

LECTURE COMPLEX

Discipline: "Cardiorespiratory system normal"

Discipline code: CSN 2211

EP name: 6B10115 "Medicine"

Amount of study hours/credits: 30/1,0

Course and semester of study: 2/3

The volume of lectures: 2 hours.

The lecture complex was developed in accordance with the working curriculum of the discipline "Cardiorespiratory system normal " (syllabus) and discussed at a meeting of the department of "Topographic anatomy and histology"

Protocol No. 11 from "16" 06 2025 y.

Head of the department, acting professor, c.m.s.,



Murzanova D.A.

ONTÜSTIK QAZAQSTAN MEDISINA AKADEMIASY «Оңтүстік Қазақстан медицина академиясы» АҚ		 SOUTH KAZAKHSTAN MEDICAL ACADEMY АО «Южно-Казахстанская медицинская академия»
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1.Topic: Cardiac histology.

2. Purpose:

To provide an understanding of the development and histophysiology of the heart, its characteristics in childhood.

3. Lecture summary:

1. Introduction to Cardiovascular Histology:

- Definition of histology as the study of tissues at the microscopic level.
- Rationale for the importance of studying histology for understanding the structure and functions of organs.

2. Cardiac Tissue Structure:

- Description of the main types of cardiac tissue: myocardium, endocardium, and epicardium.
- Examination of the structure of the myocardium: cardiomyocytes, intercalary discs, and endomysium.
- Explanation of the role of cardiomyocytes in the contractile function of the heart.

Endocardium. The following layers are distinguished in the inner lining of the heart: the endothelium, lining the inside of the heart cavity, and its basement membrane; the subendothelial layer, represented by loose connective tissue containing many poorly differentiated cells; the muscular-elastic layer, consisting of smooth muscle tissue, between the cells of which elastic fibers are located in a dense network; The outer connective tissue layer consists of loose connective tissue. The endothelium and subendothelial layers are analogous to the tunica intima of the vessels, the muscular-elastic layer is the "equivalent" of the tunica media, and the outer connective tissue layer is analogous to the outer (adventitial) tunica of the vessels. The surface of the endocardium is perfectly smooth and does not impede the free flow of blood. In the atrioventricular region and at the base of the aorta, the endocardium forms duplications (folds) called valves. A distinction is made between atrioventricular and ventricular-vascular valves. Fibrous rings are present at the valve attachment sites. The heart valves are dense plates of fibrous connective tissue covered by endothelium. The endocardium is nourished by the diffusion of substances from the blood in the cavities of the atria and ventricles. The myocardium (the middle layer of the heart) is a multi-tissue membrane consisting of striated cardiac muscle tissue, loose intermuscular connective tissue, numerous vessels and capillaries, and neural elements. The primary structure is cardiac muscle tissue, which in turn consists of cells that generate and conduct nerve impulses, and cells of the working myocardium that ensure cardiac contraction (cardiomyocytes). Among the cells that generate and conduct impulses in the cardiac conduction system, three types are distinguished: β -cells (pacemaker cells), intermediate cells, and Purkinje cells (fibers). β -cells are the pacemaker cells located in the center of the sinus node of the cardiac conduction system. They have a polygonal shape and are determined to spontaneously depolarize the plasma membrane. Myofibrils and organelles of general significance are poorly expressed in pacemaker cells. Intermediate cells are a heterogeneous group of cells that transmit excitation from β -cells to Purkinje cells. Purkinje cells are cells with a small number of myofibrils and a complete absence of the T-system, with a larger amount of cytoplasm compared to working contractile myocytes. Purkinje cells transmit excitation from intermediate cells to contractile cells of the myocardium. They are part of the bundle of His of the cardiac conduction system. Pacemaker cells and Purkinje cells are adversely affected by a number of medications and other factors that can lead

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to the development of arrhythmias and heart block. The presence of the heart's own conduction system is extremely important, as it ensures the rhythmic alternation of systolic contractions and diastole of the heart chambers (atria and ventricles) and the work of its valve apparatus. The bulk of the myocardium is made up of contractile cells—cardiac myocytes, or cardiomyocytes. These elongated cells have an ordered system of striated myofibrils located at the periphery. Mitochondria with numerous cristae are located between the myofibrils. The T-system is weakly expressed in atrial myocytes. The granular endoplasmic reticulum is poorly developed in cardiomyocytes. An oval-shaped nucleus is located in the central part of the myocytes. Sometimes, binucleated cardiomyocytes are found. Cardiomyocytes with osmiophilic secretory granules containing natriuretic peptide are present in the atrial muscle tissue. Glycogen inclusions, which serve as the energy source for the cardiac muscle, are found in cardiomyocytes. Its content in left ventricular myocytes is higher than in other parts of the heart. Myocytes of the working myocardium and the conduction system are connected to each other by intercalated discs—specialized intercellular junctions. Actin contractile myofilaments attach to the intercalated discs, and desmosomes and gap junctions (nexuses) are present. Desmosomes facilitate the strong adhesion of contractile myocytes into functional muscle fibers, while nexuses ensure the rapid propagation of plasma membrane depolarization waves from one muscle cell to another and the existence of the cardiac muscle fiber as a single metabolic unit. A characteristic feature of myocytes of the working myocardium is the presence of anastomosing bridges—interconnected fragments of the cytoplasm of muscle cells of different fibers containing myofibrils. Thousands of these bridges transform cardiac muscle tissue into a meshwork structure capable of synchronously and effectively contracting and ejecting the required systolic volumes of blood from the ventricular cavities. Following extensive myocardial infarctions (acute ischemic necrosis of the heart wall), when the cardiac muscle tissue, intercalated disc system, anastomosing bridges, and conduction system are diffusely damaged, cardiac arrhythmias, including fibrillation, occur. In this case, cardiac contractility devolves into isolated, uncoordinated twitches of muscle fibers, and the heart is unable to eject the required systolic portions of blood into the peripheral circulation. The myocardium consists generally of highly specialized cells that have lost the ability to divide by mitosis. Cardiomyocyte mitosis is observed only in certain areas of the atria (Rumyantsev P.P., 1982). However, the myocardium is characterized by the presence of polyploid myocytes, which significantly enhances its working potential. The phenomenon of polyploidy is most often observed during compensatory reactions of the myocardium, when the load on the heart increases, and in pathologies (heart valve insufficiency, lung diseases, etc.). In these cases, cardiac myocytes sharply hypertrophy, and the heart wall thickens in one or another section. The myocardial connective tissue contains a richly branched network of blood and lymphatic capillaries, which provides the constantly working heart muscle with nutrition and oxygen. The layers of connective tissue contain dense bundles of collagen fibers, as well as elastic fibers. Overall, these connective tissue structures form the supporting skeleton of the heart, to which Cardiac muscle cells are attached. The heart is an organ with the ability to contract automatically. It can function autonomously within certain limits. However, in the body, the heart's activity is under the control of the nervous system. The intramural ganglia of the heart contain sensory autonomic neurons (Dogel cells type II), small, intensely fluorescent cells—

