1. Cytology

1. The concentration of some ions outside a cell is lower than that in the cell cytoplasm. Can the ions pass through the plasmalemma into the cell?

2. The cells cultivated *in vitro* are attached to the substratum and to each other. What cellular structures provide the attachment?

3. The experiments with tissue cultures revealed that the cells did not respond to the influence of the hormone studied. Give an explanation to the experimental results.
4. When a wound heals, it becomes full of cells and fibers. How do these cells and fibers appear in the healing wound?

5. A healing wound is rich in collagen fibers and the cells containing numerous lysosomes and phagosomes. Is it true that the cells take part in collagen fiber production?
6. Young growing cells are known to be characterized by the basophilic cytoplasm. Give an explanation to this phenomenon.

7. The action of ionizing radiation results in the destruction of cell organelles. How do these cells utilize the organelle residues?

8. There are three cell populations in the lymph node: the cells rich in free ribosomes, the cells with numerous lysosomes, and the cells with a large amount of the rough endoplasmic reticulum. Which cells increase in number when the blood level of immune proteins (antibodies) considerably rises?

9. Histologists studying malignant cells revealed numerous keratin filaments in the cell cytoplasm. What type of tissue did the malignant cells arise from?

10.
11. The histological slide shows several neurons with large light nuclei and marked nucleoli. Assess the level of protein synthesis in these cells.

12. A cell enters mitotic division. Does protein synthesis occur in the dividing cell?

13. The cytophotometric investigation revealed one-nucleated and binucleated tetraploid cells in the liver. What are the mechanisms of the appearance of these polyploid cells?

14. Forensic experts established that the blood smear they examined belonged to a female. What led them to this conclusion?

15. The investigators observed and described two types of cell death in a tissue culture. In the first type, the cell membrane is ruptured, the cells become swollen, and a severe inflammatory reaction develops. The second type of death is characterized by DNA fragmentation, a decrease in cell volume, plasmalemma blebbing, and the formation of membrane-bounded bodies causing cell breakage. Inflammation does not occur. What are the two types of cell death?

2. Epithelial Tissues

1. Absorption is the main function of the small intestine lined with the epithelium. What type of epithelia is adequate to this function?

2. The brush border on the epithelial cells of the small intestine can be destroyed in some diseases (sprue). What cell functions are impaired in this case?

3. There are two epithelia in the histological section of an organ. One of them covers the surface of the organ; the other epithelium is located in the wall depth of the organ. Specify the epithelia and suggest their functions.

4. The cells of the stratified squamous keratinized epithelium are cultivated in two flasks. One of them contains the stratum basale cells; the other flask contains the stratum lucidum cells. Which of the flasks will contain proliferating cells?

5. The stratified squamous keratinized epithelium covers the skin. Are there any differences in the structure of the epithelium covering the thick (hairless) skin and the epithelium covering the thin skin?

3. Blood

1. The patient's blood test revealed 2.5×10^{12}/L of erythrocytes and 12% of reticulocytes. What term is used to describe these blood formula changes? What are the possible causes of the condition?

2. The blood of two patients is being tested. One of the patients lives in a highland area; the other patient is a lowlander. What differences may be found in the hemograms of patients living in highlands and lowlands? Explain your answer.

3. A blood smear shows leukocytes with round heterochromatic nuclei and a narrow rim of the light blue cytoplasm. In accordance with the leukocytic formula they account for about 35% of all leukocytes. What blood formed elements are described? Does their number correspond to the physiological norm?

4. The clinical blood test revealed 63% of neutrophils, 9% of eosinophils, 22% of lymphocytes, and 6% of monocytes. Does the leukocytic formula correspond to the physiological norm? If it does not, what are the possible causes of the formula alterations?

5. A child blood smear is being examined. The leukocytic formula reveals 30% of neutrophils and about 60% of lymphocytes. How would you assess this result?

4. Connective Tissues

1. Two types of connective tissues are visible in a histological section. One of them contains relatively fewer fibers but a lot of the amorphous ground substance. The matrix of the other tissue is rich in collagen fiber bundles arranged parallel to each other. What types of connective tissue are represented in the slide?

2. There are collagen, elastic, and reticular fibers in the connective tissue matrix. What types of fibers stain with Eosin? What histological methods are employed to reveal the other types of fibers?

3. A sting of a bloodsucking insect results in the development of swelling. Explain the phenomenon if it is known that the insect saliva contains the enzyme hyaluronidase.

4. Vitamin C deficiency results in scurvy characterized by bleeding gums, loose teeth, and poor bone growth. Explain the mechanism of vitamin C participation in the development of the symptoms.

5. The histological slides stained with Sudan to reveal lipids show two types of adipose cells. The first type is round cells with flattened nuclei; the cytoplasm appears as a thin rim around a large lipid droplet. The second type is polyhedral cells with round nuclei and a cytoplasm with abundant small fat droplets. Specify the cells and suggest their functions.

6. Immune reactions are characterized by increased blood levels of immunoglobulins (antibodies). What connective tissue cells produce immune proteins? What is the origin of these cells?

7. Patients with type I diabetes quickly lose their weight. Explain the pathogenesis of the symptom on the basis of the effect of insulin on the white adipose cells.

8. Melanocytes (pigment cells) are found in both the skin epidermis and dermis. Why is the tumor arising from the cells (melanoma) classified as the nervous tissue tumor?

5. Skeletogenic Tissues

1. There is a histological section of the hyaline cartilage stained with Hematoxylin and Eosin. The section periphery is pink and subdivided into two layers: the outer layer is dense, the inner layer is looser. What part of cartilage is described? What tissues does it consist of? What is the layer where the chondrogenic cells and chondroblasts are located?

2. There are three histological slides of different cartilage types. Two of them stain with Hematoxylin and Eosin, the third slide stains with Orcein. Which of the cartilage matrix fibrils do these methods detect? Identify the cartilage type in which the fibrils are revealed?

3. There are two slides of bone tissues. The first slide demonstrates bundles of collagen fibrils in the bone matrix. The second slide reveals collagen arranged in lamellae. Specify the bone tissue types and indicate their localization.

4. An electron micrograph of the bone tissue shows two cells. One of them contains plenty of rough endoplasmic reticulum and is surrounded by collagen fibrils. The other bone cell possesses narrow processes extending through the mineralized matrix; the cytoplasmic organelles are sparse. Specify the cells and suggest their functions.

5. An electron micrograph of bone tissue reveals a multinucleated giant cell located in a depression of the bone surface. The cell plasmalemma forms a ruffled border, and the cytoplasm contains numerous lysosomes. Specify the bone cell and determine its functions. Name the blood formed element the bone cell originated from. What body system does the bone cell belong to?

6. The histological slide of the developing tubular bone reveals two regions of ossification. In one of them, the bone matrix stains strongly eosinophilic. In the other region of ossification, the bone matrix includes basophilic areas. Specify the regions of ossification and explain why they look differently.

6. Muscle Tissues

1. The histological section of an organ demonstrates two cellular tissues. In one of them, each cell is surrounded by the basement membrane. In the other tissue, the cells rest on the basement membrane. Identify the tissues seen in the slide.

2. The electron micrograph shows some cells tightly adjacent to each other and joined together by numerous desmosomes. The second electron micrograph shows other cells also adjacent to each other, but separated by the basement membrane and joined together by numerous gap junctions (nexuses). What tissues do these cells belong to?

3. The histological section of muscle tissue stained with Iron hematoxylin reveals crossbanding striations. What additional morphological features enable us to identify the cardiac muscle tissue?

4. The electron micrograph of the skeletal muscle fiber reveals a small cell found between the plasmalemma and the basement membrane. Identify the cell and suggest its function.

5. There are two electron micrographs of the skeletal muscle fibers. In one of them, thin myofilaments deeply penetrate into the A bands so that the I bands considerably decrease in size. In the other micrograph, the I bands are wide. Explain the functional state of the muscle fibers.

6. The electron micrograph of the transverse section of skeletal muscle fibers shows a thick myofilament surrounded by six thin ones. What sarcomere band was crosscut?

7. There are two slides demonstrating regeneration of muscle tissues. One of them shows fibroblast-like cells. The other slide shows tube-like structures with several nuclei centrally arranged in a chain. Which one demonstrates regeneration of the skeletal muscle tissue?

