Functional anatomy of heart, development.

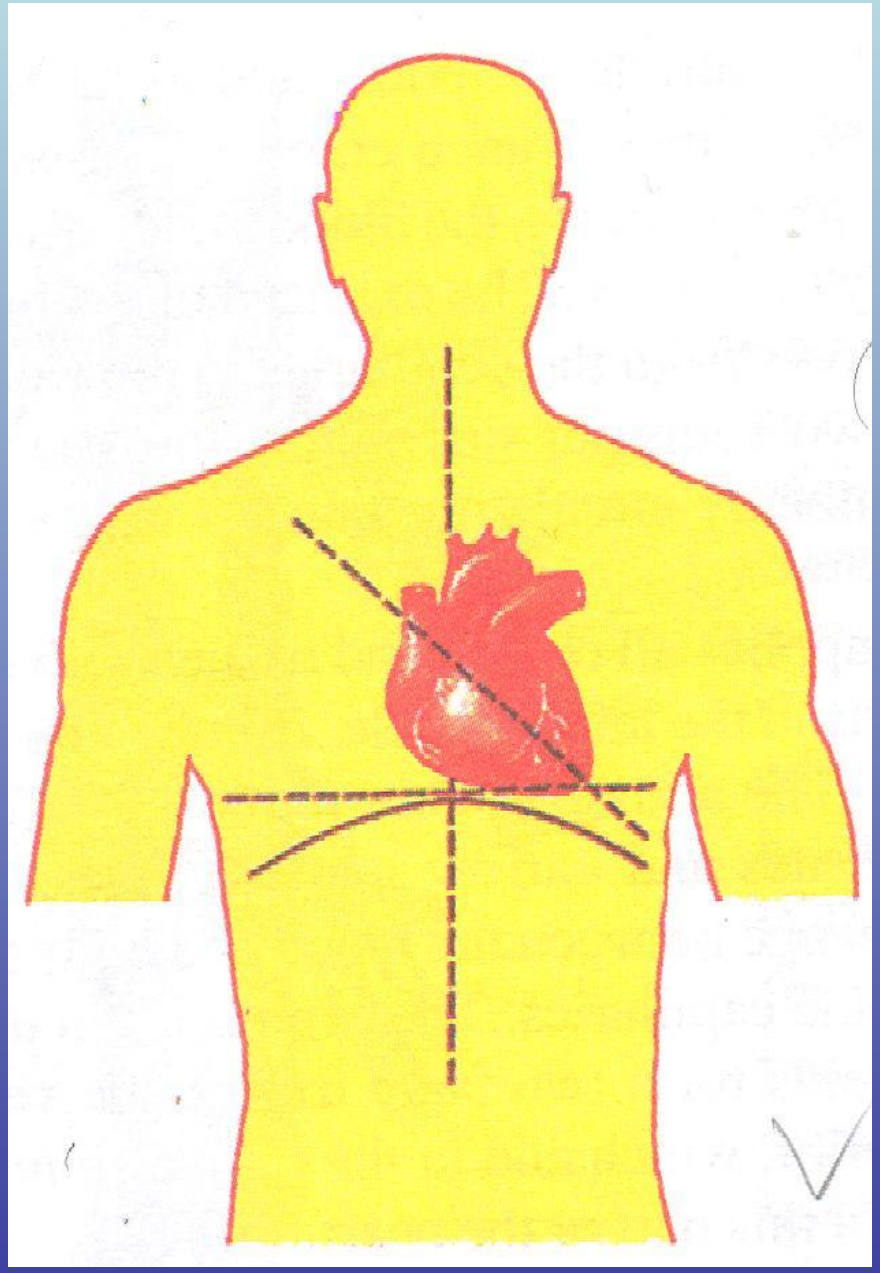
The plan of lecture:

