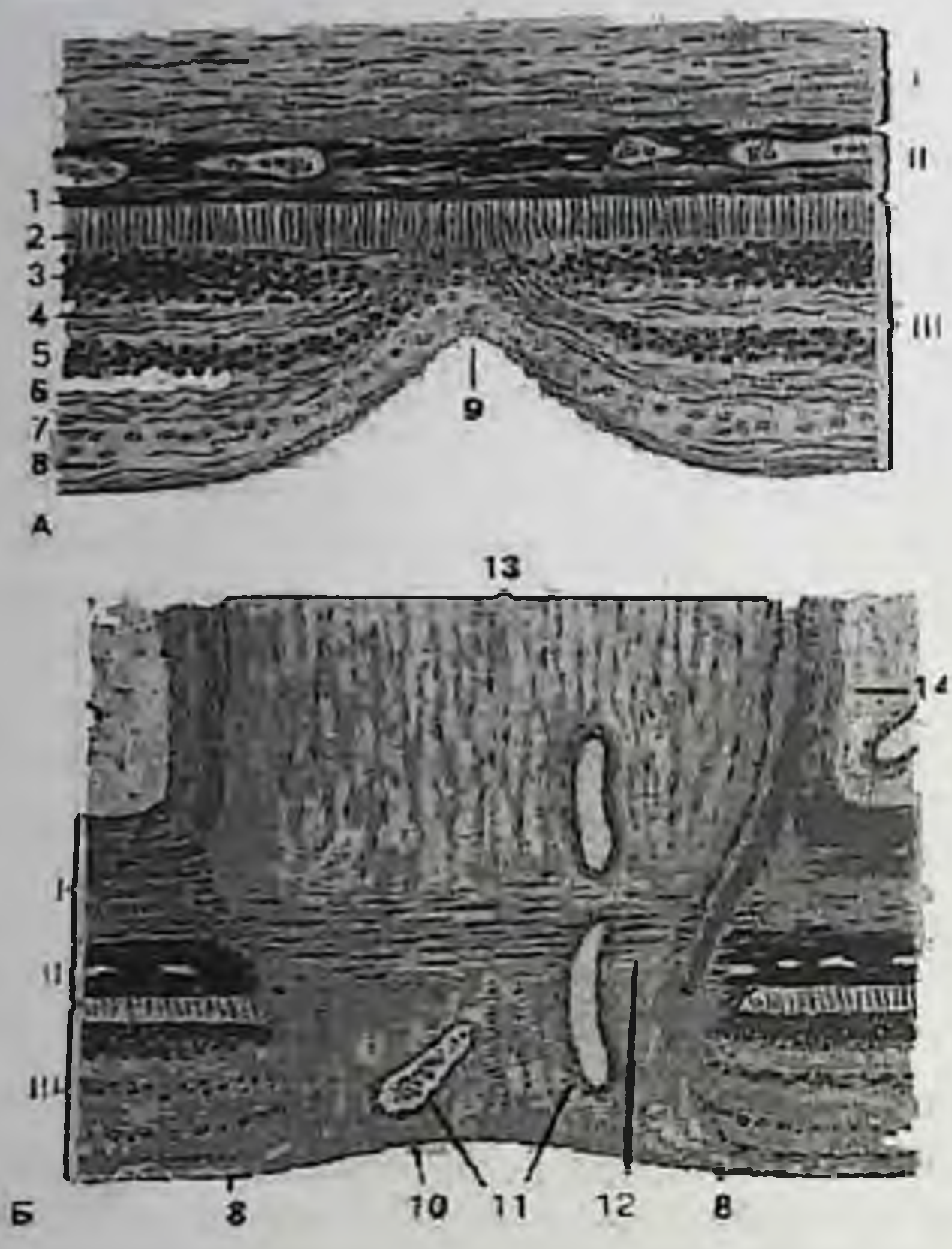
gers a chain of reactions that alter membrane permeability to ions and cause the formation of the nerve impulse.



139-img. **Structure**
(A) Rod and.
(B) Of cone neurosensory cells.
I outer segment;
II the Division;
III inner segment;
IV perikarion;
V axon.
1-drives and half-disc;
2-cytolemma;
3-basal bodies resnichok;
4-body lipid;
5-mitochondria;
6-endoplasmic reticulum;
7-nucleus;
8-synapse.

Fourth, in the half-disks cones contain visual pigment rhodopsin. This pigment decomposes under the influence of the red, green or blue light. Fifth, the membrane cones are not subject to renewal. Cone inner segment has the same structure as in the sticks, the difference lies in the fact that the core of a larger cone cells, relative to the core rod-shaped. The total number of cone neurons is about 7 million. They lie at the center of the retina. Especially great is their content in the macula - the best field of vision (Figure 140). Cone cells react to light of high intensity, providing color daytime zrenie.Mehanizm photoreception associated with the decay of rhodopsin molecules and Photopsin under the influence of light energy. This starts a chain of reactions that alter membrane permeability for ions and cause the formation of a nerve impulse.

3. Outdoor glial membrane is located between the layer of rods and cones and the external granular layer. Formed shoots glial cell fibers.



140-img. **The retina.** A-yellow spot. B-blind spot (exit of the optic nerve). I. Sklera. II.vascular shell. III. Retina. 1-pigment layer; 2-layer photoreceptors; 3-outer nuclear layer; 4-outer plexiform layer; 5-inner nuclear layer; 6-inner plexiform layer; 7-ganglionic layer; 8-layer of nerve fibers; 9-yellow spot; 10-out of the optic nerve; 11-central artery and Vienna; 12-retinal chip; 13-optic nerve; 14 RVST.

4. Outer granular (nuclear) layer is formed bodies and nuclei of photoreceptor neurons. This is most pronounced in the three nuclear layers of the retina.

5. Outer plexiform layer is formed photoreceptor axons of neurons, dendrites of bipolar neurons and synapses between them.

6. Internal granularlayer consists of several bodies of neurons: bipolar, horizontal, amakrinal, interpleksiform and glial cell nuclei fibers Muller.

Dendrites of bipolar neurons form synapses with photoreceptor axons of neurons in the outer plexiform layer, and their axons form synapses with the dendrites of ganglion neurons in the inner mesh layer.

Horizontal neurons have many horizontal reaching dendrites that form synapses with several photoreceptor neurons. Axon horizontal

neurons form synapses on the border between bipolar and photoreceptor cells. Through these synapses can pass braking, which increases contrast.

Amakrinal neurons have dendrites, replaces the body of the cell, playing the role of the synaptic surface. Axon branches out and forms a connection with several ganglion and bipolar neurons. Amakrinal neuronal function is the same as that of the horizontal cells. Interpleksiform neurons perform associative function. **Glial cells have extended fiber Müller** processes that go up and down, connected on the level 2 and 3 layers.

These compounds form the outer border glial membrane. The inner membrane is formed by glial cells bases Muller fibers and basement membrane.

It is located behind a layer of nerve fibers, separating it from the vitreous. From basic processes of Muller cells leaves many secondary processes that surround the body of retinal neurons and their synapses, performing support function. In addition, the processes surrounding retinal capillary wall, participating in the formation of gematoretinal barrier. Despite this variety of cells to form, the inner nuclear layer is noticeably thinner than the outer.

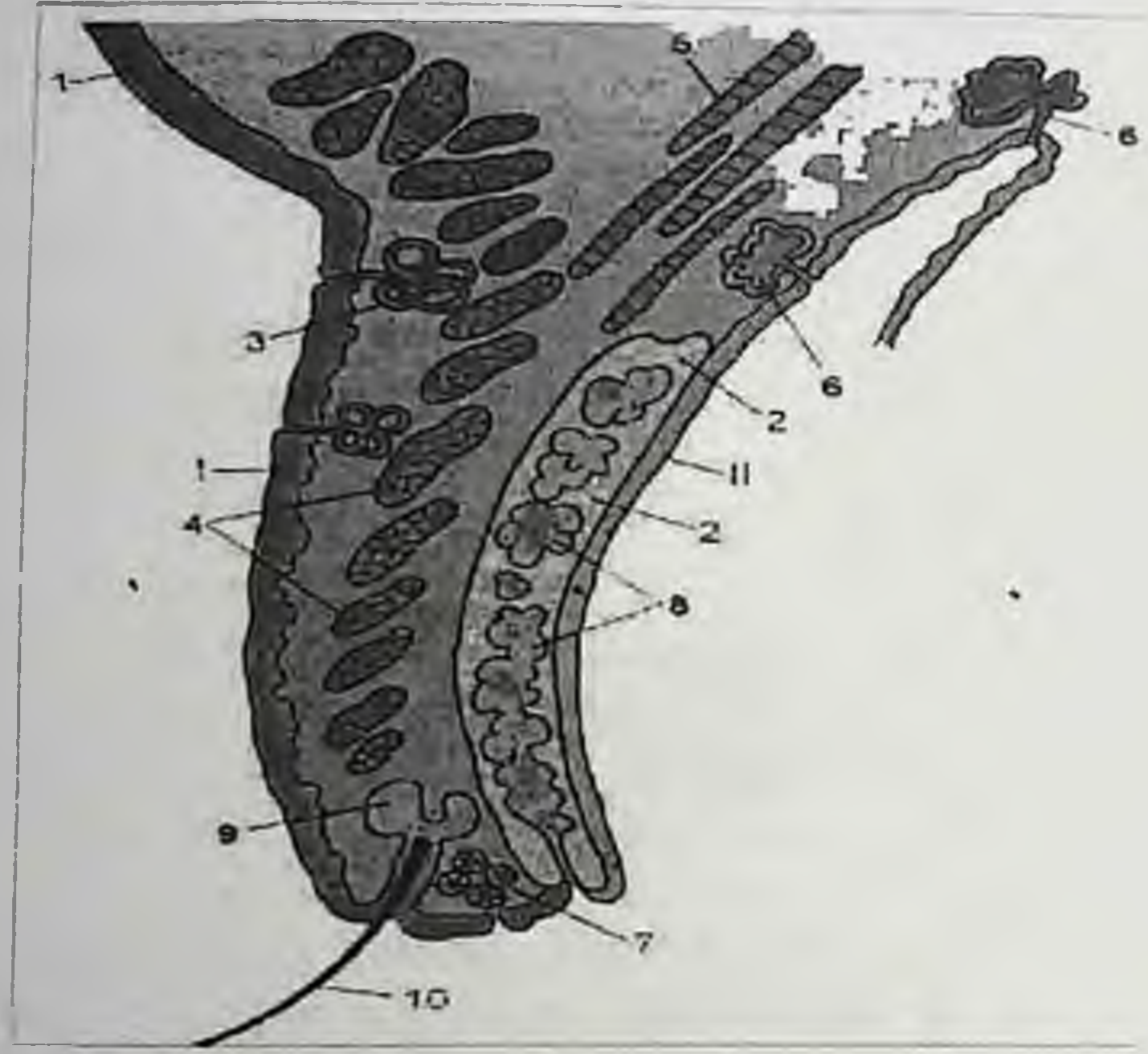
7. The inner plexiform layer is formed by the axons of bipolar neurons and dendrites of ganglion neurons. Here are the synapses between these processes.

8. Ganglionic layer consists of core ganglion neurons. These neurons are the largest in the retina, but the least. As a result of decrease of cells from the outer to the inner layers of a convergence of nerve impulses in the retina. Thus, in one bipolar neurons form synapses several photoreceptor cells. In turn, the number of bipolar cells contacted with one ganglion neuron. As a result, the number of nerve fibers in the optic nerve is about 100 times smaller than the number of photoreceptor neurons. Convergence is not in the macula, where each has a unique photoreceptor bipolar neuron.

9. Layer of nerve fibers formed by the axons of ganglion neurons. Retinal nerve fibers are in the blind spot, surrounded by a myelin sheath, spreads across the retina and form the optic nerve, in which the fibers are crossed and go to the thalamus.