7. Nervous Tissue

1. There is a neuron in a slide stained with Toluidine blue. The neuronal perikaryon and some processes contain dark blue clumps. Identify the clumps and the neuronal processes in which the blue clumps are revealed.

2. A student attempts to find “neurofibrils” in the neurons in a slide stained with Hematoxylin and Eosin. Help the student. Explain why the term “neurofibrils” is in inverted commas.

3. A microphotograph shows a neuron and numerous glial cells surrounding the neuron soma and its processes. Which of the glial cells are lemmocytes and which of them are satellites?

4. There are two slides of nerve fibers cut across. The axis cylinder in the first slide stained with Osmic acid is light and its sheath is black. The axis cylinder in the second slide stained with Silver nitrate is black and its sheath is white. What types of nerve fibers are represented in the slides? Specify the visible sheaths.

5. A microphotograph demonstrates a synapse. The right synaptic part contains small vesicles, whereas the left synaptic part contains no vesicles. Where is the presynapse? Indicate the direction in which the synapse conducts nerve impulses.

6. A patient became paralyzed. Which of the neurons of the reflex arch are damaged in this case?

7. Two patients do not respond when a doctor pricks their hands with a needle. One of them feels pain but cannot jerk his hand away. The second patient does not feel pain on pricking. Which neurons of the reflex arch are damaged to cause these conditions?

8. PNS and Spinal Cord

1. An investigator has been set the task to study sensory (afferent) neurons in the peripheral nervous system. What PNS organs are they found in? What morphological type do the sensory neurons belong to?

2. An investigator has been set the task to study the motor (efferent) neurons innervating the skeletal muscles and the neurons innervating the smooth muscle cells. What organs are the neurons located in? What morphological type do the efferent neurons belong to?

3. The microscopic examination of the spinal cord dorsal root reveals myelinated nerve fibers. What is the organ the myelinated fibers arise from? What neuronal processes form axis cylinders in the fibers? What neurons do the processes belong to?

4. The microscopic examination of the spinal cord ventral root reveals myelinated nerve fibers. What processes form axis cylinders in the myelinated fibers? What neurons do the processes belong to?

5. The spinal cord dorsal root has been experimentally cut. What is the fate of the cut myelinated fibers in the root portion connected with the spinal cord and in the root portion connected with the spinal ganglion?

6. The spinal cord ventral root has been experimentally cut. What nerve endings (receptors or effectors) stop functioning as result of cutting?

7. There is an intramural nerve ganglion and an extramural nerve ganglion with multipolar neurons. What functions do the ganglia perform? What types of neurons according to the functional classification do the ganglia contain?

8. The histological microphotograph demonstrates postganglionic nerve fibers. Are the fibers myelinated? What processes form the axis cylinders in the fibers? What neurons do the processes belong to?

9. The microscopic examination of the spinal cord reveals degeneration of the posterior column nerve fibers. What neurons have been damaged to cause degeneration? What neuron processes form the axis cylinders in the posterior column nerve fibers?

9. CNS: Brain

1. There are axodendritic synapses in the cerebellar cortex, in which the afferent mossy fibers form the presynaptic component. What structures form the postsynaptic component of the synapses? Which of the cerebellar cortex layers do the mossy fibers terminate in?

2. There are axodendritic synapses in the cerebellar cortex, in which the afferent climbing fibers form the presynaptic component. What structures form the postsynaptic component of the synapses? Which of the cerebellar cortex layers do the climbing fibers terminate in?

3. The microphotograph shows a large pear-shaped neuron of the brain. The neuron soma is surrounded by the nerve fibers that form the basket-like synapses. What part of the brain does the neuron belong to? What neurons form the basket-like synapses on the neuron soma? How do the basket-like synapses influence the neuron?

4. The microphotograph demonstrates a 120-μm pyramidal neuron of the brain. The neuron axon arising from the soma extends into the brain white matter. What part of the brain does the pyramidal neuron belong to? What tracts do the pyramidal neuron axons make up? What part of the spinal cord may the pyramidal tracts terminate in?

5. There is a histological slide of the cerebral cortex in which the 2nd and the 4th layers are well-developed. Name the cerebral cortex layers. What type of the cerebral cortex does this region belong to? What function does this type of the cerebral cortex perform?

6. There is a histological slide of the cerebral cortex in which the 3rd and the 5th layers are well-developed. Name the cerebral cortex layers. What type of the cerebral cortex does this region belong to? What function does this type of the cerebral cortex perform? What tracts arise from this type of the cerebral cortex?

7. The animal developed paralysis of the hind legs (movements became impossible) due to damage to neuron axons at the medulla oblongata level. What part of the brain are the neurons with damaged axons located in? What tracts fail to conduct impulses as a result of the traumatic injury?

10. Primary Sentient Sense Organs

1. The microphotograph shows a photoreceptor cell with a stack of flat membranous disks in its outer segment. Name the photoreceptor cell. Which of the photosensitive pigments do the disks contain? What light intensity is the photoreceptor cell sensitive to? Which kind of vision is the photoreceptor cell responsible for?

2. The microphotograph shows a photoreceptor cell with numerous membranous invaginations in its outer segment. Name the photoreceptor cell. Which of the photosensitive pigments do the invaginations contain? What light intensity is the photoreceptor cell sensitive to? Which kind of vision is the photoreceptor cell responsible for?

3. The lens is a biconvex transparent structure. If the lens focuses on distant objects, it becomes flatter. If the lens focuses on close objects, it becomes more convex. Specify the phenomenon. What eyeball structures cause the lens convexity to alter?

4. Vitamin A deficiency results in the impairment of twilight and night vision called night blindness. Explain the pathogenesis of the disease.

5. Albinism (congenital lack of pigmentation (whiteness) of the hair, skin, eyes, etc.) is characterized by day blindness, i.e., an impairment of vision in bright light. Explain why the absence of melanin in the eye structures causes day blindness.

6. There are two histological slides of the retina. In the first slide, the melanin granules are in the pigment epithelium cell bodies. In the second slide, the melanin granules are in the pigment epithelium cell processes. Which lighting condition (light or darkness) does each of the slides correspond to?

7. Mountaineers are often blinded by Alpine snow when they climb to the top of the mountain. Explain the phenomenon.

8. Patients with profuse discharge from the mucous membrane of the nose partially lose the sense of smell. Explain the phenomenon.

11. Secondary Sentient Sense Organs

1. A student wrote in his project that the organ of hearing is secondary sentient, because it develops from the otic vesicle. Is the student right?

2. A student studies the auditory conducting tract and hesitates to locate the first neuron body. Where are the first auditory neurons located? Where do their dendrites and axons pass? Identify the cells on which the dendrites form the afferent synapses?

3. The electron micrograph shows a neuroepithelial cell with the nerve fiber endings on its basal portion. Name two types of the nerve fibers that innervate neuroepithelial cells. What contacts do the nerve fibers form on the neuroepithelial cells?

4. The electron micrograph demonstrates a neuroepithelial cell with numerous stereocilia and a single kinocilium on its apical surface. A student supposes that the cell belongs to the spiral organ. Is he right?

5. The mode of action of a hearing-aid is based on the intensification of endolymph and perilymph vibrations in the inner ear. Select in which cases the use of the hearing-aid is

effective: (1) the acoustic nerve damage, (2) ankylosis of the auditory ossicle, (3) the tympanic membrane trauma, (4) the hair cell injury.

6. The patient's perception of gravity is disturbed. Specify the receptor cells whose function is lost.

7. One of the symptoms of gastrointestinal disorders is a "furred tongue." Explain why the sense of taste is impaired in this case?

12. Cardiovascular System

1. There are two arteries in the slide. One of the arteries contains the internal elastic membrane between the tunica intima and the tunica media as well as the external elastic membrane between the tunica media and the tunica adventitia. The second artery contains numerous elastic membranes in its tunica media. Identify the types of the arteries.

2. The electron micrograph shows the transverse section of a blood capillary. Its endothelial cells possess sites of thinned cytoplasm; its basal membrane is continuous. Specify the type of the blood capillary. What organs contain this type of capillaries?
3. There are two cells in the blood capillary wall. One of them rests on the basal membrane; the other cell is enclosed by the basal membrane. What do we call these cells?

