BOGOMOLETS NATIONAL MEDICAL UNIVERSITY
DEPARTMENT OF HUMAN ANATOMY

Guidelines

Academic discipline	HUMAN ANATOMY
Module №	2
Content module №	14
Topic of the lesson	Anatomy of the heart. Cardiovascular system. Pulmonary and systemic circulation.
Course	1
The number of hours	3

2017

1. The relevance of the topic:

The study of the anatomical structure of the heart is necessary for the formation of clinical thinking framework conditions for the differential diagnosis for the doctor of any specialty, but especially cardiologist and cardiac surgeon. Also, knowledge of the heart anatomy is important for future specialists? Because, they will be able to perform professional treatment of heart disease, which is one of the most popular problems of modern medicine.

2. Specific objectives

After the lesson students should:

2.1. Know and be able to demonstrate specific of the external structure of the heart.
2.2. Know and be able to demonstrate large vessels, which are connected with chambers of the heart.
2.3. Know and be able to demonstrate specific of the internal structure hearts chambers.
2.4. Know and be able to demonstrate structural features of aortic valve, pulmonary valve, tricuspid and mitral valves.
2.5. Know and be able to demonstrate layers comprising the wall of the heart.
2.6. Know and be able to demonstrate layers comprising the wall of the heart in its different parts.
2.7. Know main parts of conducting system of the heart.
2.8. Know main sources of blood supply to the heart, be able to demonstrate coronary artery.
2.9. Know the main ways of outflow of venous blood from the walls of the heart, be able to demonstrate the coronary sinus and its main tributaries, as well as the front cardiac vein.
2.10. Know about structural features of pericardium and be able to demonstrate its parts, cavity and sinuses.
2.11. Know and be able to demonstrate pulmonary and systemic circulation.

3. Basic level of knowledge.

3.1. Know and be able to determine the anatomic axis and plane of the human body.
3.2. Know and be able to demonstrate the structure of the chest.
3.3. Know and be able to demonstrate, which organs are located in area of the chest.
3.4. Know the main elements of the vascular system.

4. Task for independent during preparation to practical classes.

4.1. A list of the main terms, parameters, characteristics that need to be learned by student during the preparation for the lesson.

Термін	Визначення
Cor (cardia) Серце	Hollow muscular organ located in the middle mediastinum, pushes blood into the arteries of pulmonary and systemic circulations and receives blood from the veins of this circulations.
Basis cordis	Part of the heart, which is formed by the right and left atria.
Apex cordis	The pointed end of the heart
Facies sternocostalis; Facies anterior	One of the four surfaces of the heart
Facies diaphragmatica; Facies inferior	One of the four surfaces of the heart
Facies pulmonalis dextra/sinistra	Two of the four surfaces of the heart
Sulcus interventricularis anterior	separate right and left ventricles on the front surface
Sulcus interventricularis posterior	separate right and left ventricles on the back surface
Sulcus coronarius	Separate atrea and ventricles
Ventriculus cordis dexter/sinister	Two of the four chambers of the heart, which pumps out blood into the aorta (from left ventricle) and pulmonary artery (from right ventricle).
Atrium cordis dextrum/sinistrum	Two of the four chambers of the heart, which receive blood.
Auricula atrii	part of the right and left atrium.
Septum interventriculare	Septum between right and left ventricles
Septum interatriale	Septum between right and left atria
Trabeculae carneae	Elements of internal structure of left and right ventricles.
Mm. papillares	Part of the myocardium in the cavities of both ventricles, which are covered with endocardium
Chordae tendineae	Structures which connect parts of atrioventricular valves with mm. Papillares or trabeculae carneae
Fossa ovalis	Located on septum interatriale nearly to the right atrium
Mm. pectinati	Elements of internal structure in the cavities of both ventricles, which are