1. A structure of heart.
2. Development of heart.
3. Anomalies of development of heart.
4. Conducting system of heart.

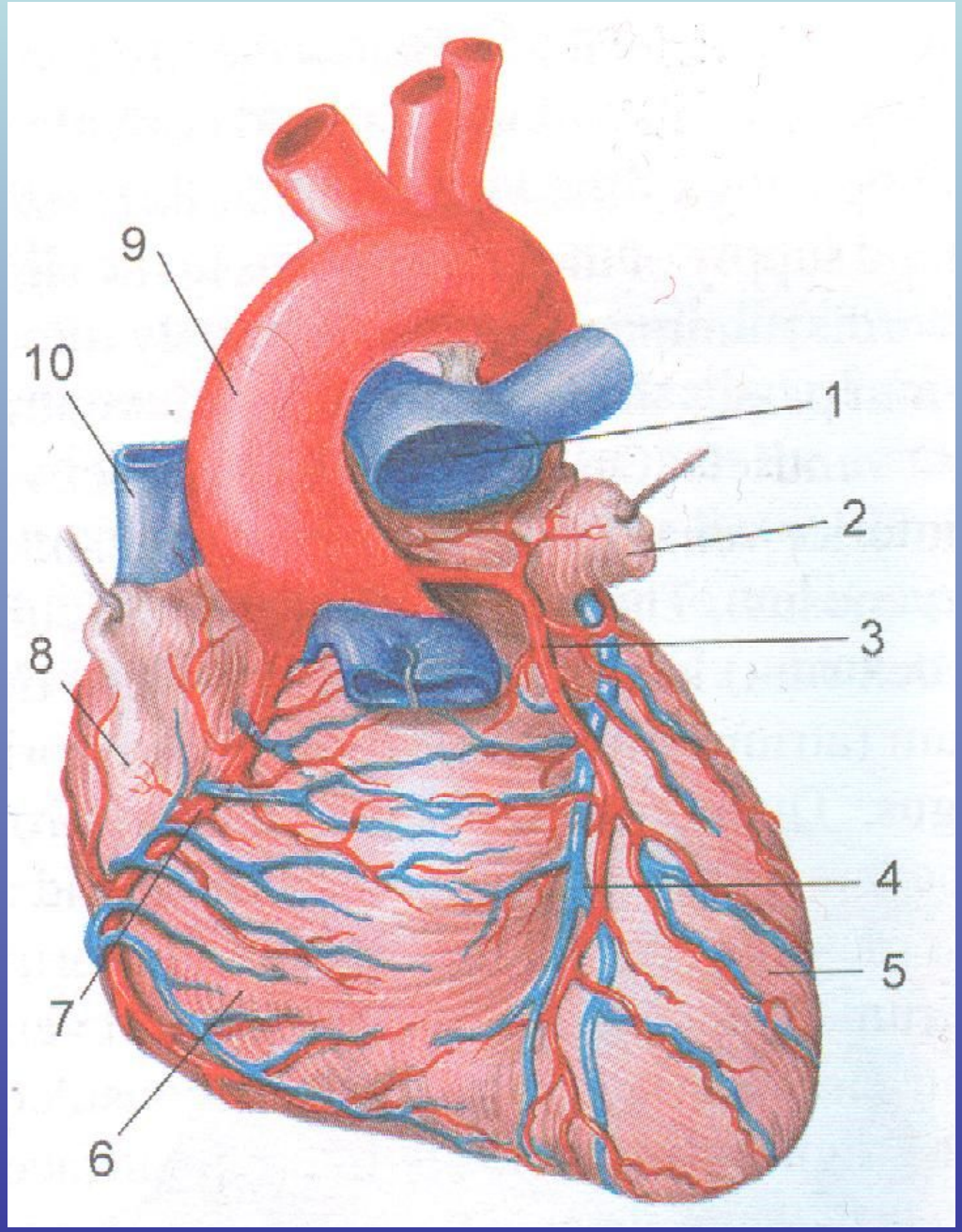
THE HEART

The heart (cor) is a hollow muscular organ, which receives blood from the veins and pumps the blood into the arterial system. The heart is situated asymmetrically in the anterior mediastinum. Its greater part is to the left of the midline.