4. The electron micrograph shows a capillary. Its endothelial cells lack the basal membrane but are attached to the surrounding collagen fibrils by the anchoring filaments. Specify the capillary.

5. There are two veins in the slide. One of them contains smooth muscle cells only in its tunica media. The other vein contains muscle cells in all the tunics, predominantly in the tunica adventitia. Identify the types of the veins. Which one belongs to the lower part of the body?

6. Hypoxia (low oxygen content) results in functional myocardial disorder. Why are contractile cardiomyocytes more vulnerable to hypoxia than conducting cardiomyocytes?

13. Hemopoiesis and the Central Organs of Hemopoiesis

1. The erythrocytes developing in the red bone marrow cluster around macrophages. What function do macrophages perform in the erythropoietic islets?

2. Megakaryocytes are revealed in an adult hemopoietic organ. Specify the organ. What blood formed elements do megakaryocytes give rise to?

3. The red bone marrow from the diaphysis of a tubular bone abounds in white adipose cells. Explain the phenomenon.

4. A student describes the structure of the hemopoietic organs and considers that the reticular tissue forms the stroma of both the bone marrow and the thymus. Is the student right?

5. The thymus of an adult animal reveals small-sized irregular lobules, scarce lymphocytes, numerous thymic corpuscles, and a well-developed connective tissue abounding in adipose cells. Comment on the disordered thymic structure.

1. Experimental newborn animals were subjected to thymectomy (excision of the thymus) followed by kidney homotransplantation. Why was the graft not rejected?

14. Peripheral Organs of Hemopoiesis and Immunogenesis

1. A series of microphotographs demonstrate lymphatic nodules from different hemopoietic organs. It is necessary to select the splenic nodules. What structural features may be employed for selection?

2. The investigator has been set the task to look into interactions between lymphocytes and epithelial cells in the peripheral hemopoietic organs. What organs can be used for this purpose?

3. Local inflammation causes the regional lymph nodes to enlarge. The enlarged lymph nodes reveal abundant plasma cells in the medullary cords and sinuses. Explain the changes in the lymph nodes.

4. A vital dye was injected into the afferent lymphatic vessel of the lymph node of an experimental animal. What are the lymph node cells where the dye droplets are found? What lymph node structures carry out lymph filtration and removal of foreign particles?

5. An investigator revealed that the mesenteric lymph nodes of experimental animals increased in size in the period of active digestion. How can you explain this fact?

15. Endocrine System

1. Two histological slides demonstrate glands. One of them has secretory portions and ducts. The second gland consists of secretory cells surrounded by a dense network of capillaries. Which of the glands is endocrine? What capillary type is typical of the endocrine glands?

2. Three groups of experimental animals were injected somatostatin, gonadoliberin, and thyroliberin, respectively. What endocrine gland is supposed to have an altered function in each of the cases? What endocrine cells are the targets for these hormones?

3. A histologist is analyzing two fields of view in the hypophysis section. One of them consists of numerous nerve fibers arranged in different directions and small cells among them. The second field of view demonstrates cords of epithelial cells with different tinctorial properties. Identify the portions of the hypophysis in each field of view.

4. The migration of the neural crest cells in an animal was experimentally arrested in embryogenesis. Which endocrine gland was affected by the intervention?

5. There are two slides of the thyroid gland. One of them was treated by silver impregnation. The second slide was prepared after an injection of radioactive iodine into an experimental animal. What thyroid gland cells are revealed in each of the slides? What hormones do these cells secrete? Are the cells adenohypophysis-dependent?

6. The histological examination of the thyroid gland reveals small follicles, columnar thyrocytes, and vacuolated colloid. What functional state of the organ does such a structure correspond to?

7. The histological examination of the thyroid gland reveals large follicles, flat thyrocytes, and dense colloid. What functional state of the organ does such a structure correspond to?

16. Digestive System – I

1. The microphotograph demonstrates the cross section of the tongue but its dorsal and lower surfaces are not designated. What structural features are indicative of the dorsal and lower surfaces of the tongue?

2. The oral cavity contains a lot of various microorganisms; therefore, lymphocytes undergo antigen-dependent proliferation and differentiation here. Where in the oral cavity do these immune processes occur?

3. Carbohydrates acted upon by the enzymes are broken down in the mouth where the first step of digestion takes place. What glands in the oral cavity secrete these enzymes?

4. The histological slides of three major salivary glands were treated with the method staining mucous cells bright crimson. Is it possible to differentiate between the parotid, submandibular, and sublingual salivary glands in the slides?

5. A student suggests that dentin is the hardest tooth component composed of collagen fibrils, the amorphous substance, and odontoblasts. What mistakes did the student make?

6. A student is examining two slides of the esophagus. In one of them, he has found skeletal muscle fibers in the muscularis externa and smooth muscle cells in the other slide. The student has explained the distinctions revealed by some pathologic changes. Is the explanation correct?

7. Gastric-like ulcers may sometimes appear in the esophagus. What features of the esophageal mucosa are linked to ulcer development? What parts of the esophagus may be vulnerable to ulceration?

17. Digestive System – II

1. There are two slides of different parts of the stomach. One of them reveals branched glands mainly consisting of mucous cells. In the second slide, the gastric glands look like tubules and contain the chief and parietal cells. What divisions of the stomach are seen in the slides? What components of gastric juice do the cells revealed secrete? What gastric tunic are the glands found in?

2. The histological slides of different digestive organs were treated with the method staining mucous cells bright crimson. What cells were revealed in the stomach and in the small intestine? Name the tunics where the cells are found.

3. The patient was diagnosed as having poor gastric digestion of proteins. His gastric juice had low acidity. What cells of the gastric glands were functionally incompetent?

4. The stomach biopsy revealed numerous gastrin-secreting cells (G-cells) and their increased activity. What gastric cells are the targets for gastrin? What physiological changes are caused by the increase in gastrin production?

5. The epithelium of the small intestine villi is completely renewed every 5 days. What cells in the small intestine epithelium are cambial and where are they located?

6. The electron micrographs of the small intestine crypts show cells with secretory granules. Some of the cells contain large dense granules at the apical cytoplasmic pole. The other cells contain smaller granules concentrated at the basal cytoplasmic pole. Identify the secretory cells and their functions.

7. Among the microphotographs of different parts of the small intestine, it is necessary to select the duodenum. What structural features are indicative of the duodenum?

18. Digestive System – III

1. If necessary, patients are administered medicines using enemas. What large intestine cells provide absorption of the medications?

2. There are two microphotographs of the lymphoid organs. They are supposed to be the tonsil and the appendix. What histological structures may be used to differentiate between the organs?

3. It was stated in a scientific article that the triad (portal area) is the hepatic lobule center. A student considers that this statement is erroneous, because the hepatic lobule center contains the central vein. Is the student right?

4. Bacterial food poisoning induces sER development in hepatocytes. What liver function is associated with sER development?

5. Some diseases cause venous blood congestion, which impairs tissue oxygenation and metabolism. Which part of the hepatic lobule (the center or periphery) is primarily affected in this case?

6. Some toxins may be absorbed in the small intestine and reach the liver in the portal blood. Which part of the hepatic lobule (the center or periphery) is primarily affected in this case?

7. Experimental ligation of the main pancreatic duct causes the death of some secretory cells. Which pancreatic cells die and which of them survive after this operation?

8. Some people like sweets and eat a lot of sugar. What pancreatic cells function with overstrain in this case?

19. Respiratory System

1. Inspired air contains dust and some foreign particles. What is the mechanism whereby air is filtered out in the respiratory passages? What cells take part in the removal of foreign particles? How do they end up in the lung interalveolar connective tissue?

2. There is a slide of the lung that shows large blood vessels next to the bronchi. Which of the circulations (systemic or pulmonary) do the blood vessels belong to?

3. The microphotograph of the lung alveolus shows an alveolar cell (pneumocyte) bulging into the air space and containing numerous cytoplasmic lamellar bodies. Specify the pneumocyte and its function.

4. On expiration, the lung alveoli become smaller, and deoxygenated air is expelled from the lungs. What structures of the interalveolar septa actively reduce the volume of pulmonary alveoli? What disease is associated with lysis and destruction of these interalveolar structures?