	situated in area of auricular atrii.
Ostium sinus coronarii	The hole in the back wall of the right atrium
Ostium venae cavae inferioris	The hole in the back wall of the right atrium
Ostium venae cavae superioris	The hole in the back wall of the right atrium
Ostium atrioventriculare dextrum	The hole between right ventricle and atrium
Valva atrioventricularis dextra; Valva tricuspidalis	Valve, which is situated between right ventricle and atrium
Ostium trunci pulmonalis	The hole between the right ventricle and the pulmonary trunk
Valva trunci pulmonalis	Valve between the right ventricle and the pulmonary trunk
Ostia venaram pulmonalium	The hole in the back wall of the left atrium
Valvula foraminis ovalis	Located on the left atrium
Ostium atrioventriculare sinistrum	The hole between left ventricle and atrium
Valva atrioventricularis sinistra; Valva mitralis	Valve, which is situated between left ventricle and atrium
Ostium aortae	The hole between right ventricle and aorta
Valva aortae	Valve located in ostium aortae
Endocardium	One of the layers comprising the wall of the heart
Myocardium	One of the layers comprising the wall of the heart
Complexus stimulans cordis; Systema conducente cordis	Structures of myocardium, which are responsible for systole and diastole
Nodus sinuatrialis	Part of the stimulant complex of the heart
Nodus atrioventricularis	Part of the stimulant complex of the heart
Fasciculus atrioventricularis	Part of the stimulant complex of the heart
Crus dextram	Part of the stimulant complex of the heart
Crus sinistram	Part of the stimulant complex of the heart
Rr. subendocardiales	Part of the stimulant complex of the heart
Pericardium	Fibro-serous closed bag that surrounds the outside of the myocardium and primary departments of large vessels associated with the heart
Pericardium fibrosum	One of two parts of the pericardium
Pericardium serosum	One of two parts of the pericardium
Truncus pulmonalis	Starts from the right ventricle and carries blood from it.
Aorta	Starts from the left ventricle and carries blood from it.
Arteria coronaria dextra	Main artery of the heart

R. lnterventricularis posterior	Branch of the right coronary artery
Arteria coronaria sinistra	Main artery of the heart
R. interventricularis anterior	Branch of the right coronary artery
R. circumflexus	Branch of the right coronary artery
Sinus coronarius	The biggest vein of the heart
V. cardiaca magna; V. cordis magna	One of the five main veins, which flow into the coronary sinus of the heart
V(v).ventriculi sinistri posterior(es)	One of the five main veins, which flow into the coronary sinus of the heart
V. obliqua atrii sinistri	One of the five main veins, which flow into the coronary sinus of the heart
V. cardiaca media; V. cordis media; V. interventricularis posterior	One of the five main veins, which flow into the coronary sinus of the heart
V. cardiaca parva; V. cordis parva	One of the five main veins, which flow into the coronary sinus of the heart

4.2. Theoretical questions for the lesson:

1. Describe and demonstrate external structure of the heart.
2. Name and show large vessels, which are connected with chambers of the heart.
3. Describe and demonstrate structural features of the internal surface of right atrium.
4. Describe and demonstrate structural features of the internal surface of right ventricle.
5. Describe and demonstrate structural features of the internal surface of left atrium.
6. Describe and demonstrate structural features of the internal surface of left ventricle.
7. Describe and demonstrate structure of interventricular septum and interatrial septum.
8. Describe and demonstrate structural features of aortic valve, pulmonary valve, tricuspid and mitral valves.
9. Describe and demonstrate layers comprising the wall of the heart.
10. Describe and demonstrate main parts of stimulant complex of the heart.
11. What are the main sources of blood supply to the heart and demonstrate the coronary arteries and their terminal branches.
12. What are the main ways of outflow of venous blood from the walls of the heart and demonstrate the coronary sinus and its main tributaries, and also some cardiac veins.
13. Describe and demonstrate structural features of the pericardium.
14. Describe and demonstrate sinuses of pericardium.
15. Talk about pulmonic and systemic circulation.