10. Internal glial limiting membrane is below the layer of nerve fibers. The compounds of the bases and processes of cells, fibers Mueller and basement membrane. Neuron of the visual analyzer:- One

neuron - OPC;- 2 neuron - bipolar;- 3 neuron - ganglionic;- The body of a neuron is located in the 4 thalamic axon of the neuron goes to the neurons in the visual cortex of the cerebral hemispheres.Gemooftalmitical barrier - a barrier between the blood in the capillaries of the retina, retinal neurocytes and fiber optic. Gemooftalmical barrier is in three different areas:-Between the vessels of the choroid and photoreceptor neurons. The composition of the barrier consists of endothelial cells and the basement membrane of the capillaries of the choroid, the connective tissue of the basal plate, the basal membrane of the pigment epithelium, the pigment epithelium.



141-img. **Eyelid** (sagittal section)

I anterior cutaneous surface II internal surface (conjunctiva)1 - keratinizing stratified squamous epithelium (epidermis) and connective tissue (dermis) 2 rudimentary cartilaginous plate 3-tubular merokrins sweat glands 4 circular muscle of the Century 5-muscle lifting the eyelid lacrimal gland 6apocrine sweat glands7producing sebaceous8 are simple tubular -alveolar (meibomian) glands,

9-simple branched alveolar galokrins (ciliary) glands secreting sebaceous 10-lash

-Inside the retina, the barrier formed by endothelium within the grid gemokapillars and basement membrane, the outer membrane of the glial border formed by astrocytic glial processes of the retina, spikes cell fibers Mueller gemokapillary others as well as bodies of neurons of the retina;-In the optic nerve, it is formed by the basement membrane and the endothelium of the capillaries of the nerve.

Auxiliary apparatus

The clinical significance

Any difficulty outflow of aqueous humor caused by obstruction of drainage channels, leads to an increase in intraocular pressure, causing a disease known as glaucoma.

With age, the elasticity of the lens is reduced, which makes it difficult when considering the accommodation of close subjects. This is a - holes mum aging (presbyopia, or presbyopia), which can be corrected by glasses with convex lenses. In old age, people in the lenticular fibers accumulate brown pigment, making them become less transparent. If the lens becomes opaque, then such a state known as a cataract, and this failure can also occur due to excessive the UV irradiation. In diabetes the development of cataracts is believed to contribute to high levels of glucose.

`Since neither of these types of outgrowths anatomically not associated with photoreceptors, these sites can be separated from one another, ¬example, when developing retinal detachment. It is a common and serious human disease can be effectively treated with laser surgery.

Clinical observations of damage to the retina in its detachment show that photosensitive cells receive nutrients from horiokapillar layer. Surface races position of retinal vessels makes it easy to study them with the ophthalmoscope. Such a study is of great value in the diagnosis and evaluation of diseases affecting the blood vessels, such as diabetes and high blood pressure

The practical part

Compilation of logical structures, the study of drugs on the organs of vision and sense of smell, and a sketch of the principles of electron shell structure of the organ of vision and cellular composition of the olfactory organ.

The objects under study: 1. The cornea of the eye; 2. The retina; 3. The electron diffraction pattern of photoreceptors.

a) sources ofdevelopment of eye;
b) nervous tube;
c) ganglion plate;
d) the ectoderm;
e) placode.

2. The transparency of the cornea is ensured;
a) epithelium;
b) keratin;
c) glycosaminoglycans;
d) boumeovoy shell.

3. The layers of retinal neurons OPC ... pad answer.
a) piramidny;
b) assotsiativny;
c) ganglion;
d) zernisty.

4. Name the cone pigments:
a) rhodopsin;
b) photopsin;
c) melanin;
d) all.

5. The retina has neurons:
a) photoreceptor;
b) pyramid;
c) bipolyarny;
d) ganglion.

Endocrine System

6.3.2. The central and peripheral organs endocrine system

I. Aims and objectives:

1. The study of the structure and function of tsentaalnyh hypothalamus and pituitary gland.

2. The study of the function and structure of the thyroid, parathyroid and adrenal glands.

II. Sample questions for self-study:

1. General hararkteristika of the endocrine system;
2. Stronach hypothalamus, his hormones;
2. Structures of the pituitary. Ipotalamo value-pituitary system.
3. pituitary hormones and their values;
4. Structures of the thyroid gland;
5. Synthesis and the role of thyroid hormones. Structure and function of the parathyroid gland;
6. Adrenal gland, cortical part;
7. Adrenal glands, brain cortical part;
8. APUD system, the role of apudocytes;
9. The clinical significance of the topic.

The theoretical part

6.3.2. The endocrine system

General characteristics

The endocrine system is one of the regulatory and integrative systems of the body, along with the cardiovascular, nervous, immune, speaking to them in the closest unity (Figure). It is run by the most important regulation of autonomic functions of the body: growth, reproduction, propagation and differentiation of cells, and energy metabolism, secretion, excretion, absorption, and other behavioral responses. In general, the function of the endocrine system can be defined as the maintenance of homeostasis.

The endocrine system consists of:

-Endocrine glands - the organs that produce hormones (thyroid, adrenal, pineal, pituitary, and others);

Not endocrine -endocrine organs (islets of Langerhans of the pancreas);

Single- hormone-producing cells located diffusely in various organs - diffuse endocrine system.

General principles of the structural and functional organization of the endocrine glands:

-Have no ducts, as secrete hormones into the blood;

-Have a rich blood supply;

-Have fenestrated capillaries or sinusoidal type;

-Are the type of parenchymal organs, most of them formed epithelial tissue forming strands and follicles;

-In endocrine organs dominated parenchyma, stroma is less developed, that is, bodies are built economically;

-Make hormones - biologically active substances that have pronounced effects in small quantities.

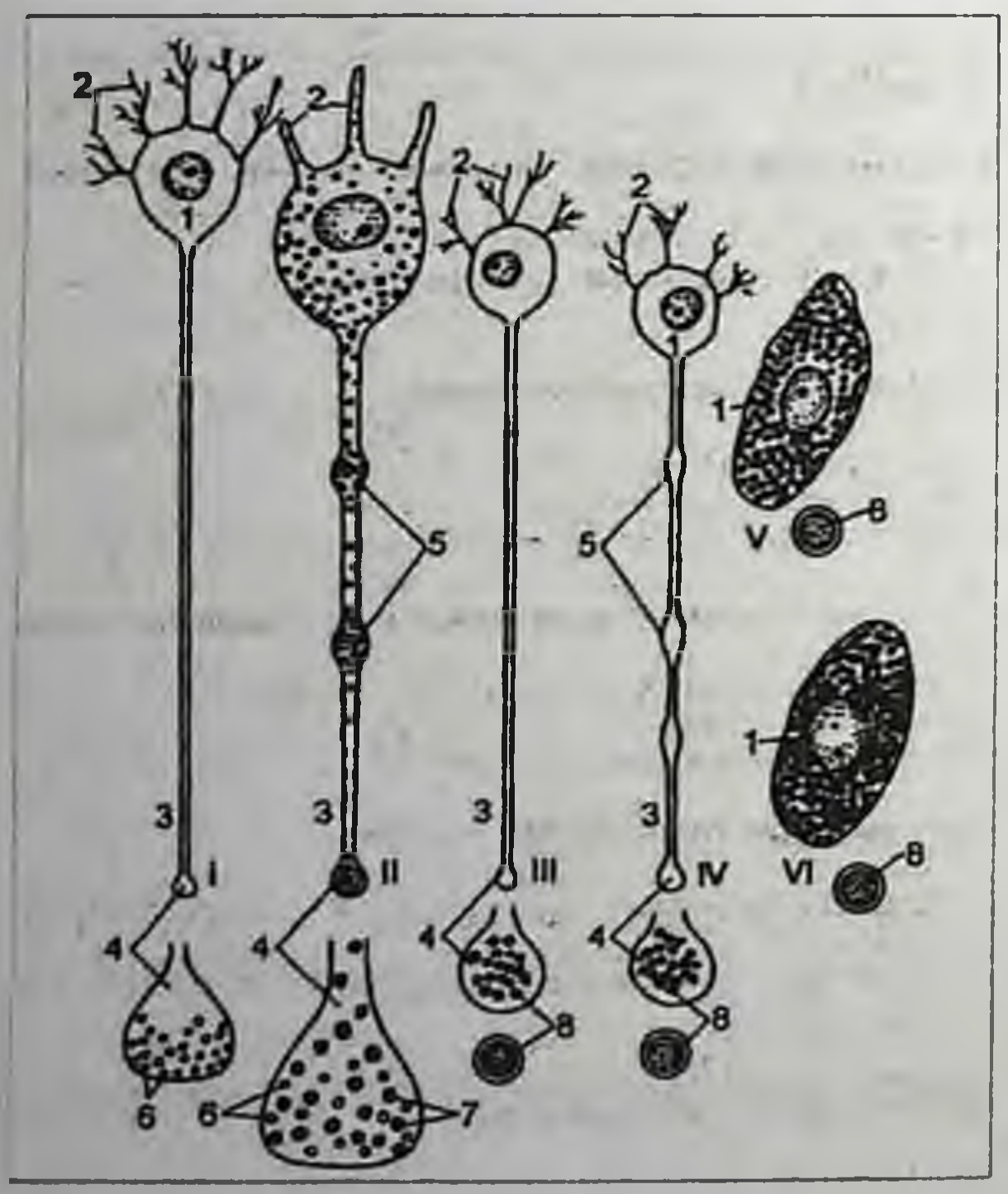
Classification of hormones:

Proteins and polypeptides - pituitary, hypothalamus, pancreas and other glands;

Derivatives of amino acids - the thyroid hormones (thyroxine and triiodothyronine), a hormone of the adrenal medulla adrenaline, serotonin produced many endocrine glands and cells, and others;

Steroids (derivatives) cholesterol - the sex hormones, adrenal hormones, vitamin D2 (calcitriol).

The active ingredients of the endocrine system are similar in nature to the substance of neurons and neurosecretory cells (img-142), which.



142-img. **The structure of the nervous, endocrine and neurosecretory cells**
1-perikarion; 2-dendrites; 3-axon; 4-terminal axons; 5-zone accumulation of neurosecretion; 6-synaptic vesicles; 7-pellets neurohormone; 8-Structure of secretory granules

Features of the hormone:

Distant - can be produced far away from the target cells;

Specificity;

-Selectivity;
-High activity at low doses.

The mechanism of action of hormones

Once in the blood, hormones and its current reach adjustable cells, tissues, organs, called targets. There are two main mechanisms of action of hormones:

The first mechanism - the hormone binds to the cell surface receptors with complementary to it and change the orientation of this receptor. The latter are transmembran proteins and consist of the receptor and the catalytic part. When binding to the hormone activates the catalytic subunit, which begins the synthesis of second messengers (messenger). Messenger activates a cascade of enzymes, leading to

changes in intracellular processes. For example, adenylyl cyclize produces cyclic adenosine monophosphate, which regulates a number of processes in the cell. According to this mechanism are functioning protein hormone whose molecules are hydrophilic and can not penetrate the cell membrane.

The second mechanism - the hormone enters the cell, binds to the receptor protein, and with it enters the nucleus, where changes the activity of the corresponding genes. This leads to changes in cell metabolism. These hormones can act on individual organelles, such as mitochondria. According to this mechanism, there are fat-soluble steroid and thyroid hormones, which are due to lipotropic properties can easily penetrate into the cell through its shell.

Classification of the endocrine glands in a hierarchical manner:

1. Central - the hypothalamus, pineal and pituitary glands. They exercise control over the activities of other (peripheral) of the endocrine glands;

2. Peripheral, which have direct control over the most important functions of the body.

Depending on whether they are under regulatory action or not the pituitary and peripheral endocrine glands are divided into two groups:

1 - Group - independent adenogipofizal: kaltsitoninotsites thyroid, parathyroid, adrenal medulla, the insular apparatus of the pancreas, thymus, endocrine cells of the diffuse endocrine system;

2 - group - dependent adenogipofizal: thyroid, adrenal cortex, gonads.

The level of structural organization:

-Endocrine organs (thyroid and parathyroid glands, adrenal glands, pituitary, pineal gland);

-Endocrine tissue sections or as part of combining endocrine and no endocrine functions (hypothalamus, islets of Langerhans of the pan-

creas, and retikuloepitelical Hassall corpuscles in the thymus, the Sertoli cells of convoluted tubules of the testis and testicular follicular epithelium);

Cell diffuse endocrine system.