5. In bronchial asthma, paroxysmal dyspnea (spasm) is due to constriction of small bronchi. What structural elements of the bronchial wall cause a sudden spasm? Why is constriction of the small bronchi markedly pronounced?

20. Integumentary System

1. A student asserts that the epidermis contains macrophages and lymphocytes. Another student considers that it is not true because the epidermis lacks blood vessels. What student opinion is correct?

2. The skin biopsy microscopic examination revealed the five-layer epidermis and simple tubular glands in the dermis. What the skin area was analyzed? What the skin glands were distinguished in the biopsy?

3. A cold weather provokes so-called “goose-skin” appearance. What is a mechanism of the symptom development? What the skin structures take part in the reaction?

4. The skin of Europeans becomes brown in color under ultra-violet ray action. What the skin cells take part in the reaction? What is the reaction significance?

5. The thick skin was proposed to study glands with merocrine and holocrine modes of secretion. Is the choice true?

6. The finger skin is characterized by the papillary picture as well as the face skin lacks it. What the skin peculiarities may explain the difference?

21. Urinary System

1. The microphotograph shows the renal substance with renal corpuscles and tubules. Specify the renal substance (the cortex or the medulla) and the type of visible tubules.

2. Some diseases are characterized by stimulation and proliferation of mesangial cells. What are the renal structures where the mesangial cells are found? What functional changes occur as a result of mesangium activation?

3. The urinalysis revealed the presence of numerous erythrocytes. Examination of the patient's excretory passages did not reveal any bleeding. What nephron divisions are affected, which results in the appearance of erythrocytes in the urine?

4. The urinalysis revealed the presence of sugar. The urine was sampled in the morning on an empty stomach. What nephron divisions are affected? What epithelial cell structures are damaged?

5. The microphotograph demonstrates two renal corpuscles. The afferent and efferent arterioles of one of them are equal in diameter. The afferent arteriole of the other renal corpuscle is larger compared to the efferent one. Which nephron types do the corpuscles belong to?

6. The patient was diagnosed as having renal hypertension, i.e., his renal disease caused his blood pressure to increase. What renal structural disorder is responsible for this complication?

7. Two students explain the localization of the renal macula densa. One of them thinks it is found in the distal convoluted tubule. The other student considers that the macula densa is part of the renal juxtaglomerular apparatus. Who is right?

22. Male Reproductive System

1. Medical examination revealed retention of one of the testes in the abdominal cavity (cryptorchism). Which of the testicular functions will be affected if surgical operation (bringing the testis down into the scrotum) is not performed?

2. The mechanical trauma of the testis results in the cessation of spermatogenesis and desolation of seminiferous tubules. What testicular structures are damaged to cause this disturbance? What process is pathogenetic for the post-traumatic testicular changes?

3. The chromosomes of a spermatogenic cell become visible and conjugate forming bivalents. Determine the seminiferous epithelium cell and the spermatogenetic stage.

4. The nucleus of a spermatogenic cell becomes more condensed and elongated. The Golgi apparatus forms the acrosomal granule, and the distal centriole gives rise to the axonemal complex. Determine the seminiferous epithelium cell and the spermatogenetic stage.

5. Two male rats were experimentally made to lower their FSH and LH production, respectively. What cells of the male gonads respond to the intervention in each case?

6. The histological examination of the prostate gland revealed thickened connective tissue trabeculae and dilated alveoli containing dense, partially calcified secretions. What age period is typical of such a prostate structure?

23. Female Reproductive System

1. There are three slides of the human ovaries. The first slide shows primordial, primary, and atretic follicles. The ovary in the second slide contains secondary and tertiary follicles. The third slide shows fewer growing follicles, numerous atretic follicles, and well-developed connective tissue. What age periods are characterized by such ovary morphology?

2. The measurement of the blood levels of gonadotropins during the cycle revealed invariably high FSH and low LH concentrations. What changes in the ovarian cycle take place in such a case? What morphology is characteristic of the ovaries? What ovarian hormone is produced?

3. The histological examination of the endometrium showed numerous enlarged, highly coiled glands filled with a mucous secretion. What phase of the menstrual cycle does the

endometrium morphology correspond to? What ovarian structure is characteristic of this phase? What female sex hormone is predominantly produced during this phase?

4. The ovary contains follicles at different stages of development, atretic follicles, and atretic bodies on the 22nd day of the cycle. Is the ovary morphology normal? Is pregnancy possible?

5. Miscarriage occurred in the third month of gestation. What functions of the ovarian structures were impaired inducing the termination of pregnancy?

6. The release of milk in a breast-feeding woman decreased whereas the secretion of milk was active. What hormone is responsible for this phenomenon?

24. Human Embryology – I

1. In the process of spermatogenesis, acrosome formation is impaired. What sperm function is lost?

2. A student contends that the sperm acrosome is a derivative of the Golgi apparatus; another student considers that the acrosome is a modified lysosome; the third student thinks that the acrosome contains hydrolytic enzymes. Assess the opinions of these students.

3. A large-sized cell with two pronuclei surrounded by envelopes is found in the oviduct. Name the cell. What embryogenesis stage does the cell correspond to?

4. The microphotograph shows an embryo in the uterus. The embryo looks like a vesicle and consists of the embryoblast and the trophoblast. What embryogenesis stage does the embryo correspond to?

5. The case of birth of identical twins was explained by the ovum having been fertilized by two spermatozoa. Comment on the explanation.

6. A blastomere isolated from the murine embryo after the first or the second cleavage divisions is known to develop into a normal animal. Any attempt to grow a murine embryo from the blastula blastomeres is unsuccessful. Explain the experimental results.

7. A student contends that the human embryo endoderm arises from the epiblast; another student considers that the endoderm develops from the hypoblast. Who of them is right?

8. A student answers that the mesenchyme appears during gastrulation and gives rise to blood vessels. Correct and enlarge on the student's answer.

9. The histological examination of an embryo revealed the body folds and the amniotic folds. Is it possible to conclude that this is a human embryo?

25. Human Embryology – II

1. The student analyzing the section of a human embryo reveals the bilaminar embryonic disk associated with two vesicles. What is the embryo gestation age? What stage of embryonic development does the embryo correspond to? What vesicles are associated with the embryo?

2. An experimental female rat was subjected to ovariectomy (excision of the ovaries) in the early period of pregnancy. Is implantation possible in such a case?

3. The injection of the urine of a pregnant woman into immature female mice stimulates the development of their ovarian follicles. Identify the substance in the urine that causes this effect. Where is this substance produced?

4. A microphotograph shows the chorionic villi floating in the blood-filled lacunae. A student assumes that the lacunae contain fetal blood. Is he right?

5. It is known that fetal blood never mixes with maternal blood in the placenta. But if a pregnant woman takes some medicine, it may be found in the fetal body. Explain the phenomenon.

6. The picture shows a human embryo in the third trimester of pregnancy developing in the uterus. The embryo has the amnion, the chorion, the placenta, and the umbilical cord, but the yolk sac and the allantois are absent. Is the picture correct?

ANSWERS AND EXPLANATIONS

1. Cytology

1. The ions can pass through the plasmalemma into the cell against the concentration gradient by active transport that requires energy.
2. The cells are attached to the substratum and to each other by their plasma membranes.
3. The cells do not respond to the influence of the hormone, because they lack membrane receptors specific to this hormone.
4. Cells appear in the healing wound by migration and cell divisions. Fibers result from active fiber production by fibroblasts.
5. It is not true. The cells producing fibers are rich in the rough endoplasmic reticulum and Golgi apparatus. The cells revealed in the healing wound and containing numerous lysosomes perform the phagocytic function.
6. Young growing cells are characterized by diffuse basophilia of their cytoplasm due to plentiful free ribosomes. Free ribosomes synthesize cytosol proteins as well as proteins for cell growth and cell differentiation.
7. The cell autolysosomes utilize the organelle residues.
8. In this case, the cells with a large amount of the rough endoplasmic reticulum increase in number, because antibodies are secretory proteins produced on the rough endoplasmic reticulum.
9. Intermediate keratin filaments are inherent in epitheliocytes; therefore, the malignant cells arise from epithelial cells.
10. The neurons are characterized by intense protein synthesis. The nuclei appear light, because they contain euchromatin that takes part in transcription. The marked nucleoli synthesize rRNA and assemble ribosome subunits.
11. Protein synthesis fails to occur in the dividing cells, because DNA is condensed in chromosomes and transcription is impossible.
12. One-nucleated tetraploid cells result from either endomitosis (reduplication without subsequent mitosis) or abortive mitotic division arrested at the metaphase. Binucleated

tetraploid cells result from abortive mitosis arrested at the telophase (mitosis without cytokinesis).