The long axis of the heart extends obliquely downward from right to **the** left and from back to the front. The heart is rotated so that the right venous part lies more to the front and the left arterial part more to the back. .The heart is chaped like a blunt cone. It is about the size of the clenched fist of its owner. It averages about 12 cm long and about 9 cm wide. The heart of an adult female usually weighs between 200 and 275 g. The heartof adult male weighs about 250 and 390g. The heart is a pair of valved muscular pumps combined in a single organ. In the four cardiac chambers, two atria recive venous blood as weakly contractile reservoirs for final filling of the ventricles, and the two ventricles provide the powerful expulsive contraction forcing blood into the main arterial trunks.

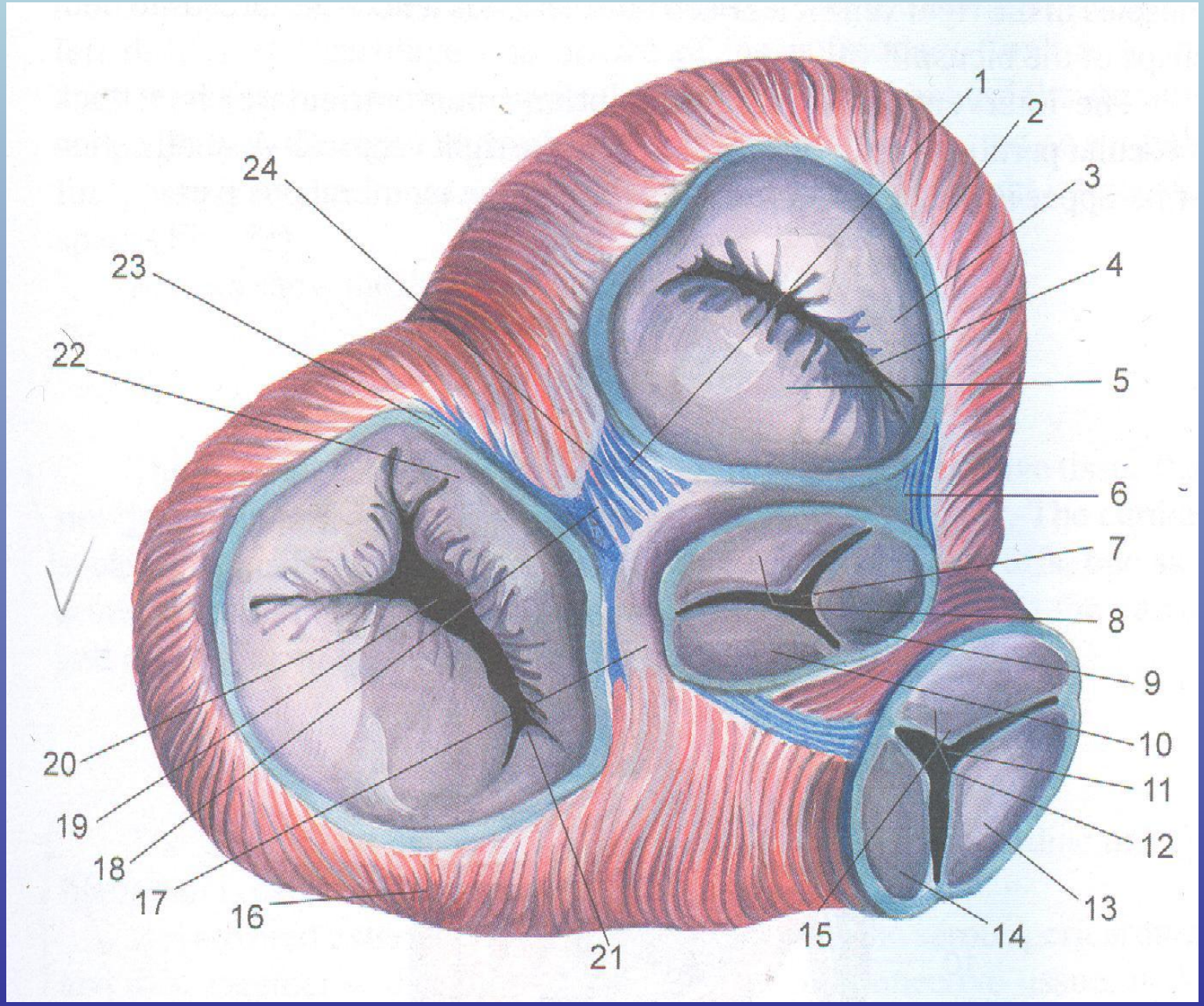


Location of heart within the thoracic cavity.
Dotted line shows heart axis.