Central endocrine organs

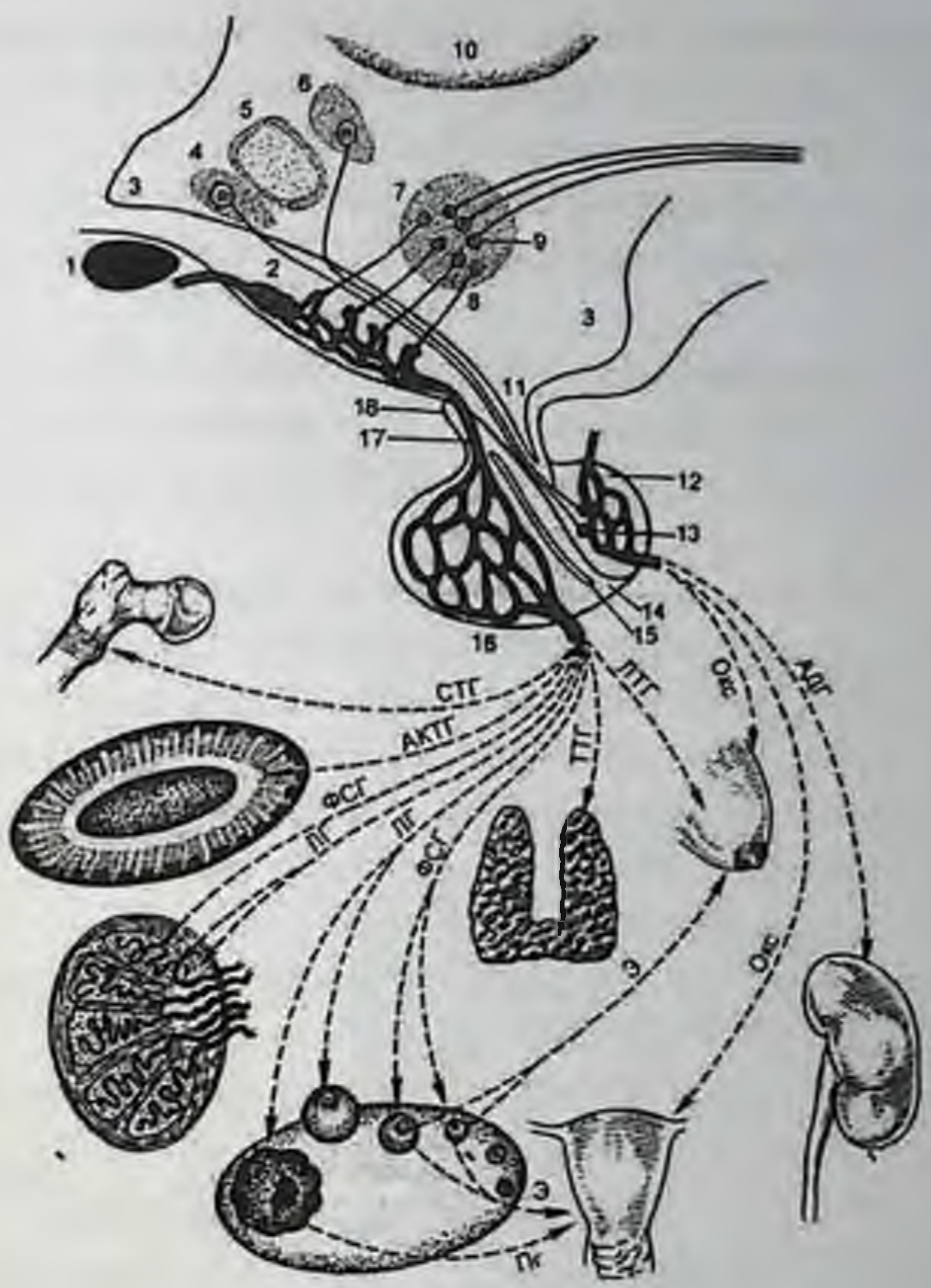
The structure of the hypothalamus

The hypothalamus is the center of the regulation of autonomic functions and higher endocrine center. He has trans adenogipofizal influence (through stimulation of pituitary tropic hormones) on the endocrine glands and dependent adenogipofizal para adenogipofizal independent adenogipofizal effect on cancer. The hypothalamus controls all functions of the visceral body combines neural and endocrine mechanisms of regulation.

The hypothalamus is the basal part of the diencephalon - beneath the optic thalamus (thalamus), forming the bottom 3 ventricle. Ventricular cavity 3 continues to funnel directed in strontium pituitary. The wall of the crater is called the pituitary stalk. Its distal end extends to the posterior lobe of the pituitary (neurohypophysis). Front of the pituitary stem thickening bottom 3 ventricle forms median eminence (medial Eminence) containing primary capillary network.

In the hypothalamus secrete: front, middle (mediobasal) rear sections. The bulk of the hypothalamus are nervous and neurosecretory cells (img-135). They form more than 30 cores.

Anterior hypothalamus contains the largest paired supraoptic and paraventricular nuclei, and a number of other nuclei. **Supraoptic nucleiare** formed in the large peptid holinergic neurons. Axons of neurons go through peptidholinergic pituitary leg in the posterior lobe of the pituitary gland and form synapses on the blood vessels - aksovazal synapses. Supraoptic nucleus neurons secrete mainly antidiuretic hormone or vazopresin. Hormone is transported along the axon to the posterior lobe of the pituitary gland and is accumulated in the expansion of the axon, which lies above aksovazal synapse and is called cumulative Mehlis Goering. If necessary, from there it goes to the synapse, and then into the blood. Vasopressin target organs are the kidneys and arteries. In the kidney, the hormone increases the reabsorption of water back (in the tubules of the nephron and collecting ducts) and thus reduces the amount of urine, promoting fluid retention and high blood pressure. In arteries hormone causes contraction of the smooth muscle layer of myocytes and increased blood pressure.



143-img. **Hypothalamic-pituitary axis and the action of hormones on the tropic organs**
1-target visual chiasm. 2-Medial emensiya (the primary capillary network).
2- III-ventricular cavity. 4-supraoptic nucleus. 5 front preoptic nucleus. 6 paraventricular yadro.7-arcuate-ventromedial complex 8-thalamus. 9-peptide-adrenergic neyresekretornye cells (mediobasal part). 10 - adrenergic neurons mediobasal part. 11-III-hopper ventricle and pituitary stalk. 12-posterior lobe of the pituitary gland. 13-Cumulative body Herring. 14-pituitary average 15-16-pituitary cleft anterior pituitary with secondary capillary network of 17 - Portal (Gate) Vienna 19 tuberalnaya part of the adenohypophysis. Adenogipofizarnye hormones and place their applications: STG-stimulates the growth of the body and its various organs (including skeletal growth) ACTH - stimulates the beam and reticular cortex of the adrenal LH - stimulates ovulation, corpus luteum formation and the production of the last progesterone stimulates the production of testosterone in the testis FSH - follicle growth and enables the processing of estrogen in the ovary, stimulates spermatogenesis in the testis of TSH - activates the production and secretion of thyroid hormone thyroid LTG - activates the production of milk in the mammary glands. The hormones contained in the posterior lobe of the pituitary gland: Ox - causes uterine contractions and milk response breasts ADH - stimulates the reabsorption of water back from the primary urine in the kidney (reduced urine output) and also increases blood pressure E - ovarian estrogens that stimulate the development of breast and uterine.

Paraventricular nucleus, together with large peptid holinergic neurons also contain small peptid adrenergic. The first hormone oxytocin, which goes along the axons to the posterior lobe of the calf Goering.

Oxytocin causes a synchronous uterine muscle during labor and activates myoepitheliocytes breast, increasing the flow of milk during nursing.

Average hypothalamus contains a number of small nuclei consisting peptid adrenergic neurosecretory neurons. The most important are arcuate and ventromedial nucleus, forming a so-called-mediobasal arcuate complex.

Neurosecretory cells of these nuclei adenogipofizotrophical produce hormones that regulate the function of adenogipofizarilizing-hormones. Gipofizotrophal releasing - hormones are oligopeptides and are divided into two groups: liberiny, increases the secretion of hormones adenohypophysis, and statins inhibit it. From liberinov marked gonadotropin, corticotropin, somatoliberin. At the same time, are described only two statins: somatostatin, which

inhibits the synthesis of pituitary growth hormone, adrenocorticotropin and thyrotropin and prolaktinostatin.

Posterior hypothalamus includes mammillary body and perifornical core. This division does not apply to the endocrine, it regulates glucose and a number of behavioral responses.

The structure of the pituitary

The pituitary gland is a parenchymal organ with the weak development of the stroma. It consists of the adenohypophysis andneurohypophysis. Adenohypophysis consists of three parts: the front, the middle lobe and tuberal part.

Adenogipofiz develops from epithelial roof of the mouth, which has an ectodermal origin. At the 4 th week of embryonic epithelial protrusion formed this roof as Rathke's pouch. Proximal pocket is reduced, and it sticks out towards the bottom 3 ventricle, from which formed the rear portion. Of the front wall of Rathke's pouch is formed anterior lobe of the back - intermediate. Connective tissue of the pituitary gland is formed from the mesenchyme (Figure 136)

Pituitary function:

Depended adenogipofizal-regulate the activity of the endocrine glands;

-Accumulation of hypothalamic neurohormones vasopressin and oxytocin;

Pigment-regulation and fat metabolism;

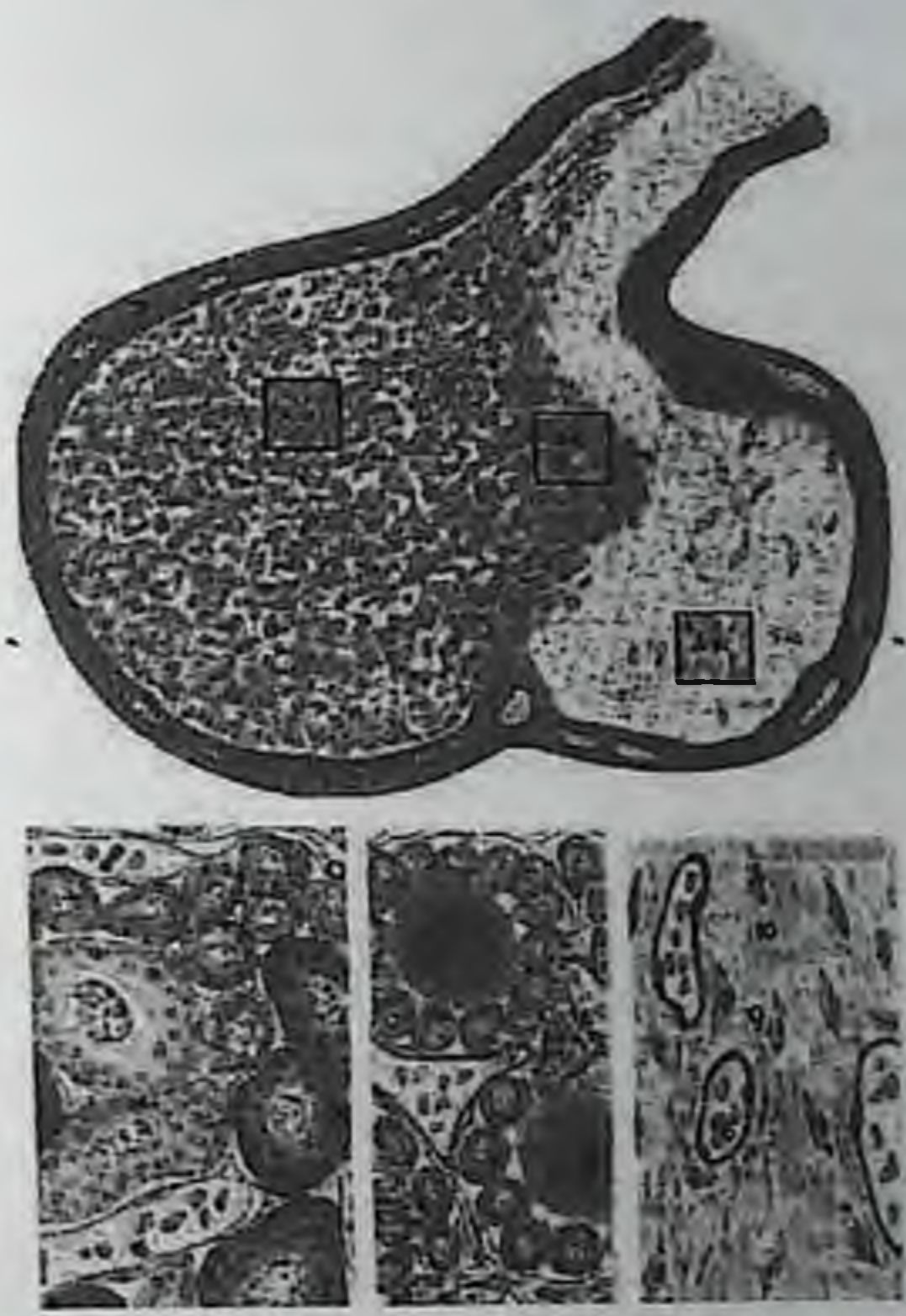
-Synthesis of a hormone that regulates the growth of the organism;

-Production of neuropeptides (endorphins).