13. The forensic experts came to this conclusion, because the neutrophils from the blood smear they examined demonstrate the so-called “drumstick” in their nuclei. The “drumstick” is a variant of “sex chromatin” that inheres in female cells only. One of two X chromosomes is strongly condensed and looks like a drumstick-appearing appendage on a neutrophil nuclear lobe.
14. The first type of cell death is necrosis; the second type is apoptosis.

2. Epithelial Tissues

1. Epithelium of the small intestine is simple columnar striated and specialized for absorption. It consists of tall columnar cells (absorptive cells) resting on the basement membrane. Apical portions of the epitheliocytes have numerous microvilli that form the brush border.
2. The brush border of the intestinal epithelium enlarges the cell surface area for absorption and membrane digestion. If the brush border is destroyed, these functions are impaired.
3. The epithelium that covers the surface of the organ is the covering epithelium. Its main functions are protection and external exchange. The epithelium located in the wall depth of the organ is glandular epithelium that forms exocrine and some endocrine glands. Its main function is secretion.
4. Proliferating epithelial cells may be found in the flask with the stratum basale cells, because this layer is cambial and contains stem cells. The stratum lucidum consists of differentiating cells that lack mitotic capacity.
5. The epithelium covering the thick skin consists of five distinct layers: the stratum basale, the stratum spinosum, the stratum granulosum, the stratum lucidum, and the stratum corneum. The epithelium covering the thin skin consists of only four layers, because it lacks the stratum lucidum. Its stratum granulosum is poor-developed; its stratum corneum is thin.

3. Blood

1. The deficiency of circulating erythrocytes clinically manifests itself as anemia. Reticulocytes account for about 1% of all blood erythrocytes. The abundance of reticulocytes results from hemolytic diseases or bleeding.

2. A highland is characterized by low partial oxygen pressure; therefore, the blood of the highlander contains more erythrocytes than the blood of the patient living in lowlands.
3. These are lymphocytes. In accordance with the leukocytic formula, lymphocytes account for 19 to 39%.
4. The clinical blood test reveals an increase in the eosinophil count. Allergic reactions or parasite invasions may be the causes of the formula alteration.
5. The leukocytic formula shows 30% of neutrophils and 60% of lymphocytes if the child age varies between 4 days and 4 years.

4. Connective Tissues

1. The first tissue visible in the slide is the loose connective tissue; the second tissue is the dense regular connective tissue.
2. Eosin stains collagen fibers pink; reticular fibers are revealed by silver impregnation (they become black); elastic fibers stain brown by orcein.
3. The enzyme hyaluronidase acts upon hyaluronic acid separating water from it. The permeability of loose connective tissue and capillaries increases with the resultant swelling.
4. Vitamin C (ascorbic acid) functions as a cofactor in collagen fiber formation. Vitamin C deficiency is characterized by poorer development of collagen fibers in connective tissues, bones, blood vessels, and periodontal ligaments, which causes the symptoms of scurvy.
5. The first type of cells is the white (unilocular) adipocyte; the second type of cells is the brown (multilocular) adipocyte. The functions of white adipose cells include storage of energy, insulation, cushioning of vital organs, and secretion of hormones. Brown adipose cells metabolize lipids to generate heat, mainly in newborns and infants.
6. Immunoglobulins (antibodies) are produced by plasma cells. They arise from B lymphocytes and function as the effectors of humoral immunity.
7. White adipose cells are the targets of the hormone insulin that promotes lipid synthesis and inhibits lipid degradation. Type I diabetes is characterized by low insulin levels that stimulate lipid utilization and a quick loss of weight by the patients.
8. Melanocytes (pigment cells) arise from the neural crest; therefore, melanoma is classified as a nervous tissue tumor.

5. Skeletogenic Tissues

1. The perichondrium is described. It consists of two layers: the outer fibrous layer composed of dense connective tissue and the inner cellular layer composed of loose connective tissue. The cellular layer contains chondrogenic cells and chondroblasts.
2. Eosin stains collagen fibers in histologic sections. In hyaline cartilage, the collagen fibers are not discernible, because they are fine and have the same refractive index as the amorphous substance. In fibrocartilage, the collagen fibers are visible, because they are more in number and arranged in thick bundles. Orcein reveals elastic fibers abundant in the elastic cartilage matrix.
3. The first slide shows the coarsely bundled bone tissue (primary, immature). It mainly occurs in embryogenesis. Later, it is replaced by the secondary bone tissue, except for the tooth sockets, the skull suture lines, and the insertion sites of tendons. The second slide shows the lamellar bone tissue (secondary, mature) that replaces the primary bone tissue and makes up the human skeleton.
4. The first cell is an osteoblast; its function is to secrete the organic portion of the bone matrix. The second cell is an osteocyte; it maintains bone homeostasis but lacks secretory activity.
5. The electron micrograph reveals an osteoclast; its function is bone resorption. Osteoclasts arise from the blood monocytes and belong to the mononuclear phagocytic system.
6. The slide shows the perichondral bone and the endochondral bone. The perichondral bone matrix stains strongly eosinophilic due to abundant collagen fibers. The endochondral bone matrix includes the basophilic areas of calcified cartilage.

6. Muscle Tissues

1. The slide, in which the cells are surrounded by the basement membrane, shows either the smooth muscle tissue or the cardiac muscle tissue. The second slide, in which the cells rest on the basement membrane, shows any simple epithelium.
2. The cells tightly adjacent to each other and joined together by numerous desmosomes are epitheliocytes. The cells enclosed by the basement membrane and joined together by numerous gap junctions are smooth muscle cells.
3. Both the skeletal muscle tissue and the cardiac muscle tissue reveal crossbanding striations due to striated myofibrils. The skeletal muscle tissue lacks cellular structure and consists of the symplasts called muscle fibers. The cardiac muscle tissue consists of

cardiomyocytes; their intercellular junctions are termed intercalated disks. The intercalated disks, which can be seen in slides stained with Iron hematoxylin, enable us to identify the cardiac muscle tissue.

4. This cell is a satellite cell. It is a stem cell of the skeletal muscle tissue which takes part in muscle reparative regeneration.
5. The skeletal muscle fiber, in which thin myofilaments deeply penetrate into the A bands so that the I bands considerably decrease, is in a contracted state. The second muscle fiber, in which the I bands are wide, is in a resting state.
6. The electron micrograph shows a cross section of skeletal muscle fibers in the peripheral regions of the sarcomere A bands.
7. Both of them. The first slide with the fibroblast-like cells represents the stage of myoblasts arising from satellite cells. The second slide with tube-like structures containing several nuclei represents the stage of myotubes resulting from myoblast fusion.

7. Nervous Tissue

1. The blue clumps revealed in the neuron with Toluidine blue staining are called Nissl bodies. They are characterized by strong basophilia, because they contain the rough endoplasmic reticulum. Nissl bodies are located in the neuron soma and the neuron axon; they are absent in the neuron dendrites, because dendrites lack rER.
2. “Neurofibrils” are invisible in slides stained with Hematoxylin and Eosin; they are revealed using Silver impregnation method. The term “neurofibrils” is in inverted commas, because they are fixation artifacts and represent aggregated microtubules and microfilaments.
3. The glial cells surrounding the neuron soma are satellites; the cells surrounding the neuron processes are called lemmocytes. They both belong to oligodendrocytes.
4. Both slides show the myelinated fibers cut across. The myelinated fiber contains a single axis cylinder surrounded by a myelinated sheath. The myelinated sheath includes several layers of the lemmocyte plasma membrane and is predominantly made up of lipids. In the first slide, Osmic acid stains lipids black; therefore, the myelinated sheath appears black. In the second slide, the myelinated sheath looks white, because myelin lipids are removed by alcohol in Silver nitrate staining; the axis cylinder appears black due to “neurofibrils.”