4.3. The list of practical skills

- Base of the heart
- Apex of the heart
- Four hearts surface
- Coronary sulcus
- Anterior interventricular sulcus
- Posterior interventricular sulcus
- Aorta
- Superior vena cava
- Inferior vena cava
- pulmonary trunk
  -- pulmonary artery

Right atrium

- right auricle
- pectinati muscles
- Ostium superior vena cava
- Ostium inferior vena cava
- Ostium coronary sinus

Left atrium

- Left auricle
- pectinati muscles
- ostium pulmonary veins

Interatium septum

Right ventricle
- tricuspidal valve
  -- anterior cuspid
  -- posterior cuspid
  -- septalis cuspid
- pulmonary trunk valve
- anterior and posterior papillary muscle
-chordae tendineae
- trabeculae carneae

Left ventricle
- mitral valve
  --anterior cuspid
  -- posterior cuspid
- vestibule of the aorta
- valve of aorta
- anterior and posterior papillary muscle
-chordae tendineae
- trabeculae carneae

Interventricular septum
Endocardium
Myocardium
Pericardium

The content of the topic

The heart is a muscular organ about the size of a closed fist that functions as the body's circulatory pump. It takes in deoxygenated blood through the veins and delivers it to the lungs for oxygenation before pumping it into the various arteries (which provide oxygen and nutrients to body tissues by transporting the blood throughout the body). The heart is located in the thoracic cavity medial to the lungs and posterior to the sternum.
On its superior end, the base of the heart is attached to the aorta, pulmonary arteries and veins, and the vena cava. The inferior tip of the heart, known as the apex, rests just superior to the **diaphragm**. The base of the heart is located along the body's midline with the apex pointing toward the left side. Because the heart points to the left, about 2/3 of the heart's mass is found on the left side of the body and the other 1/3 is on the right.

Pericardium

The heart sits within a fluid-filled cavity called the pericardial cavity. The walls and lining of the pericardial cavity are a special membrane known as the pericardium. Pericardium is a type of serous membrane that produces serous fluid to lubricate the heart and prevent friction between the ever beating heart and its surrounding organs. Besides lubrication, the pericardium serves to hold the heart in position and maintain a hollow space for the heart to expand into when it is full. The pericardium has 2 layers—a visceral layer that covers the outside of the heart and a parietal layer that forms a sac around the outside of the pericardial cavity.

Structure of the Heart Wall

The heart wall is made of 3 layers: epicardium, myocardium and endocardium.
Epicardium. The epicardium is the outermost layer of the heart wall and is just another

name for the visceral layer of the pericardium. Thus, the epicardium is a thin layer of serous membrane that helps to lubricate and protect the outside of the heart. Below the epicardium is the second, thicker layer of the heart wall: the myocardium.

Myocardium. The myocardium is the muscular middle layer of the heart wall that contains the **cardiac muscle tissue**. Myocardium makes up the majority of the thickness and mass of the heart wall and is the part of the heart responsible for pumping blood. Below the myocardium is the thin endocardium layer.

Endocardium. Endocardium is the simple squamous endothelium layer that lines the inside of the heart. The endocardium is very smooth and is responsible for keeping blood from sticking to the inside of the heart and forming potentially deadly blood clots.
The thickness of the heart wall varies in different parts of the heart. The atria of the heart have a very thin myocardium because they do not need to pump blood very far—only to the nearby ventricles. The ventricles, on the other hand, have a very thick myocardium to pump blood to the lungs or throughout the entire body. The right side of the heart has less myocardium in its walls than the left side because the left side has to pump blood through the entire body while the right side only has to pump to the lungs.

Chambers of the Heart

The heart contains 4 chambers: the **right atrium**, **left atrium**, **right ventricle**, and **left ventricle**. The atria are smaller than the ventricles and have thinner, less muscular walls than the ventricles. The atria act as receiving chambers for blood, so they are connected to the veins that carry blood to the heart. The ventricles are the larger, stronger pumping chambers that send blood out of the heart. The ventricles are connected to the arteries that carry blood away from the heart.
The chambers on the right side of the heart are smaller and have less myocardium in their heart wall when compared to the left side of the heart. This difference in size between the sides of the heart is related to their functions and the size of the 2 circulatory loops. The right side of the heart maintains pulmonary circulation to the nearby lungs while the left side of the heart pumps blood all the way to the extremities of the body in the systemic circulatory loop.