Anterior lobe consists of epithelial strands trabeculae, between which the fenestrated capillaries. Anterior pituitary cells called adenocyteses.

In the anterior lobe of two types: Hromofil adenocyteses located on the periphery of the trabeculae and contain secretion granules in the cytoplasm, which are intensely colored dyes, and are divided into: oxyphilic, basophilic.

144-img. **Pituitary**
A-overall look.
AI-front.
AII-average.
AIII-rear.
1-pituitary stalk.
2-capsule.
3-oxyphilic cell adenocyteses.
4-basophilic cells adenocyteses.
5-chromophobic cells.
6-blood capillaries.
7-cell middle.
8-follicles.
9-pituitary cells.
10-nerve fibers.



Oxyphilic adenocyteses are divided into two groups:

Somatotropotsites-growth hormone (somatotropin), which stimulates cell division in the body, and its growth;

-Laktotropotsites produce lactotropic hormone (prolactin, mammotropin). This hormone increases the growth of mammary glands and secretion of milk during and after pregnancy, as well as contributes

to the formation of the corpus luteum in the ovary and making them the hormone progesterone.

Basophilic adenocyteses also divided into two types:

-Tirotropotsites - produce thyroid-stimulating hormone, a hormone that stimulates the production of thyroid hormones in the thyroid gland;

Gonadotropotsites-divided into two types - follitropotsity produce follicle stimulating hormone in the female body, it stimulates the synthesis of oogenesis and female hormone estrogen. In the male body follicle-stimulating hormone activates spermatogenesis. Lyutropotsites produce luteotrophic hormone, which stimulates the development of female body yellow body and their secretion of progesterone.

Another group of hromofilical adenocytes - **adrenokortikotropotsites**. They are at the center of the anterior lobe and produce adrenocorticotropic hormone, which stimulates the secretion of hormones beam and mesh zones of the adrenal cortex. Thanks to adrenocorticotropic hormone is involved in adaptation to starvation, injury, and other types of stress.

Chromophobic cells are concentrated in the center of the trabeculae. This heterogeneous group of cells, which are the following varieties:

-Immature, undifferentiated cells that play a role for the cambium adenocytes;

-Highlight the secret and therefore not stained at the moment hromofilnye cells;

-Follicular stellate cells - small, with small spines, with which they are connected to each other and form a network. Their function is not clear.

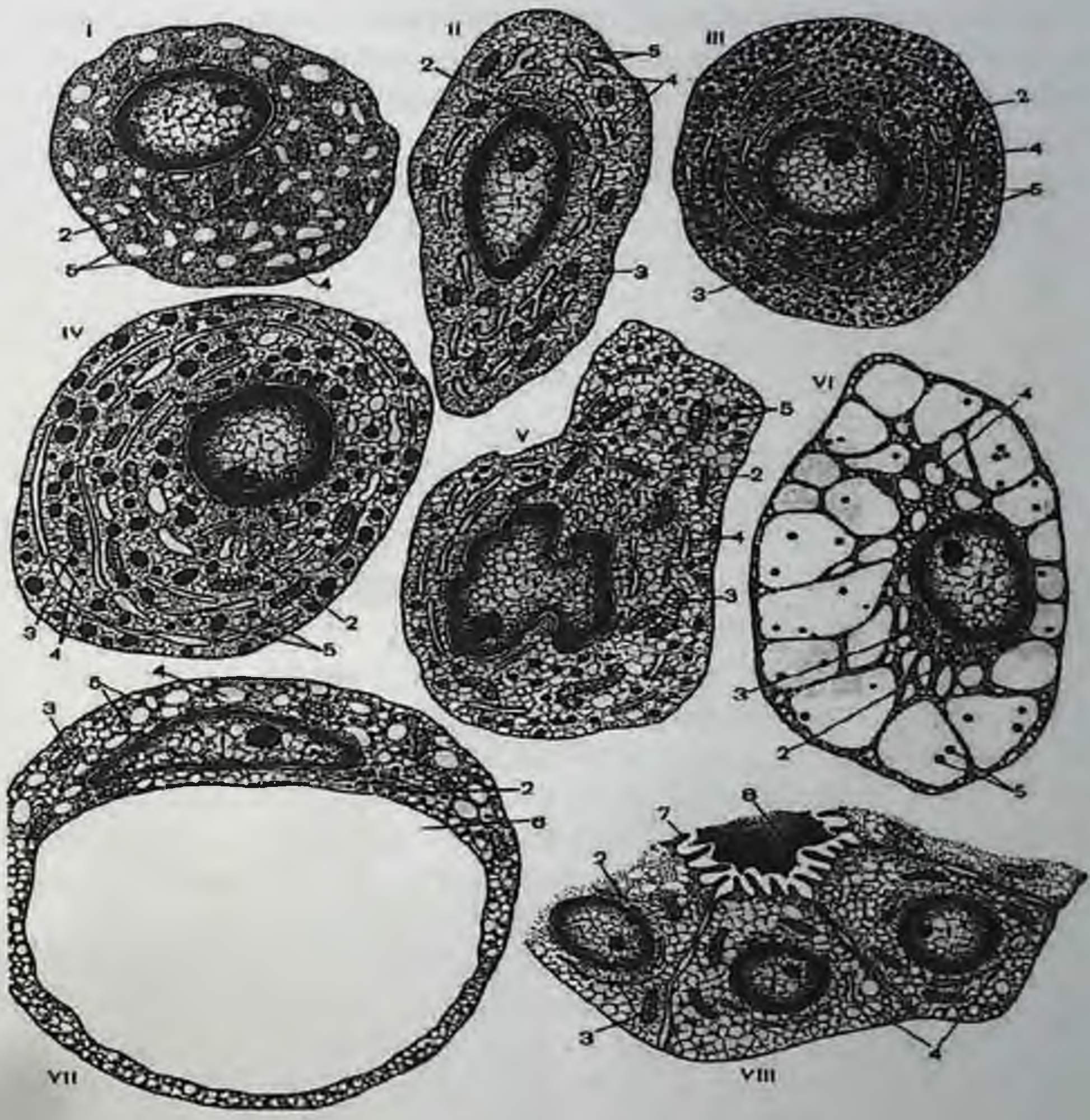
The average share has broken strands of basophilic and chromophobe cells. There cystic cavity lined with ciliated epithelium and containing colloid protein nature in which no hormones. Adenocyteses intermediate fraction produces two hormones:

1. **Melanocyte** stimulating hormone, it regulates pigment metabolism, stimulates the production of melanin in the skin, retina adapts to vision in the dark, activates the adrenal cortex;

2. **Lipotropin**, which stimulates fat metabolism.

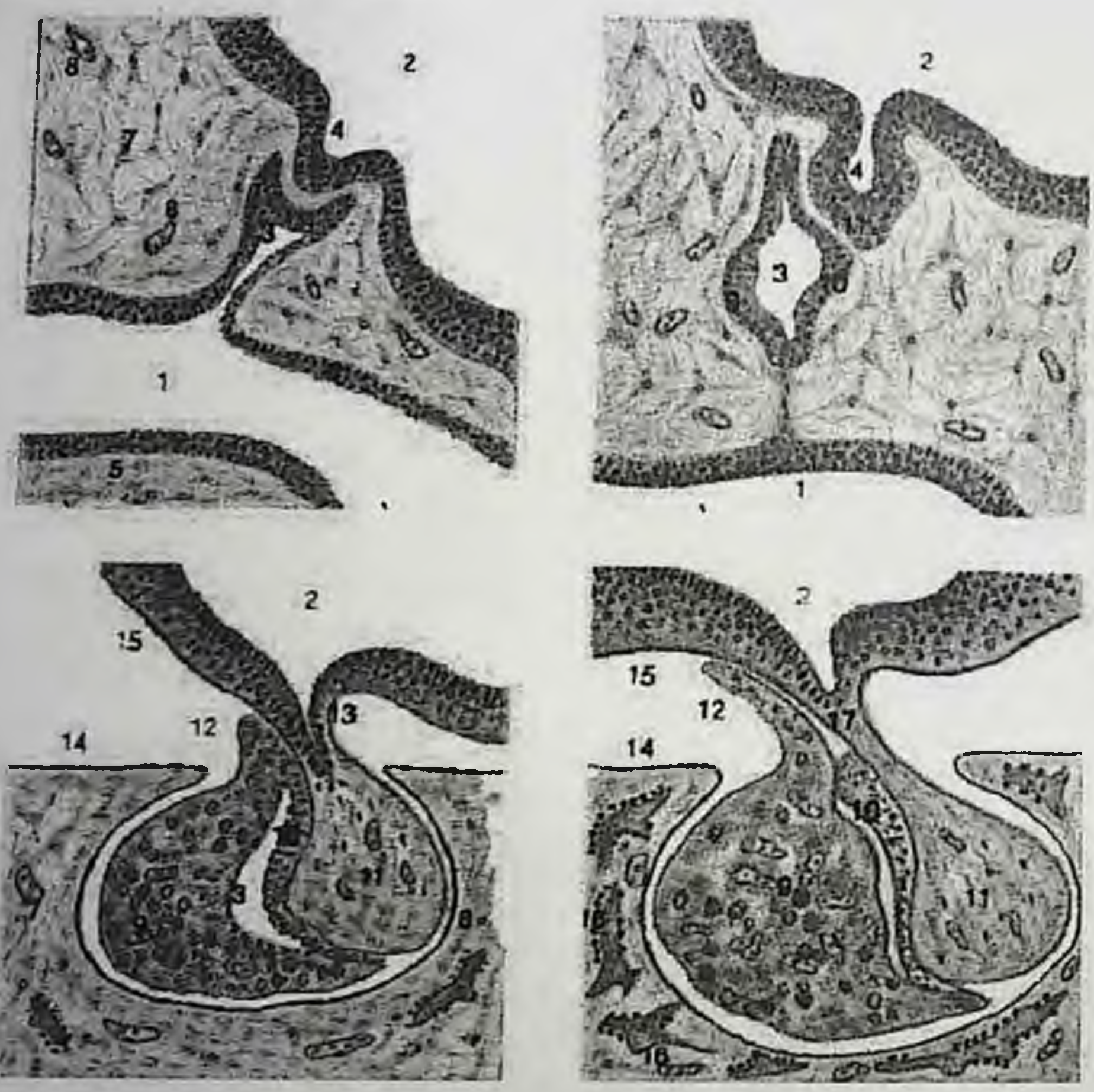
Tuberal zone is formed by a thin epithelial cells surrounding the epiphyseal leg. In tuberal share held pituitary portal veins that connect the primary capillary network of the medial elevation with secondary capillary network of the adenohypophysis. **Posterior lobe or neurohy-**

pophysis has neuroglial structure. It can not produce hormones, but only accumulated. Here comes along the axons and deposited in Taurus Goering **vasopressin and oxytocin** neurohormones anterior hypothalamus.