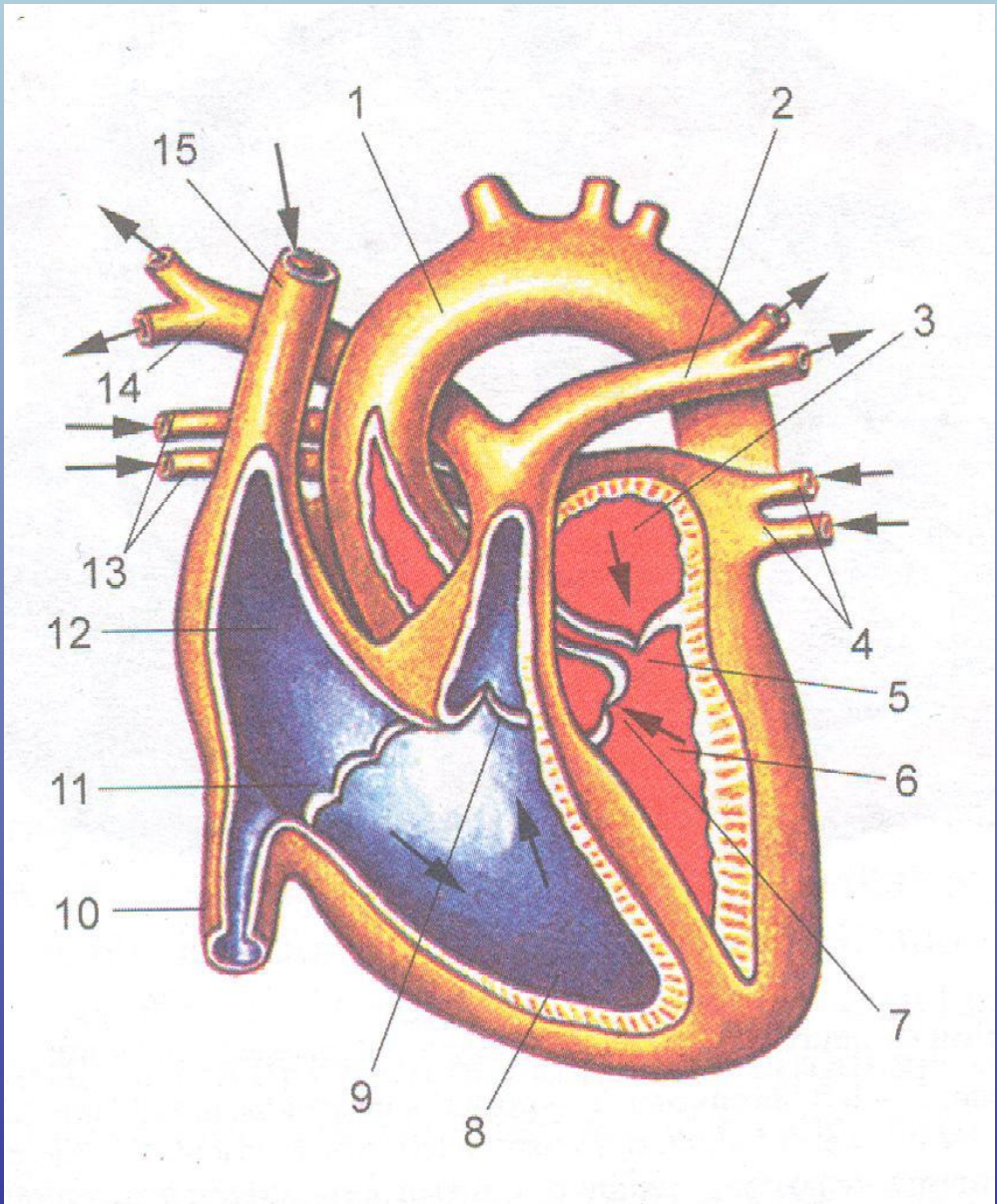


The heart. Anterior aspect.
1 — pulmonary trunk;
2 — left auricle;
3 — anterior interventricular branch of left coronary artery;
4 —great cardiac vein;
5 — left ventricle;
6 — right ventricle; 7 — right coronary artery; 8 — right auricle;
9 — arch of aorta; 10 — superior vena cava.