Valves of the Heart

The heart functions by pumping blood both to the lungs and to the systems of the body. To prevent blood from flowing backwards or “regurgitating” back into the heart, a system of one-way valves are present in the heart. The heart valves can be broken down into two types: atrioventricular and semilunar valves.

***Atrioventricular valves*.** The atrioventricular (AV) valves are located in the middle of the heart between the atria and ventricles and only allow blood to flow from the atria into the ventricles. The AV valve on the right side of the heart is called the **tricuspid valve** because it is made of three cusps (flaps) that separate to allow blood to pass through and connect to block regurgitation of blood. The AV valve on the left side of the heart is called the **mitral valve** or the bicuspid valve because it has two cusps. The AV valves are attached on the ventricular side to tough strings called **chordae tendineae**. The chordae tendineae pull on the AV valves to keep them from folding backwards and allowing blood to regurgitate past them. During the contraction of the ventricles, the AV valves look like domed parachutes with the chordae tendineae acting as the ropes holding the parachutes

taut.

***Semilunar valves*.** The semilunar valves, so named for the crescent moon shape of their cusps, are located between the ventricles and the arteries that carry blood away from the heart. The semilunar valve on the right side of the heart is the **pulmonary valve**, so named because it prevents the backflow of blood from the pulmonary trunk into the right ventricle. The semilunar valve on the left side of the heart is the **aortic valve**, named for the fact that it prevents the **aorta** from regurgitating blood back into the left ventricle. The semilunar valves are smaller than the AV valves and do not have chordae tendineae to hold them in place. Instead, the cusps of the semilunar valves are cup shaped to catch regurgitating blood and use the blood's pressure to snap shut.

Conduction System of the Heart

The heart is able to both set its own rhythm and to conduct the signals necessary to maintain and coordinate this rhythm throughout its structures. About 1% of the cardiac muscle cells in the heart are responsible for forming the conduction system that sets the pace for the rest of the cardiac muscle cells.

The conduction system starts with the pacemaker of the heart—a small bundle of cells known as the sinoatrial (SA) node. The SA node is located in the wall of the right atrium inferior to the **superior vena cava**. The SA node is responsible for setting the pace of the heart as a whole and directly signals the atria to contract. The signal from the SA node is picked up by another mass of conductive tissue known as the atrioventricular (AV) node.

The AV node is located in the right atrium in the inferior portion of the interatrial septum. The AV node picks up the signal sent by the SA node and transmits it through the atrioventricular (AV) bundle. The AV bundle is a strand of conductive tissue that runs through the interatrial septum and into the interventricular septum. The AV bundle splits into left and right branches in the interventricular septum and continues running through the septum until they reach the apex of the heart. Branching off from the left and right bundle branches are many **Purkinje fibers** that carry the signal to the walls of the ventricles, stimulating the cardiac muscle cells to contract in a coordinated manner to efficiently pump blood out of the heart.

The Cardiac Cycle

The cardiac cycle includes all of the events that take place during one heartbeat. There are 3 phases to the cardiac cycle: atrial systole, ventricular systole, and relaxation.

Atrial systole: During the atrial systole phase of the cardiac cycle, the atria contract and push blood into the ventricles. To facilitate this filling, the AV valves stay open and the semilunar valves stay closed to keep arterial blood from re-entering the heart. The atria are much smaller than the ventricles, so they only fill about 25% of the ventricles during this phase. The ventricles remain in diastole during this phase.

***Ventricular systole*:** During ventricular systole, the ventricles contract to push blood into the aorta and pulmonary trunk. The pressure of the ventricles forces the semilunar valves to open and the AV valves to close. This arrangement of valves allows for blood flow from the ventricles into the arteries. The cardiac muscles of the atria repolarize and enter the state of diastole during this phase.