145-img. **The figure shows the ultrastructure of glandular cells of the adenohypophysis.** I-gonodotropnaya Follicle cell; II -tireotropnaya cell; III- samototropnaya cell; IV - lactotropic cell; V - kortikotropnaya cell; VI- cell pireoidektomii; VII- cell castration; VIII-follicular stellate cells psevdofillikula. 1- nucleus; 2-Golgi apparatus; 3 mitochondria; 4-EDT; 5-secretory granules; 6- vacuole; 7 microvilli; 8-cavity pseudofolliculitis zapolnënnoy kolloidopodobnoy weight

Neurohypophysis is composed of ependymal cells - **pituitary cells and axons of paraventricular and supraoptic nuclei of the hypothalamus**, and the blood capillaries and cells Goering - extensions of axons of neurosecretory cells of the hypothalamus. Pituitary cells take up 30% of the posterior lobe. They have shape and form three-dimensional network, surrounding the axons and terminals of neurosecretory cells. The functions of the pituitary cells are trophic and maintenance functions, as well as the regulation of the release of neurosecretion axon terminals in gemokapillyary.



146-img. **Stage of development of pituitary**
1-mouth; 2-ventricle cavity; 3 rathke's pouch; 4-diencephalon; 5-language; 6-buccal; 7-mesenchyme; 8-blood vessels; 9-front wall rathke's pouch; 10-rear wall rathke's pouch; 11-pituitary posterior lobe; 12-tuberalnaya part; 13-ependymomas; 14-dura; 15-pia mater; 17-pituitary stalk.

Blood supply of the adenohypophysis and neurohypophysis isolated. Adenohypophysis supplied with blood from the upper hypophyseal artery, which enters into the medial hypothalamus Eminence and splits the primary capillary network. On the capillaries of the network end aksovazalsynapses axons mediobasal hypothalamic neurosecretory neurons that produce releasing factors. Primary capillary network of capillaries and axons form synapses with first neyrogemal pituitary body. Then collected in a capillary portal veins that go to the anterior pituitary and there fall into the secondary capillary network of fenestrated or sinusoidal type. In her releasing factors and reach adenocytes here is releasing hormone adenohypophysis. These capillaries gather in front pituitary veins that carry blood to the anterior pituitary hormones to target organs.

As the capillaries of the adenohypophysis are between two veins (portal and pituitary), they are "wonderful" capillary network. Posterior lobe of the pituitary gland supplied with blood by the pituitary lower artery. This artery splits up the capillaries, which form synapses aksovazal neurosecretory neurons - the second neyrogemaly pituitarybody. Capillaries going to the rear pituitary vein.

Development. Adenohypophysis develops from the epithelium of the roof of the mouth, have ectodermal origin. On the 4th week of embryogenesis formed epithelial protrusion of the roof in the form of Rathke's pouch. The proximal part of the pocket is reduced, and it bulges towards the bottom 3 ventricle, which is formed from the posterior lobe. From the front wall of Rathke's pouch formed by the anterior lobe of the back - intermediate. Connective tissue is formed from the pituitary gland mesenchyme(Figure 138).

The structure of the epiphysis

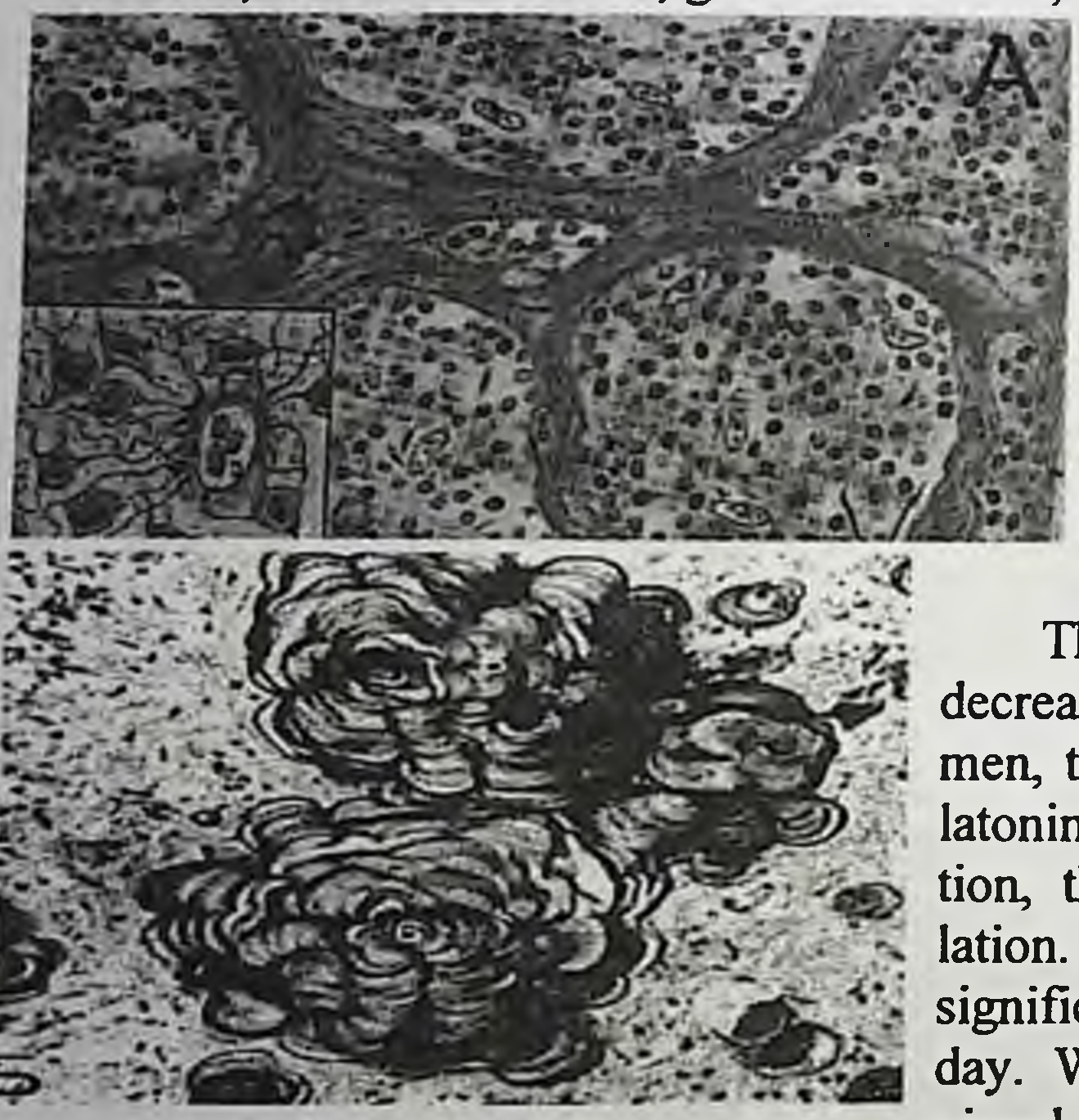
Epiphysis is located between the front colliculus. In embryogenesis formed on 5-6th week of fetal development, as bulging roof of the diencephalon.

Epiphysis - parenchymal lobed body. Outside covered with a capsule of loose fibrous connective tissue, from which depart septum separating the epiphysis into wedges. Parenchyma lobules formed anastomosing cell cords, islands and follicle cells and is presented in two types: pinealocytes and glial cells. Pinealocytes up to 90% of cells. Gliocytes epiphysis related, obviously, to astroglia, up to 5% of the parenchyma cells. They are distributed throughout the parenchyma of

the lobules, sometimes forming groups of 3-4 cells. Function of glial cells - support, trophic, regulatory.

The most active pineal function in young age. Body decreases with aging, it can deposit in the form of crystals of calcium phosphates and carbonates that are associated with the organic matrix of disrupted cells (epiphyseal sand, 147-figure).

Epiphysis synthesizes these **hormones serotonin and melatonin** regulate "biological clock" of the body. Hormones are derivatives of the amino acid tryptophan. Initially Serotonin is synthesized from tryptophan and is formed from the last melatonin. He is the antagonist of melanocyte stimulating hormone pituitary gland, is produced at night, inhibits the secretion of gonadotropin-releasing hormone, thyroid hormones, adrenal hormones, growth hormone, the body adjusts to rest.



147-img. **General view of the epiphysis.**
1 capsule.
2 interlobular connective tissue.
3-a blood vessel.
4 melanocytes.
5 gliocytes.
6-brain sand.

The boys of melatonin decreases at puberty. In women, the highest level of melatonin is defined in menstruation, the least - during ovulation. Production of serotonin significantly prevalent in the day. While sunlight switches pineal melatonin formation with the synthesis of serotonin, leading to a revival and awakening the body (serotonin is an activator of many biological processes).

About 40 peptide hormones, the most studied:

hormone that regulates calcium metabolism, hormone arginine vasotocin regulating arterial and depressing secretion of pituitary follicle-stimulating hormone and luteinizing hormone. It is shown that the pineal gland hormones suppress the development of malignant

tumors. Light reduces the function of the pineal gland, and darkness stimulates it. Identified neural pathway: retina – retinogipotalamic tract - the spinal cord - the sympathetic ganglia - epiphysis.

Thus, the functional activity was most pronounced in children. At this time, it prevents premature puberty, allowing the body of the child to mature physically. Pineal gland function is suppressed by light exposure. Obviously, excessive sun exposure inhibits the inhibitory effect of the pineal gland on the gonads, which explains the earlier sexual maturation of children in the South.

6.3.3. Peripheral endocrine organs

The structure of the thyroid gland

The thyroid gland produces several **hormones:**

-Thyroid hormones - **triiodothyronine and tetraiodothyronine.** They regulate the basal metabolic rate, and the process of development, growth and differentiation of tissues. Thyroid hormones accelerate protein catabolism (with simultaneous activation of synthesis), fats and carbohydrates, increase the consumption of oxygen by cells. Targets of thyroid hormones are almost all cells of the body, the thyroid gland is producing cells **thyrocalcitonin hormone, somatostatin and serotonin**. Thyrocalcitonin is a functional antagonist of the parathyroid hormone parathyrin. They lower blood calcium levels by stimulating bone cells (osteoblasts). In this case, calcium is deposited in the bones, which leads to their high salinity. Thyrocalcitonin simultaneously stimulates calcium excretion by the kidneys.

Somatostatin inhibits the growth and proliferation of cells, the secretion of other glands, and serotonin has multiple effects: regulates the function of a number of endo-and exocrine glands microcirculation function of connective tissue, immune responses.