Cardiac Chambers



Location of heart valves (atrium, aorta, pulmonary tmnk are removed).
1 — right fibrous trigone; 2 — left fibrous ring; 3 — posterior cusp of the mitral (atrioventricular) valve; 4 — left atrioventricular orifice; 5 — anterior cusp of left atrioventricular valve; 6 — left fibrous triangle; 7 — aortic ostium; 8 — posterior semilunar cusp (of aortic valve); 9 — left semilunar cusp (of aortic valve); 10 — right semilunar cusp (of aortic valve); 11 — pulmonary trunk ostium; 12 — left semilunar cusp of (pulmonary) valve; 13 — anterior semilunar cusp (of pulmonary valve); 14 — right semilunar cusp (of pulmonary valve); 15 — nodules of semilunar cusps; 16 — myocardium; 17 — fibrous ring; 18 — right bundle of atrioventricular fascicle; 19 — right atrioventricular orifice; 20 — anterior cusp (of right atrioventricular valve); 21 — scptal cusp (of right atrioventricular valve); 22 — posterior cusp (of right atrioventricular valve); 23 — right fibrous ring; 24 — membranous part of
interventricular septum.



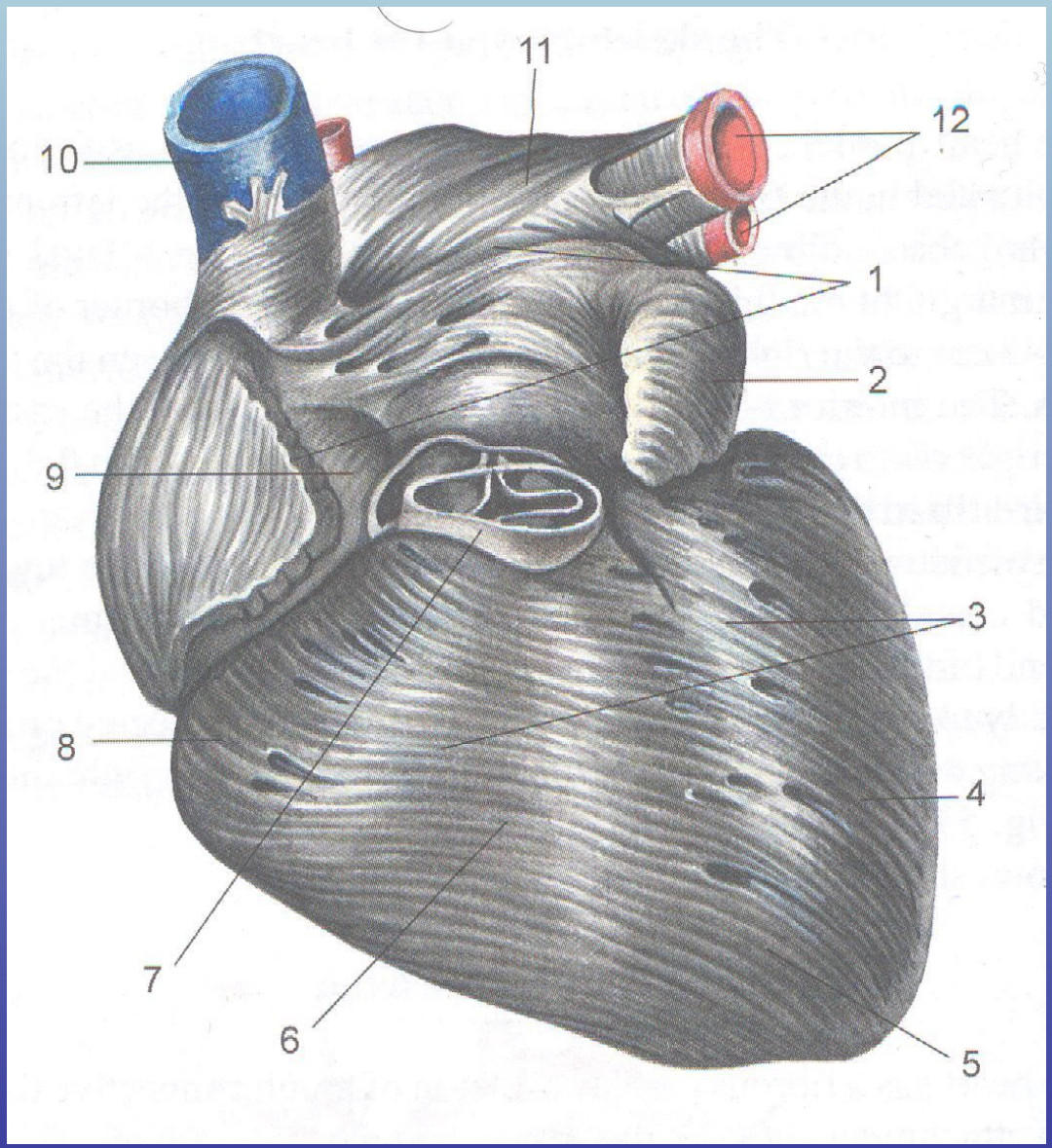
Structure of heart. Longitudinal (frontal) section.
1 — aorta; 2 — left pulmonary artery; 3 — left atrium; 4 — left pulmonary veins; 5 — left atrioventricular orifice; 6 — left ventricle; 7 — aortic valve; 8 — right ventricle; 9 — pulmonary valve; 10 — inferior vena cava; 11 — right atrioventricular orifice; 12 — right atrium; 13 — right pulmonary veins; 14 — right pulmonary arteries; 15 — superior vena cava.