MIF cells—and effector autonomic neurons (Dogel cells type I). MIF cells are considered interneurons. The epicardium is the outer membrane heart - is the visceral layer of the pericardium. Free surface The epicardium is lined with mesothelium, just like the surface The pericardium faces the pericardial cavity. Beneath the mesothelium, these serous membranes contain a connective tissue base of loose fibrous connective tissue.

4. Illustrative material: presentation, including:

- color micrographs of histopreparations
- electronograms, diagrams, drawings

5. Literature:

Main literature

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Additional literature

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6. Control questions (feed back):

1. Sources of Heart Development
2. Structure of the Heart's Membrane
3. Characteristics of the Heart in Childhood
4. Structure of the Vein Wall – Muscular and Nonmuscular
5. Age-Related Characteristics
6. Sources of Heart Development
7. Structure of the Heart's Membrane
8. Characteristics of the Heart in Childhood
9. Age-Related Characteristics

Lecture #2.

1.Topic: Histology of blood and lymphatic vessels.

2.Objective: To provide an understanding of the development and histophysiology of arteries, including their characteristics in childhood.

- To provide an understanding of the development and histophysiology of the microcirculatory bed. To provide an understanding of the development and structure of muscular and amuscular veins, the valve apparatus, and age-related characteristics of veins and lymphatic vessels.

Lecture abstracts:

Morphology of the vascular system:

- Description of the structure of arteries, veins, and capillaries.
- Study of the layers of the arterial wall: the inner lamina (endothelium), the middle lamina (smooth muscle, elastic fibers), and the outer lamina (external elastic layer).
- Discussion of the structural features of veins: fewer muscle and elastic fibers, valves.

Microscopic structure of capillaries:

- Description of the capillary endothelium.
- Study of the features of capillary structure in various tissues and organs.

Physiological role of blood vessels:

- Discussion of the role of arteries in transporting blood with oxygen and nutrients to tissues.
- Examination of the functions of veins in blood drainage and heat exchange.
- Explanation of the role of capillaries in gas exchange and the exchange of substances between the blood and tissues. Conclusion:

- Summarizes the main points of the lecture.
- Emphasizes the importance of understanding the histology of the cardiovascular system for the diagnosis and treatment of cardiovascular diseases.

Blood vessels—arteries, veins, and capillaries—are the pathways through which blood circulates throughout the body, delivering oxygen and nutrients to organs and tissues. These vessels form the systemic and pulmonary circulations, which encompass all organs. If a problem occurs in one area of the bloodstream (such as a blood clot), it can lead to serious consequences, including death.

The lymphatic system, which includes the lymphatic vessels and lymphatic pathways, is, like the circulatory system, the most important transport system in the human body.

Lymphatic vessels, like blood vessels, run through almost the entire body. They carry lymph, a tissue fluid that serves as drainage for body tissues and also transports various substances and cells (immune system cells).

The body produces about two liters of lymph every day. This clear, colorless or pale yellow fluid forms when blood plasma leaves the capillaries and enters the body's tissues. It contains nutrients and oxygen, which are responsible for nourishing cells, as well as certain immune system cells called lymphocytes.

Penetrating the crevices of organs, lymph removes metabolic waste products (waste and carbon dioxide) from the organs. Finally, the lymph returns through a branched network of lymphatic vessels to the circulatory system near the heart. Lymph also carries nutritious fats from the intestines into the blood.

4. Illustrative material: presentation, including:

- color micrographs of histopreparations
- electronograms, diagrams, drawings

5. Literature:

Main literature

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6. Control questions (feed back):

1. Morphofunctional characteristics of arteries.
2. Sources of arterial development
3. Structure of the arterial wall membranes
4. Morphofunctional characteristics of microcirculatory vessels
5. Sources of development
6. Arteriole-venular anastomoses

7. Structure of the venous wall – muscular and amuscular

8. Age-related characteristics