Structure. The thyroid gland is a solid organ lobed structure. Stroma forms a capsule of dense connective tissue unformed and off-trabeculae formed unformed loose fibrous connective tissue. In addition, the stroma is supporting parenchyma intralobular frame of loose fibrous connective tissue containing blood and lymph vessels and nerves. Trabeculae divide the gland into lobules. Parenchyma form: clusters of follicles, interfollicular islets. The follicle is the structural and functional unit of the thyroid gland. It consists of two types of cells: thyrocites, parafollicular C-cells (Figure 140). Both types of cells lie on the basement membrane, but with their apical cell poles do not

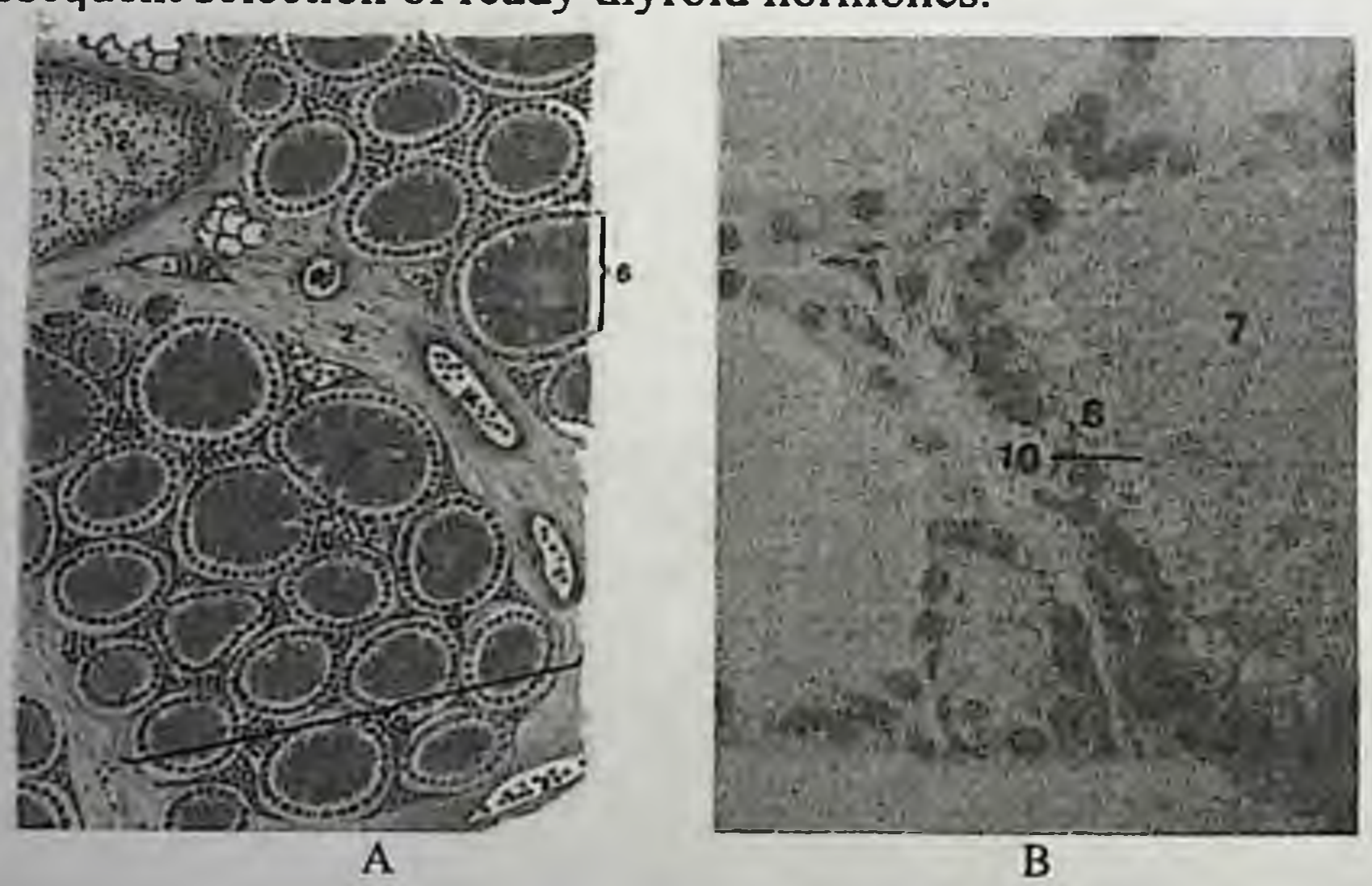
reach the lumen of the follicle. Within the follicle is kolloidoksifilical substance, which is a depot form of thyroid hormone. Thyrocytes form depends on the functional state of cancer. When normofunctial cells have a cubic shape, and are found in the colloid resorption sites, indicating that the expenditure of the colloid. When hypothyroidism thyrocites flattened follicles increase in size, and disappear in the colloid resorption zone, indicating that the deposit of large amounts of hormones. When hyperthyroidism thyrocites acquire cylindrical shape and the number of colloid is greatly reduced, it appears a lot of resorption vacuoles.

Thyrocites have well-developed organelles of protein synthesis: the granular endoplasmic reticulum, Golgi apparatus, mitochondria. In the cytoplasm, there are several types of bubbles:

-Secretory - contain iodized thyroglobulin, they are disconnected from the Golgi complex and carry synthesized thyroglobulin in follicular cavity;

-Fringed - contain immature, non-iodized thyroglobulin, which is captured from the cavity of the follicle thyrocytes iodization in the apical part of the cell;

-Endocytotic - contain mature iodinated colloid, which is captured from the cavity thyrocytes follicle lysosomes for degradation and the subsequent selection of ready thyroid hormones.



A B

148-img. **Thyroid. A-overall look. B-follicular wall**

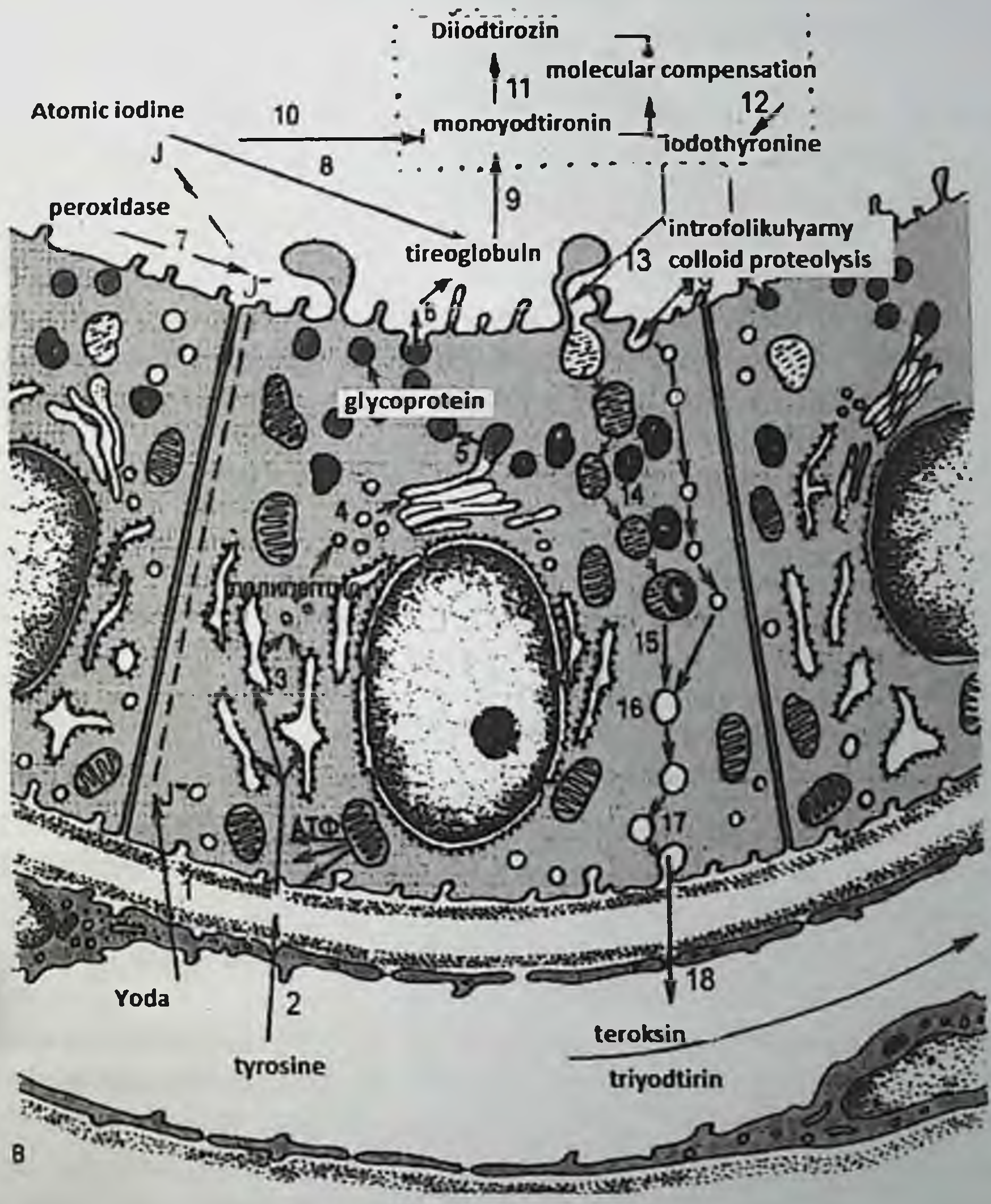
1-capsule; 2-between abdominal septa; 3-slices; 4-interlobular vessel; 5-capillary; 6-follicles; 7-colloid; 8-makuol resorption; 9-thyrocites follicle; 10-parafollicular thyrocites; 11-mezhfollikular island; 12-parathyroid gland.

There are three phases of the secretory cycle:

-thyroglobulin biosynthesis - organic basis hormones T3 and T4;

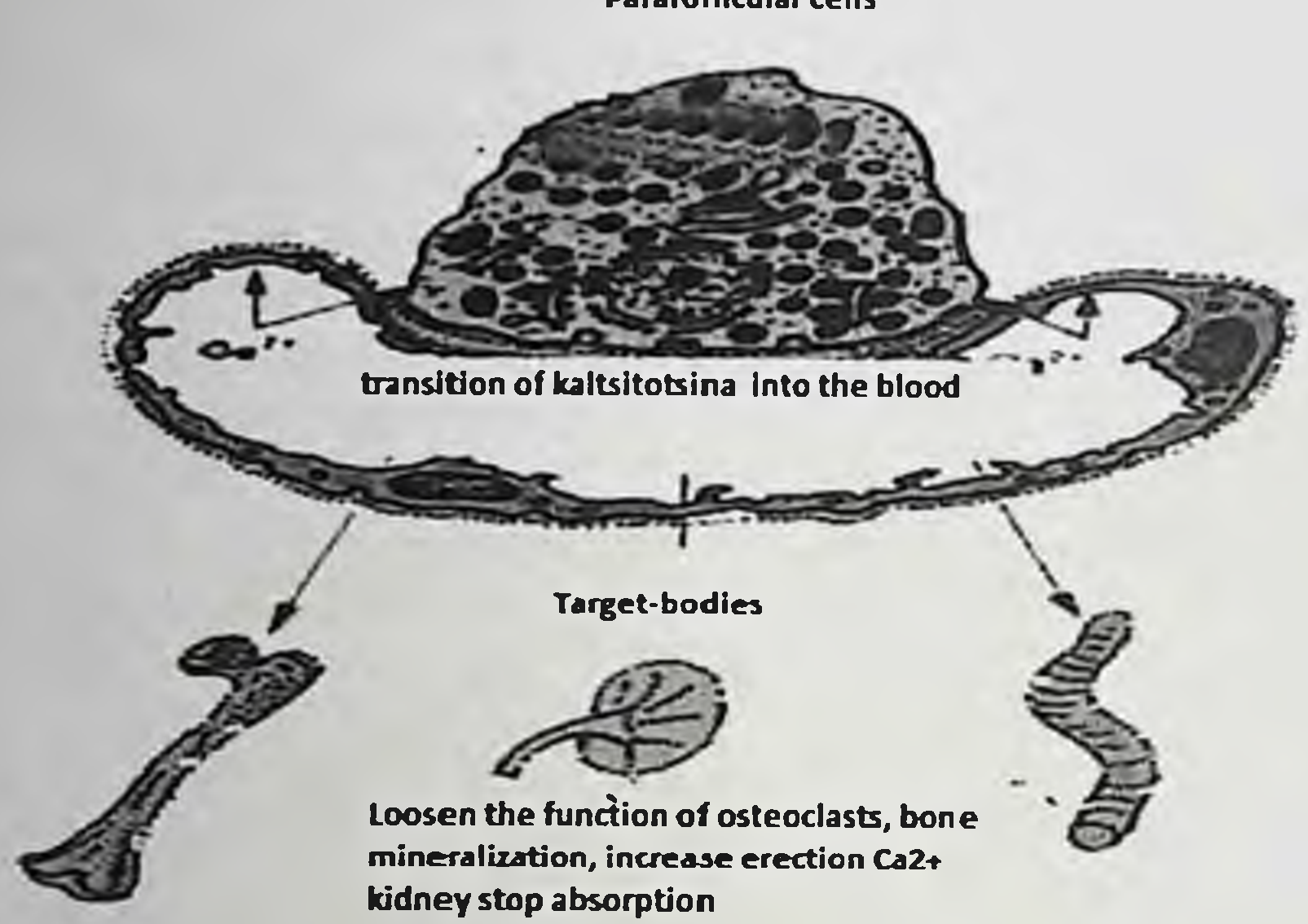
-allocation of thyroglobulin in the cavity of the follicle, iodized organic basis of thyroid hormones and thyroglobulin deposited in the follicle;

-elimination gormons of cells in the blood, with the bulk of the molecule remains in tirotsite thyroglobulin (149-img).