5. The right synaptic part including synaptic vesicles with neurotransmitters is the presynapse. The left synaptic part is the postsynapse containing the membrane receptors for neurotransmitters. The synapse conducts nerve impulses from right to left.
6. In such a case, either the reflex arch motor or associative neuron may be damaged.
7. If the patient feels pain but cannot jerk his hand away, his damaged neurons are motor or associative. If the patient does not feel pain on pricking, his damaged neurons are sensitive or associative.

8. PNS and Spinal Cord

1. The sensory (afferent) neurons are found in the PNS. They occupy the sensory ganglia (the dorsal root ganglia and the ganglia associated with some cranial nerves) and the primary sentient sense organs (the retina and the olfactory epithelium). Sensory neurons belong to either pseudounipolar or bipolar morphological types.
2. The neurons innervating the skeletal muscles are called the somatic motor neurons and found in the CNS. They occupy the spinal cord anterior horns and the brain stem efferent nuclei. The neurons innervating the smooth muscle cells are called the autonomic motor neurons and found in the autonomic ganglia. Both the somatic and autonomic motor neurons belong to the multipolar morphological type.
3. The spinal cord dorsal roots contain myelinated axons of the sensory pseudounipolar neurons of the spinal ganglia. These fibers send sensory impulses to the CNS; therefore, the spinal cord dorsal roots are called sensory roots.
4. The spinal cord ventral roots contain myelinated axons of the spinal cord somatic motor and autonomic associative neurons. These fibers conduct impulses away from the CNS; therefore, the spinal cord ventral roots are called efferent roots.
5. The spinal cord dorsal root contains the myelinated axons of the sensory neurons of the spinal ganglion. After the operation, the cut fibers in the root portion connected with the spinal ganglion may regenerate, because they retain structural integrity with the neuron bodies. The cut fibers in the portion connected with the spinal cord have no connection with the neuron bodies and degenerate. Their remnants are phagocytosed by glial cells.
6. The spinal ventral root contains the myelinated axons of the somatic motor neurons. The axons innervate the skeletal muscle fibers and terminate to form effectors – the motor end plates. After being cut, these effectors stop functioning.
7. Both ganglia are autonomic, contain the autonomic motor neurons, and perform the motor function. Their efferent neurons innervate smooth muscle cells, cardiac muscle

cells, and glands. The extramural ganglion may be either sympathetic or parasympathetic; the intramural ganglion belongs to the parasympathetic system. The intramural ganglia located in the wall of hollow tubular organs are called metasympathetic ganglia. These ganglia contain motor, sensory, and associative neurons forming the local reflex arch. The metasympathetic ganglia provide peristalsis of the tubular organs.

8. The postganglionic nerve fibers are unmyelinated. Their axis cylinders are the motor neuron axons located in the autonomic ganglia.
9. The nerve fibers of the spinal cord posterior columns include the sensory neuron axons located in the spinal ganglia. Damage to these neurons causes degeneration of the posterior column nerve fibers forming the ascending tracts of the spinal cord.

9. CNS: Brain

1. The mossy fibers terminate in the granular layer of the cerebellar cortex and synapse with the dendrites of the granular neurons (the postsynaptic component).
2. The climbing fibers terminate in the molecular layer of the cerebellar cortex and synapse with the dendrites of the Purkinje cells (the postsynaptic component).
3. The neuron belongs to the cerebellar cortex and is called Purkinje cell. The axons of the basket cells form the basket-like synapses on the Purkinje cell soma. These synapses inhibit the activity of Purkinje cells.
4. The pyramidal neurons belong to the cerebral cortex. The axons of the pyramidal neurons extend away from the cortex to form descending pyramidal tracts. The latter terminate in the anterior horns of the spinal cord and synapse on the motor somatic neurons.
5. The 2nd and the 4th layers of the cerebral cortex are called the external granular layer and the internal granular layer, respectively. These layers are well-developed in the granular type of the cerebral cortex. This cortex is sensory and responsible for the analysis of impulses coming from the sense organs.
6. The 3rd and the 5th layers of the cerebral cortex are called the external pyramidal layer and the internal pyramidal layer, respectively. These layers are well-developed in the agranular type of the cerebral cortex. This cortex is motor and sends impulses to the motor neurons of the spinal cord.
7. The neurons with damaged axons are the pyramidal cells located in the 3rd and the 5th layers of the cerebral cortex. The pyramidal cell axons make up the pyramidal tracts conducting impulses to the motor neurons of the spinal cord. These tracts fail to conduct impulses as a result of the traumatic injury.

10. Primary Sentient Sense Organs

1. This photoreceptor cell is a rod. Its flat membranous disks contain the photosensitive pigment rhodopsin. The rods are sensitive to low-intensity light and responsible for black-white vision (twilight and night vision).
2. This photoreceptor cell is a cone. Its membranous invaginations contain the photosensitive pigment iodopsin. The cones are sensitive to bright light and are responsible for colour vision (day vision).
3. The phenomenon is called accommodation; it is a function of the ciliary muscles. The contraction and relaxation of the ciliary muscles change tension on the suspensory ligaments attached to the lens, which becomes more or less convex. Accommodation allows the lens to focus images of nearby or distant objects on the retina.
4. The vitamin A aldehyde form called retinal is part of rhodopsin, a photosensitive pigment of the rods. Hypovitaminosis A causes rhodopsin deficiency and an impairment of the rod function (night blindness).
5. The vascular tunic of the eye and the retina contain numerous pigment cells with melanin that absorbs light. Lack of pigmentation activates iodopsin dissociation and inhibits its resynthesis, which impairs the cone function (day blindness).
6. The first slide corresponds to darkness. The melanin granules are concentrated in the pigment cell bodies, thus enabling the rods to function. The second slide corresponds to bright light. The melanin granules migrate to the pigment cell processes and protect rhodopsin against the unnecessary dissociation.
7. On mountain tops, sparkling Alpine snow activates iodopsin dissociation and inhibits its resynthesis blinding mountaineers.
8. Profuse discharge from the mucous membrane of the nose carries away the dissolved odoriferous molecules and prevents their interactions with the olfactory receptors.

11. Secondary Sentient Sense Organs

1. The organ of hearing develops from the optic vesicle, but it belongs to secondary sentient organs, because its receptors (hair cells) are epitheliocytes, i.e., neuroepithelial cells.
2. The first auditory neurons are located in the spiral ganglion housed inside the spiral lamina. They are afferent bipolar neurons. Their axons pass through the modiolus to form

the nerve fibers of the eighth cranial nerve. Their dendrites pass through the tunnel and form afferent synapses on the hair cells.

3. Afferent and efferent nerve fibers innervate the neuroepithelial cells. The afferent fibers are the dendrites of the sensory neurons; they form light contacts on the neuroepithelial cells. The efferent fibers are the axons of the brain neurons; they form dark contacts on the neuroepithelial cells.
4. The student is not right. The neuroepithelial cell with numerous stereocilia and a single kinocilium on its apical surface belongs to the vestibular apparatus.
5. The use of a hearing-aid is effective in cases of ankylosis of the auditory ossicles and the tympanic membrane trauma.
6. In such a case, the function of the hair cells located in the vestibular maculae is lost.
7. The "furred tongue" symptom results from active epithelium keratinization on the dorsal surface of the tongue. Thick keratinous masses close the interpapillary clefts and prevent the taste molecules from interacting with the taste bud receptors.

12. Cardiovascular System

1. The first artery belongs to the muscular type of arteries; the second artery belongs to the elastic type of arteries.
2. This is the fenestrated type of capillaries. These capillaries are typical of the endocrine glands, the small intestine, and the kidney.
3. The cell resting on the basal membrane is an endothelial cell. The cell enclosed by the basal membrane is a pericyte.
4. This is a lymphatic capillary.
5. Both veins are muscular veins. The first of them is a vein with small muscle content. The second vein is a vein with large muscle content and belongs to the lower part of the body.
6. The contractile cardiomyocytes are aerobic cells susceptible to hypoxia. Conducting cardiomyocytes are anaerobic cells; therefore, they are more tolerant of oxygen deficiency.