The Cardiac Skeleton

The heart has a fibrous cardiac skeleton of tough connective tissue that \ provides attachment sites for the valves and muscular fibers. The cardiac \skeleton is made up of a fibrous trigone and four rings, or cuffs, one surrounding each of the heart's four openings. Four rings support the valves jand prevent them from stretching. The greater part of the wall of the heart is made up of cardiac muscle fibers and is called the myocardium.

It is covered externally by the visceral layer of the serous pericardium and this, together with a thin subserous layer of connective tissue, is the epicardium. The chambers of the heart are lined by the endocardium, which also covers the valves nd continuous with the endothelium and underlying connective tissue of the vessels entering and leaving the chambers.

The myocardium is made up two separate, rather complex systems of spiraling and loping bundles of fibers, one for the atria one fr the ventricles. A superficial and a deep muscular layer are distinguished in the atria. The superficial layer consists of circular or transverse fibres, where as the deep layer is made up of longitudinal fibres arising from the fibrous rings. The musculature of the ventricles has three layers. A thing superficial layer iscomposed of longitudinal fibers which arise from the right fibrous ring and descend obliquely, passing also onto the left ventricle. The fibres of the middle layer (between the longitudinal outer and inner layers) are more or less circular. They do not pass from one ventricle to the other but independent components of each ventricle. The two systems are nowher continuous with each other, hence, the need for a specialized atrioventri| ular conducting system to bridge the electrical gap.



. Myocardium of atriums and ventricles. Anterior aspect
1 — atrial myocardium; 2 — left auricle; 3 — ventricular myocardium; 4 — left ventricle; 5 — anterior interventricular sulcus; 6 — right ventricle; 7 — pulmonary trunk; 8 — coronary sulcus; 9 — right!
atrium; 10 — superior vena cava; 11—left atrium; 12 — left pulmanary veins.

The Conducting System of the Heart

The heart system consists of the sinu — atrial node, atrioventricular node, atrioventricular bundle, its cruses and radicles of conducting fibers.

The conducting system conveys nerve impulses, which are rhythmical potentials of action. Specialized cells of the sinu — atrial node (nodus sinu-atrialis) generate the rhythmical impulses. The sinu — atrial node (node Keith — Phleka) is under the epicardium of the right atrium, between the confluence of the vena cava superior and the right auricle. This node sends impulses along the cardiomyoeytes of the atrium to the node atrioventricular node (node Ashoff — Tavara), which is located in the lower part of the interventricular septum near the septale cuspid of the tricuspid valve. Thereis a momentary delay in excitation in the atrioventricular node (nodus atrio- ventrieulaiis), after which it is delivered to the short atrioventricular bundle (bundle of His).