149-img. **Recently phase synthesis and secretion in thyrocytes**

Parafollicular cells (C cells) make up about 0.1% of the total parenchymal cell cancer. They are referred to APUD-system. They produce the protein hormones thyrocalcitoninum, somatostatinum and biogenic amine serotonin. These cells may be part of the follicle, but their apical surface of the cavity does not reach the follicle. In addition, these cells are part of the interfollicular islands, and are isolated.



Interfollicular islands - a cluster of thyrocytes without cavity. Thyrocites islands to produce a small amount of thyroid hormones. The functional load on the hardware, these bubbles can be activated at the same time begin to produce thyrocites colloid, and the island becomes a follicle. Thus, the islands are the reserve to form new follicles. Thyrocytes of islands are the C-cells.

Vascularization of the thyroid gland. The thyroid gland receives abundant blood supply. Feeding her arteries abundantly branched, their branches are in the interlobular connective tissue. Depart from the interlobular arteries mezofollikular artery going between follicles and forming perifollicular anastomosing capillaries, which have the form of baskets, heavy Entangling follicles. In humans, each capillary "basket" is a separate structure and is not connected with its neighbors. Capillary

blood from the "baskets" or flowing mezfollikular, or directly into the interlobular veins, which merge in the thyroid veins.

The structure of the parathyroid

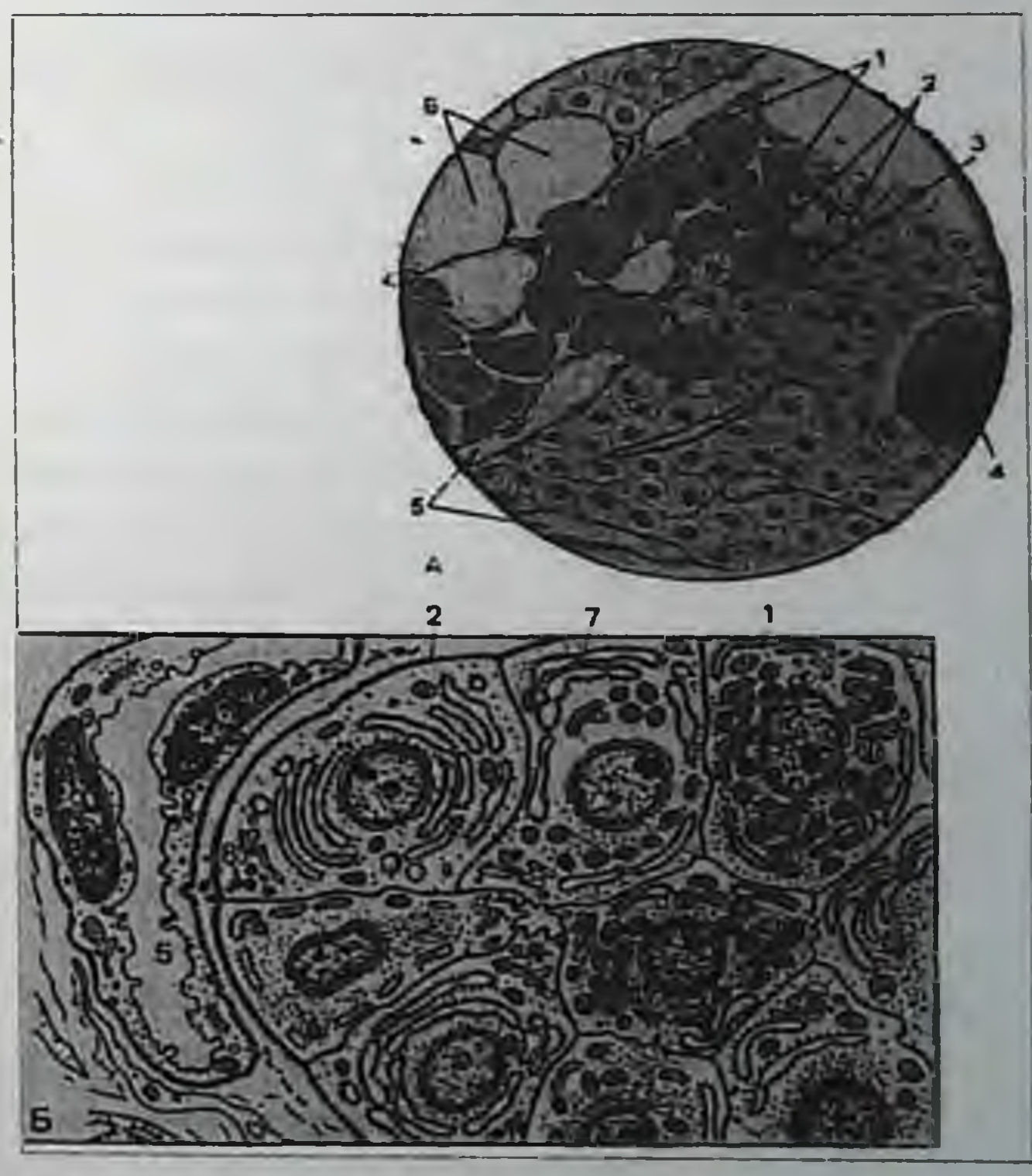
The main function of the parathyroid glands - the secretion of hormones.

Parathyrin hormone, which is an antagonist thyrocalcitonin, it raises the level of calcium in the blood in two ways:

-Through the destruction of the mineral component of bone by activating osteoclasts, while calcium is in the blood, where its content is increased;

-By activating the formation in the intestine of vitamin D, which enhances calcium absorption.

Cancer stroma formed capsule with radiating trabeculae of loose fibrous connective tissue executed that do not provide complete separation of the body into segments. In the stroma of many vessels and fat accumulation. Parathyroid gland - is parenchymal organ parenchyma is composed of trabecular structure. Trabekular paratirotsites cells, which are divided into two types: oxyphilic, major (basophilic) (151-fig).



151-img.
The structure of the parathyroid gland.
1-oxyphilic paratirotsites
2-main paratirotsites
3-connectivelayer
4-follicle kolloidoform content
5-gemokapillyary
6-adipocytes
7-intermediate cells
8 presekretory pellets

Principal cells are divided according to functional status at: willow and dark. Brown are actively functioning, contain more developed granular endoplasmic reticulum and Golgi complex. In the cytoplasm revealed a large number of secretory granules of 400 nm, containing parathyrin. Light cells are functionally inactive. Secretory activity of the principal cells of feedback regulates calcium in the blood, it increases at lower and suppressed by increasing its level.

Artery supplying the cancer fall into abundant capillary network that surrounds paratirotsites. Capillaries going into the veins, forming looped network and anastomosing with each other. Vienna poured into subcapsular venous plexus associated with the veins of the thyroid gland.

The structure of the adrenal

Adrenal function:

-Production of mineralocorticoids (aldosterone, deoxycorticosterone acetate, etc.), regulating water-salt metabolism and activating the inflammatory and immune responses.

Mineralocorticoids stimulate the reabsorption of sodium by the kidneys, which leads to a delay in the body of water and high blood pressure;

-Production of glucocorticoids (cortisol, hydrocortisone, and others). These hormones increase the level of glucose in the blood due to the synthesis of its decay products of fats and proteins. Hormones suppress inflammatory and immune responses, which is used in medicine for the treatment of autoimmune, allergic reactions, and so on;

-Production of sex hormones, mainly androgens (DHEA and androstenedione), which are weakly androgenic effect, but standing under stress, stimulate muscle growth. Production and secretion of androgens stimulate adrenocorticotropic hormone;

-Medulla produces catecholamines - the hormone epinephrine and the neurotransmitter norepinephrine, which are produced during stress.

Thus, the adrenal glands are vital organs, their complete removal or destruction of the pathological process leading to changes incompatible with life and death

The adrenal glands are paired parenchymal organs zone type. Outside covered with a capsule of dense fibrous tissue unformed, from which depart layers deep body - trabeculae. In the capsule is smooth muscle, autonomic ganglia, clusters of fat cells, nerves and blood

vessels. Capsule and loose fibrous layer of connective tissue form unformed body stroma. Parenchyma is represented by a set of cells: **kortikotsites** in the cortex and in the brain **hromaffinotsites**. Adrenals clearly divided into two structurally and functionally different zones (Figure)

Cortex consists of several areas:

-Subcapsular zone is formed by small undifferentiated kortikotsites playing the role of the cambium bark;

-Glomerular zone is 10% bark adrenal glands. Formed small kortikotsites forming glomerulus. They are moderately developed smooth endoplasmic synthesis of corticosteroid hormones. Function of the glomerular zone production of mineralocorticoids, and more specifically, in this zone is only the final stage of mineralocorticoid biosynthesis of their predecessor, corticosterone, which comes here from the beam area;

-Beam zone - is most pronounced cortex adrenal glands. Formed oxiphylic kortikotsitamical large size, forming bands and beams. Between the beams in a thin layer of loose fibrous connective tissue are sinusoidal capillaries. There are two types of beam kortikotsites: dark and light. It is one type of cells in different functional states. The function of the beam area - development glyukortikoidal (mainly cortisol and cortisone).

Netlike zone occupies about 10-15% of the cortex. Is composed of small cells, which are in the form of a network. In the reticular zone formed glyukortikoid and male sex hormones, such as androstenedione and DHEA, as well as a small amount of female hormones (estrogen and progesterone). Adrenal androgens, in contrast to gonadal androgen, has a weak androgenic effect, but their anabolic effects on skeletal muscle is saved, which is of great adaptive significance.

Adrenal hormones are lipid-soluble substances, and easily cross the cell membrane, so kortikotsites secretory granules are absent.

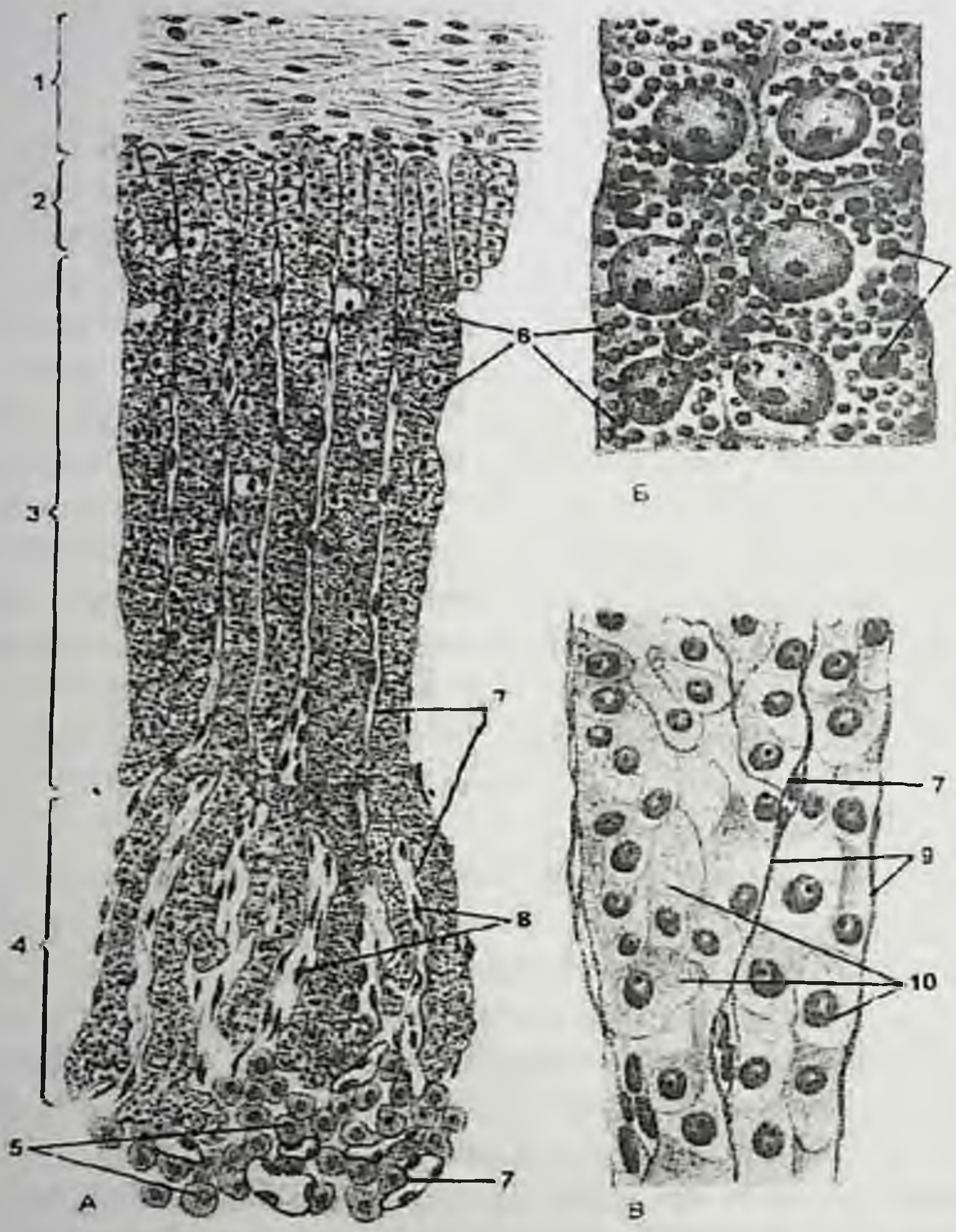
Brain substance is separated from the cortical thin capsule of loose fibrous connective tissue. It is a cluster of cells hromaffinotsites that stain well chromium salts.