13. Hemopoiesis and Central Organs of Hemopoiesis

1. The red bone marrow macrophages take part in erythropoiesis and are called nurse cells. The nurse cells capture iron in the spleen (after erythrocyte degradation), migrate to the red bone marrow, and supply the erythropoietic cells with iron.

2. It is the red bone marrow. Megakaryocytes are the precursors of platelets.
3. Adipose cells of the red bone marrow take part in the creation of microenvironment, because they produce some hemopoietic growth factors. With age, the red bone marrow in the diaphyses of tubular bones is replaced by the yellow bone marrow mostly consisting of white adipose cells. The yellow bone marrow retains the hemopoietic potential.
4. The student has made a mistake. The reticular tissue forms the stroma of the red bone marrow. The thymic lobule stroma is composed of the epithelial tissue (epithelioreticular cells).
5. This is a morphological picture of age-related thymus involution.
6. The kidney graft was not rejected due to the absence of T killer cells arising in the thymus.

14. Peripheral Organs of Hemopoiesis and Immunogenesis

1. The lymph nodes, the tonsils, and the spleen have lymphatic nodules consisting of lymphocytes at different stages of development. The distinctive feature of the splenic nodule is the acentrically located central artery. The periarterial sheath is a T-dependent zone.
2. Gut-associated lymphatic tissue (GALT) including the palatine tonsils, the appendix, and lymphatic nodules can be used for this purpose. In these organs, lymphocytes infiltrate both the lamina propria and the tunica mucosa epithelium. For example, the intestinal epithelium contains M-cells presenting antigens to lymphocytes.
3. In inflammation, regional lymph nodes receive lymph rich in antigens. Antigen-dependent proliferation and differentiation of lymphocytes are activated. B-lymphocyte differentiation results in the formation of numerous plasma cells producing immunoglobulins.
4. Droplets of the dye injected into the afferent lymphatic vessel are found in the cytoplasm of macrophages. Lymph filtration and removal of foreign particles occur in the lymph node sinuses containing numerous macrophages.
5. In the period of active digestion, antigens are absorbed in the small intestine and reach the mesenteric lymph nodes. The antigens stimulate antigen-dependent proliferation and differentiation of lymphocytes. The cells increase in number causing the lymph node to enlarge.

15. Endocrine System

1. The second gland is endocrine, because it is ductless and releases hormones into the blood. The endocrine glands are characterized by the fenestrated type of blood capillaries.
2. The hormones mentioned above are produced by the hypothalamus and affect the adenohypophysial endocrine cells. Somatostatin inhibits the somatotropes (acidophils) producing GH. Gonadoliberin activates the gonadotropes (basophils) producing LH and FSH. Thyroliberin stimulates the thyrotropes (basophils) producing TSH.
3. The first field of view shows the neurohypophysis (the pars nervosa) consisting of neurosecretory axons, their endings, and small glial cells called the pituicytes. The second field of view shows the adenohypophysis (the pars distalis) consisting of different endocrine cells: acidophils, basophils, and chromophobes.
4. Two endocrine glands were affected by the intervention: the thyroid gland whose parafollicular cells (calcitoninocytes) arise from the neural crest and the adrenal medulla whose chromaffin cells also originate from the neural crest.
5. The slide treated by silver impregnation shows the parafollicular cells secreting calciotonin. These cells are nonadenohypophysis-dependent. The experiment with an injection of radioactive iodine reveals the follicular cells producing the iodide-containing hormones T_4 and T_3. The follicular cells depend on the adenohypophysis and are stimulated by TSH.
6. The small follicles, columnar thyrocytes, and vacuolated colloid are the morphological features of the thyroid gland hyperfunction.
7. The large follicles, flat thyrocytes, and dense colloid are the morphological features of the thyroid gland hypofunction.

16. Digestive System – I

1. On the dorsal surface of the tongue, the mucosa forms papillae; the papillary epithelium contains the taste buds; the epithelium covering the filiform papillae is keratinized; the submucosa is absent. On the lower surface of the tongue, the mucosa lacks papillae; there are no taste buds; the mucosal epithelium is nonkeratinized; the submucosa is present.
2. In the oral cavity, antigen-dependent proliferation and differentiation of lymphocytes occur in the tonsils, e. g., in the palatine tonsils.

3. The enzymes breaking down carbohydrates in the oral cavity are synthesized by the salivary glands and released with saliva.
4. Yes, it is possible. The parotid glands are serous and lack mucous cells; they do not stain with this method. The submandibular and sublingual salivary glands are mixed, contain mucous cells, and stain with this method. But, the submandibular glands are more serous, include some mixed acini arranged in groups, and partially stain with this method. The sublingual glands are more mucous, include many mixed and mucous acini, and almost completely stain with this method.
5. The enamel is the hardest tooth component due to its high mineralization (about 98%). The dentin is less mineralized (about 70%) and includes collagen fibrils as well as the amorphous substance. Odontoblasts are located in the peripheral region of the dental pulp, but their processes project into the dentinal tubules.
6. The student's explanation is not correct. The esophageal muscularis externa contains the skeletal muscle tissue in the upper third and the smooth muscle tissue in the distal third of the organ. The esophageal middle third consists of both striated muscle fibers and smooth muscle cells.
7. The esophageal cardiac glands are linked to ulcer development. These glands can be found in the mucosal lamina propria in the proximal and terminal portions of the esophagus.

17. Digestive System – II

1. In the first slide, the pyloric region of the stomach is seen; in the second slide, the fundic part. Gastric glands produce gastric juice and are found in the mucous membrane. Glandular mucous cells secrete mucus, the chief cells secrete enzymes, mainly pepsinogen, and the parietal cells produce hydrochloric acid and the intrinsic factor.
2. The method described reveals mucus-secreting cells in the mucosa of the stomach and the small intestine. In the stomach, these cells are the covering epitheliocytes and the mucous cells in the gastric glands. In the small intestine, these cells are the goblet cells of the intestinal epithelium.
3. The hypoacidity of gastric juice results from functional inhibition of the parietal cells of gastric glands. Hydrochloric acid converts the inactive enzyme pepsinogen to active pepsin- digesting proteins. The patient's poor protein digestion is due to low acidity of gastric juice.

4. The targets for gastrin are the parietal cells of gastric glands. The activation of G-cells and the increased gastrin production result in hyperacidity of gastric juice.
5. The cambial epithelial cells in the small intestine are called intermediate cells located in crypts.
6. The cells containing granules at the apical cytoplasmic pole are Paneth cells. These cells secrete enzymes and lysozyme and take part in the regulation of normal intestinal bacterial flora. The basally granulated cells are endocrine cells (cells of the APUD system). These cells produce hormones regulating secretory, proliferative, and contractile activity of the small intestine cells.
7. The duodenal glands located in the submucosa.

18. Digestive System – III

1. The epithelium lining the large intestine mucosa is simple columnar striated. It is characterized by the predominance of goblet cells. The columnar cells of this epithelium possess the brush border and take part in the absorption of some substances (water, electrolytes, vitamins, glucose) including medications.
2. The palatine tonsil is found in the oral cavity mucosa and includes the stratified squamous epithelium. The appendix is part of the large intestine and includes the simple columnar epithelium.
3. Both statements are true. The triad is a center of the portal hepatic lobule, while the central vein is a center of the classic hepatic lobule.
4. The hepatocyte sER is responsible for detoxication of different substances, including bacterial poisons.
5. Arterial oxygenated blood flows from the periphery to the center in the classic hepatic lobule and from the center to the periphery in the portal hepatic lobule. In venous blood congestion, the center of the classic lobule and the periphery of the portal lobule are the first to be affected.
6. Venous portal blood flows from the periphery to the center in the classic hepatic lobule and from the center to the periphery in the portal hepatic lobule. In such a case, the periphery of the classic lobule and the center of the portal lobule are the first to be affected.
7. Experimental ligation of the main pancreatic duct causes the death of exocrine glandulocytes. The endocrine cells of the pancreatic islets survive after the operation,

because they are not associated with the duct system and release hormones into the islet blood capillaries.

8. In this case, B cells of the pancreatic islets function with overstrain. B cells are adenohypophysis-independent and regulated by glucose blood levels. If people eat a lot of sweets, their blood glucose levels rise and stimulate B cells to produce insulin.