***Relaxation phase*:** During the relaxation phase, all 4 chambers of the heart are in diastole as blood pours into the heart from the veins. The ventricles fill to about 75% capacity during this phase and will be completely filled only after the atria enter systole. The cardiac muscle cells of the ventricles repolarize during this phase to prepare for the next round of depolarization and contraction. During this phase, the AV valves open to allow blood to flow freely into the ventricles while the semilunar valves close to prevent the regurgitation of blood from the great arteries into the ventricles.

Blood Flow through the Heart

Deoxygenated blood returning from the body first enters the heart from the superior and **inferior vena cava**. The blood enters the right atrium and is pumped through the tricuspid valve into the right ventricle. From the right ventricle, the blood is pumped through the **pulmonary semilunar valve** into the **pulmonary trunk**.

The pulmonary trunk carries blood to the lungs where it releases carbon dioxide and absorbs oxygen. The blood in the lungs returns to the heart through the **pulmonary veins**. From the pulmonary veins, blood enters the heart again in the left atrium.

The left atrium contracts to pump blood through the bicuspid (mitral) valve into the left ventricle. The left ventricle pumps blood through the aortic semilunar valve into the aorta. From the aorta, blood enters into systemic circulation throughout the body tissues until it returns to the heart via the vena cava and the cycle repeats.

Tests:

1. Increased blood pressure in the aorta caused a strain on the heart muscle. The muscular wall of the heart which responds to stimulation?

A. right ventricle.
B. left atrium.
C. left ventricle.
D. right atrium .
E. sinus coronary veins.

2. Increased blood pressure in the pulmonary trunk caused a strain on the heart muscle. The muscular wall of the heart which responds to stimulation?

A. right ventricle.
B. left atrium.
C. left ventricle.
D. right atrium .
E. sinus coronary veins.

3. In hypertension, often, the left heart border is shifted to the left. Through which the chambers of the heart or blood vessels occurs this shift?

A. left atrium.
B. left ventricle.
C. left ventricle and left atrium.

D. arcus aortae.
E. pulmonary trunk.

4. The patient during the examination of the blood vessels of the heart doctor showed worsening venous blood flow in the veins of the heart basin, which runs in front of the interventricular sulcus of heart. What is the name of this vein?
A. V. obliqua atrii sinistri.
B. V. cordis media.
C. V. cordis parva.
D. V. posterior ventriculi sinistri.
E. V. cordis magna.

5. The patient was diagnosed infarction, thrombosis which is the result of one of the arteries. What?
A. left coronary artery.
B. right coronary artery.
C. r. meningeus left coronary artery.
D. pulmonary artery.
E. posterior artery of left ventricle.

6. A patient diagnosed with myocardial back of the interventricular septum. Which arterial circulatory disorders?
A. R. atrialis intermedius.
B. R. marginalis dexter.
C. R. interventricularis posterior.
D. R. circumflexus.
E. R. marginalis sinister.

7. The patient, 50, was hospitalized with complaints of chest pain, breathlessness. After angiography revealed pathological changes in the posterior interventricular branch of the right coronary artery. What area of the heart affected?
A.rignt atrium.
B. left atrium.
C. front wall of right and left atria.
D. back wall of right and left atria.
E. tricuspidal valve.

8. During the examination of a teenager a doctor detected a congenital heart defect - functioning arterial duct (Batalova Strait). What connects the Strait in utero?
A. pulmonary trunk and aorta.
B. left and right ventricles.
C. aorta and inferior vena cava.
D. left and right atrium.
E. pulmonary trunk and superior vena cava.

9. When heart ultrasound it was found that the thickness of the left ventricular wall is 23 mm. is this Normal? If not, what is the wall thickness of the left ventricle in normal?

A. Yes.
B. Yes.
C. No. (10-15 мм.)
D. No. (3-5 мм.)
E. No. (5-8 мм.)

10. The patient is diagnosed with inflammation of the endocardium (endocarditis). What is the structure of the heart affected in this pathology?
A. Complexus stimulans cordis.
B. hearts valve.
C. vasa coronaria .
D. pericardium.
E. myocardium.

Answers:

1	2	3	4	5	6	7	8	9	10
C	**A**	**B**	**E**	**A**	**C**	**D**	**A**	**C**	**B**