These cells are divided into two types:

Large-cell light-producers hormone adrenaline (A) cells containing cytoplasmic granules moderately;

Small dark-hromatoffinotsites (AT) cells, containing a large number of dense granules, they secrete norepinephrine.

also found autonomic neurons (the ganglion cells) and supporting cells - a kind of neuroglia. Their spines they surround hromaffinotsites.

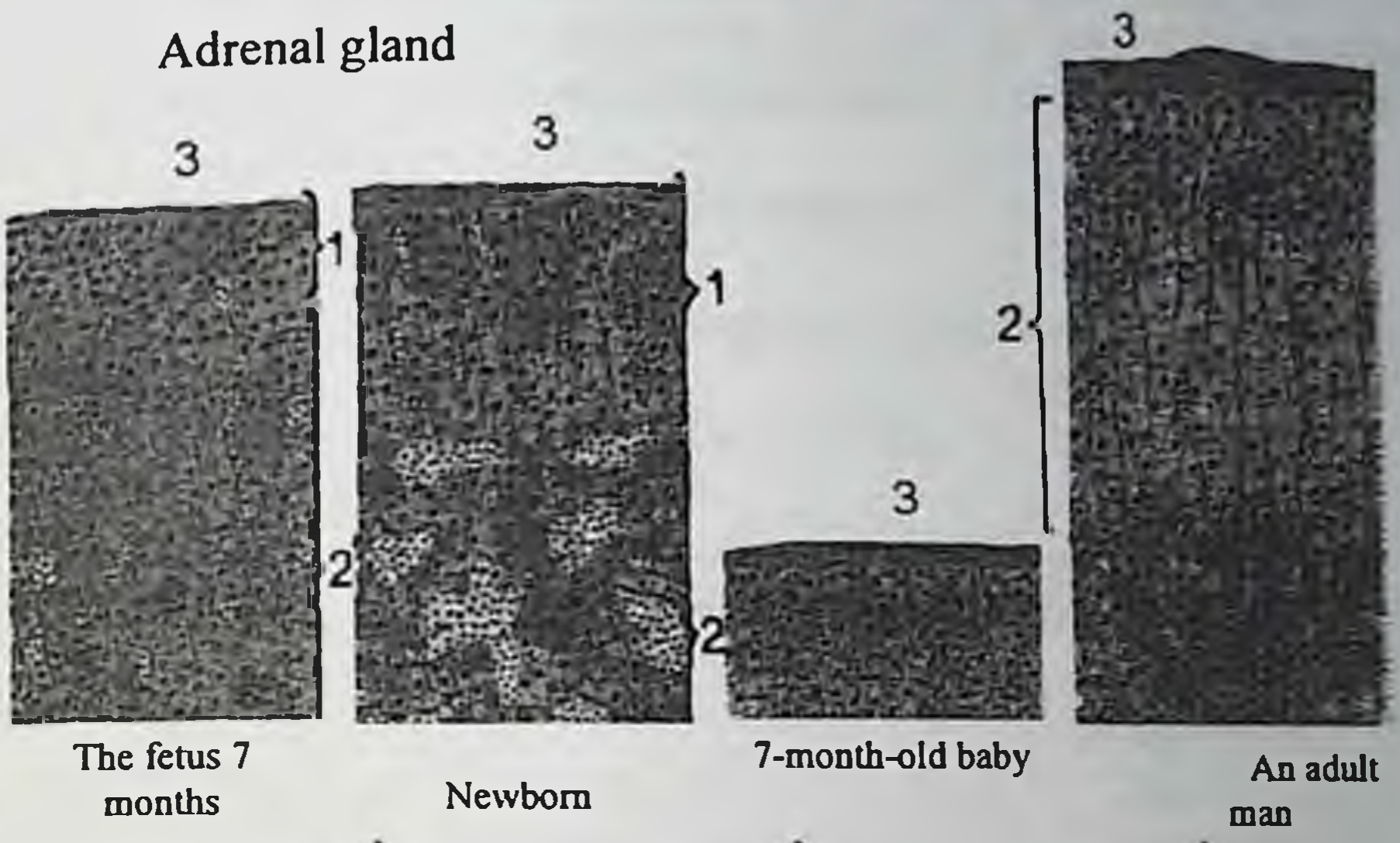


152-img. **The structure of the adrenal gland.** A, B, lipid accumulation in the B-adrenokortikotsital adrenokortikotsity fascicular zone after dissolving lipids. 1-capsule 2-glomerular zone 3 -mesh zone 4-beam zone 5 hromofilnye cells medulla 6 drops of lipids adrenokortikotsites 7-capillary 8- endothelium 9 connective layer between tragic adrenokortikotsital 10-spongiotsite

Blood supply of the adrenal gland

Artery entering into the capsule to break the arterioles, forming dense subcapsular network and fenestrated capillaries and sinusoidal

type that supply blood to the cortex. Fabric zone capillaries penetrate the brain substance, where it is converted into broad sinusoid, merge into venules. Venules pass into the veins, forming venous plexus of the brain substance. Of subcapsular network medulla penetrate as arterioles, breaking it up to the capillaries.



153-img. **1-FETAL (embryonic cortex) 2-constant bark 3- capsule**

Clinical significance.

Hyperparathyroidism is characterized by reduced phosphate concentration and increased concentration of Ca2 + in the blood. At the same time in a state of personal organs such as the kidneys and arteries, often formed abnormal calcium deposits. Bone disease caused, which is characterized by increased numbers of osteoclasts and multiple cavities in the bones E is known as fibrocystic osteitis. The bones of patients with fibrocystic osteitis less robust and often break down. Hypoparathyroidism - a condition in which rum phosphate concentration in the blood increased and the concentration of Ca2 + in the blood - reduced. Bones hundred denser their mineralization strengthens. This condition causes spastic muscle contractions and generalized convulsions, known as tetany. These symptoms are caused by increased excitability of the nervous system as a consequence of an insufficient level of Ca2 + in the blood. Patients with hypoparathyroidism treated with salts of calcium and vitamin D.

The practical part

Compilation of logical structures, the study of drugs, multimedia, electron diffraction on the endocrine system and the sketch of the principles of the structure of the pituitary, thyroid and adrenal glands to albums

The objects under study: 1. Pituitary gland. 2. The thyroid gland. 3. Nadpochenaya iron. 4. The electron adenohypophysis cells, thyroid cells and cells of the zona fasciculata of the adrenal gland.

Sample test items

1. Sources of pituitary development:

a) the neural tube;
b) the ectoderm;
c) the endoderm;
d) diencephalon.

2. What generates the middle part of the hypothalamus;

a) statins;
b) vasopressin;
c) oxytocin;
d) liberiny.

3. Hormones middle lobe of the pituitary.

a) somatostatin, mammotropin;
b) fsh and lutropin;
c) melatonin and lipotropin;
d) calcitonin.

4. Name the layers of the cortex of the adrenal gland;

a) glomerular;
b) beam;
c) the fibrous;
d) net.

Approximate refereed report on "APUD system and its role in the body"

The practical part

Compilation of logical structures, the study drugs, and viewing of multimedia electron diffraction on nerve tissue, and a sketch of the principles of the structure of the nervous tissue albums.

The objects under study:

1. The spinal cord.
2. Nerves.
3. Schemes glia.
4. The electron myelinated and unmyelinated nerve fibers and synapses.

Sample test items

1. What applies to macroglia?

a) ependimotsity;
b) astrocytes;
c) oligodendrocytes;
d) the giant neurons of the cerebral cortex;
e) glial macrophages.

2. What function is performed by astrocytes?

a) barrier;
b) demarcation;
c) a reference;
d) secretory;
e) generate nerve impulses.

3. What gliocytes form a layer that resembles a single-layer prismatic epithelium?

a) ependimotsity;
b) protoplasmic astrocytes;
c) oligodendrocytes;
d) microglia.

4. Where are the ependimotsity?

a) lining the ventricles of the brain and the central canal of the spinal cord;
b) surround large neurons of the brain;
c) accompany nerve fibers;
d) surrounding blood vessels.

5. Where are the oligodendrocytes?

a) around perikaryons neurons;
b) around the processes of neurons;
c) lining the ventricles of the brain and channels;
d) around the blood vessels of the brain.

6. What is the function of microglia?

a) dividing the barrier;
b) trophic;
c) the protective;
d) he participated in phagocytosis destruction of nerve tissue;
e) secretory.

Approximate refereed report on "Age Changes of nervous tissue"

Right answers to the test:

Topic 1: 1b; 2b; 3a; 4ab; 5ad.
Topic 2: 1c; 2c; 3e; 4ab; 5bc.
Topic 3: 1b; 2bd; 3bcd; 4ab; 5cd; 6de; 7bd; 8ae; 9b;10abd.
Topic 4: 1a; 2d; 3b; 4ac; 5a; 6e; 7d; 8a.
Topic 5: 1e; 2d; 3b; 4ac; 5a; 6b.
Topic 6: 1a; 2c; 3c; 4c.
Topic 7: 1d; 2b; 3ace; 4ace; 5e; 6d.
Topic 8: 1ab; 2bc; 3be; 4acde; 5bc; 6acde; 7bc; 8d.
Topic 9: 1ad; 2bd; 3c; 4e; 5ce; 6ad; 7abce; 8abc.
Topic 10:1e; 2abc; 3bce; 4ab; 5abcd; 6a.
Topic 11: 1e; 2acd; 3ac; 4bde; 5b.
Topic 12: 1c; 2d; 3a; 4c; 5d; 6bc.
Topic 13: 1ad; 2bde; 3bc; 4acd; 5ace; 6cdf; 7be.
Topic 14:1a; 2e; 3abd; 4acd; 5abcd; 6ac; 7abe.
Topic 15: 1b; 2bc; 3b; 4c; 5abc; 6ac; 7d.
Topic 16: 1d; 2a; 3ab; 4d; 5bce; 6bc.
Topic 17: 1abc; 2bc; 3a; 4a; 5b; 6cd.
Topic18: 1abe; 2ab; 3bc; 4abc.
Topic 19:1c; 2ad; 3abd.
Topic 20: 1ac; 2b; 3bc; 4b; 5acd.
Topic 21: 1be; 2ad; 3c; 4abd.

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