19. Respiratory system

1. Inspired air is filtered out in the respiratory passages by the mechanism called the "mucociliary escalator." Goblet cells of the epithelium lining the respiratory passages produce mucus that precipitates dust and foreign particles from inspired air. The cilia of the epithelial ciliated cells sweep the mucus with dust particles towards the nasal cavity. The particles reaching the alveoli are phagocytosed by pulmonary macrophages. The macrophages subsequently migrate from the alveolar space to interalveolar connective tissue.
2. This blood vessel belongs to the pulmonary circulation.
3. This is a type II pneumocyte. Its main function is surfactant production. In extensive destruction of alveoli, type II pneumocytes act as stem cell precursors for type I alveolar cells.
4. Elastic fibers of the interalveolar septa actively reduce the volume of the pulmonary alveoli on expiration. Lysis and destruction of the interalveolar elastic fibers are associated with pulmonary emphysema.
5. Smooth muscle cells of the lamina muscularis mucosa cause a sudden spasm in bronchial asthma. The constriction of small bronchi is markedly pronounced, because their muscularis mucosa is well-developed but there are no cartilage plates.

20. Integumentary System

1. The epidermis lacks blood vessels and is supplied by diffusion from the underlining loose connective tissue. But the epidermis contains macrophages (Langerhans cells) and T lymphocytes migrating from the dermis.
2. This skin area is the thick skin covering the palms and the soles. The glands revealed in the biopsy material are the sweat glands. They are simple nonbranched tubular coiled glands with the merocrine mode of secretion.

3. The so-called “goose flesh” results from constriction of the arrector pili muscle attached to the connective tissue sheath of the hair follicle. The muscles raise the hair causing goose pimple appearance.
4. Melanocytes located in the epidermis of the thin skin are responsible for this reaction. These cells produce melanin and provide keratinocytes with it. Melanin protects the skin from ultraviolet light and the ionizing effect of electromagnetic radiation.
5. The choice is not correct. The thick skin contains sweat glands with the merocrine mode of secretion and lacks holocrine sebaceous glands.
6. The finger skin is characterized by the unique papillary print, because its papillary dermis layer consists of numerous high (up to 2 mm) papillae. In the face skin, the dermal papillae are small, sparse, and may disappear with age.

21. Urinary System

1. This is the renal cortex, because the renal medulla lacks renal corpuscles. The cortex contains the following tubules: convoluted (proximal and distal) tubules and straight tubules of the medullary rays (the initial parts of collecting tubules and straight nephron tubules).
2. Mesangial cells are located in the renal corpuscles between the capillary loops. An increase in the number of mesangial cells decreases the surface of the filtration barrier and reduces filtration.
3. In such a case, the filtration barrier is damaged, because the filtration barrier prevents erythrocytes from passing into the primary urine.
4. In such a case, the proximal convoluted tubules are affected, because glucose is reabsorbed by the epithelial cells of the proximal tubules. The epitheliocyte brush border that takes part in reabsorption is damaged.
5. The first renal corpuscle belongs to the juxtaglomerular nephron, which hardly takes part in filtration and urine production. The second renal corpuscle belongs to the cortical nephron, which is very active in filtration.
6. The morphofunctional disorder of the juxtaglomerular apparatus may lead to the development of renal hypertension.
7. Both of them are right. The renal macula densa consists of the epithelial cells of the distal convoluted tubules and belongs to the juxtaglomerular apparatus where it functions as sodium chemoreceptors.

22. Male Reproductive System

1. Spermatogenic cells are sensitive to temperature. The temperature in the peritoneum is higher than in the scrotum; therefore, in cryptorchism spermatogenesis fails to occur.
2. The testis trauma damages the blood–testis barrier that maintains immune homeostasis in the seminiferous tubules. An autoimmune reaction develops and specific antibodies against spermatogenic cells desolate the seminiferous tubules.
3. The cell is a primary spermatocyte that represents the spermatogenic stage of growth.
4. The cell is a spermatid that represents the spermatogenic stage of formation.
5. The FSH acts on Sertoli cells stimulating ABP production. The LH acts on Leydig cells stimulating the secretion of testosterone. In the experiment described, the secretory activity of these testicular cells is inhibited.
6. This prostate gland structure is typical of elderly and old men.

23. Female reproductive system

1. The first slide shows the ovary morphology typical of prepuberty; the second slide, of the reproductive period; the third slide, of the preclimacteric period.
2. In such a case, the ovarian cycle lacks the ovulation (anovulatory cycle), because the LH peak fails to occur. The ovaries contain follicles at different stages of development (except Graafian follicles), atretic follicles, and atretic bodies but lack the corpus luteum. The ovaries produce estrogens during the whole cycle.
3. The endometrium morphology corresponds to the secretory (premenstrual) phase of the menstrual cycle. The ovarian corpus luteum is characteristic of this phase. Progesterone is predominantly produced during this phase.
4. This ovary morphology is not normal, because the corpus luteum is absent on the 22nd day of the cycle. It means that ovulation did not occur; therefore, pregnancy is impossible.
5. Progesterone production by the corpus luteum of pregnancy was impaired inducing the miscarriage.
6. Oxytocin is responsible for milk release in a breast-feeding woman; milk secretion is regulated by prolactin. In this case, the circulating oxytocin levels decrease, but the prolactin levels are normal.

24. Human Embryology – I

1. The enzymes released from the acrosome facilitate the sperm passage through the oocyte envelopes. If acrosome formation is impaired, the sperm cannot penetrate an ovum.
2. All the students are right.
3. This cell is a human zygote called a synkaryon, because it contains two (male and female) pronuclei. The zygote is surrounded by the zona pellucida. The zygote corresponds to the final stage of fertilization.
4. The embryo corresponds to the final stage of cleavage (blastula formation). The human blastula is called a blastocyst, because it looks like a vesicle. The blastocyst is implanted into the endometrium.
5. Human fertilization is characterized by monospermy due to the cortical reaction preventing multiple sperm penetration. Identical twins result from separation of two blastomeres and the embryoblast or primitive streak duplication.
6. After the first or the second cleavage divisions, blastomeres retain the zygote totipotentiality and may develop into an embryo. The blastula blastomeres undergo determination, become pluripotential, but cannot give rise to an embryo.
7. The first student is right. In human gastrulation, all the three germ layers (ectoderm, mesoderm, and endoderm) arise from the epiblast. The hypoblast does not take part in the formation of the embryo body proper and is displaced to extraembryonic regions.
8. The mesenchyme arises from the mesoderm at the stage of the axial organ formation. The mesenchyme gives rise to blood vessels, blood, all types of connective tissue, smooth muscle cells, microglial cells, and the endocardium.
9. It is not a human embryo. In human embryogenesis, only the body folds develop; the amniotic folds fail to appear, because the amnion forms earlier, in the second week of gestation.

25. Human Embryology – II

1. The embryo is in the second week of development. The embryo looks like a bilaminar disk that corresponds to the first stage of gastrulation. The embryo is associated with the amniotic vesicle and the yolk sac.

2. The female sex hormone progesterone prepares the endometrium for implantation. Progesterone is produced by the ovarian corpus luteum. After the ovariectomy, the experimental female rat lacks progesterone, which makes implantation impossible.
3. The urine of a pregnant woman contains human chorionic gonadotropin (hCG) that stimulates folliculogenesis in the ovaries of immature female mice. This hormone is secreted by the chorionic syncytiotrophoblast into maternal blood and then excreted in maternal urine. Human chorionic gonadotropin maintains the maternal corpus luteum and stimulates it to continue progesterone production. The detection of hCG in the woman's urine is an early pregnancy test.
4. No, the student is not right. The placental intervillous spaces or lacunae contain maternal blood from the eroded endometrial arteries. Fetal blood flows in the blood vessels of the chorionic villi.
5. In placenta, fetal blood never mixes with maternal blood owing to the placental barrier that is characterized by selective permeability. Most medicines may pass through the placental barrier and be found in the fetal body. Some of them, e.g., thalidomide, cause congenital malformations.
6. The picture is correct. By the end of the second month of gestation, the yolk sac and the allantois degenerate; after that, their remnants exist as parts of the umbilical cord.