Innervation of the Heart

The cardiac nerves and branches go first to the superficial and pro- found extraorgan cardiac plexus. The superficial cardiac plexus is located on the front surface of the pulmonary trunk and on the curve semicircular 1 of the arc of the aorta. The profound cardiac plexus is situated behind the arc of the aorta (in front of trachea). Branches of extraorganic cardiac plexus pass to intraorganic cardiac plexus. It contains nerve cells, which form accumulations (cardiac ganglia). Conditionally intraorganic cardiac plexuses are divided into three marts connected with each other: subepicardiac, intramuscular and suben- docardiac plexuses.

The subepicardiac plexus consists of six different parts, or plexuses, (which have definite location. Three of them are situated in front of die heart and three — behind. In front side of the right and left atrio — ventricular are atriale plexuses. The right and the left front ventricular plexuses are distinguished and are located under the epicardium of the right and left ventricles on both sides of the artery cone. The front atrium plexus is in the front wall of the atrium.

The right and left ventricle plexuses are located on the rear wall of the right and left ventricles respectively. Back atrium plexus (plexus of Galer ′ sinus) is situated mainly in the upper part of the rear wall of the left atrium, between the confluences of pulmonary veins.

Development of the Heart and Pericardium

The human heart begins its development from the twin layer of meso- derm on the 17th day of life of an embryo. At first, simple tube — shaped heart is formed in the area of the neck. It consists of a primitive bulb of the heart (anterior part), passing from the rear to wider part called sinus venosus. The anterior part of the tube — shaped heart is arterial; the posterior part is venous. The middle part is intensively extended and it curves as an arch in the ventral direction (in the sagittal plane). The top of the arch will be the apex of the heart in future. The lower part of the arch is a venous part of the heart. The upper part is arterial. Then the heart bents S — shaped way counter — clockwise, (sigmoid heart). Atrio — ventricular and bulbo — ventricular furrows appear on the external surface of the heart.

Bulbo — ventricular furrows disappear after the confluence of the bulb with the arterial trunk.
The common auricle grows up surrounding from behind the arterial trunk. On the sides of arterial trunk wrinkles appear, they lie on the right and left auricles (auricula). The atrium is connected with ventricle by means of a narrow atrio — ventricular channel. In the walls of the channel anterior \ and posterior thickenings appear. On the basis of these thickenings bicuspid \ and tricuspid valves are developed. The place of transition of the ventricle to the primitive bulb of the heart is narrowed. In the mouth of the arterial trunk four endocardiac bolsters are formed. They turn into semilunar valves of the aorta and pulmonary trunk.
/ An initial partition is formed on the 4th week of life of an embryo on | the internal surface of the common atrium. It grows in the direction of the \ atrio — ventricular channel. In the interatrial partition a primary interatri-al partition remains. From the side of the upper posterior partition of the atrium, Ле secondary interatrial partition is formed. The superior part of this septum bursts open, forming secondary interatrial hole. In the beginning of the 8th week of life of an embryo, on the internal surface of the \ common atrium initial (interatrial) septum appears. It grows in the direction ! of atrio — ventricular channel. In the interatrial septum the primary intera-/ trial hole remains. From the side of the upper — posterior partition of the / atrium is formed the secondary interatrial septum. It grows together with the primary, commonly separating the atriums.

The superior part of this \ septum burst open and forms the secondary interatrial hole. In the begin-! ning of the 8th week of the embryonic life in the bottom — posterior part of I the ventricle a wrinkle appears. It grows upwards and ahead to the en-j docardium bolsters of the atrio — ventricular channel and forms the inter-! ventricular partition, which separates the both ventricles from each other. [At the same time in the structure of the arterial trunk two longitudinal folds j appear. They grow in the sagittal plane in the direction of each other and | towards interventricular septum. After joining they form a septum, which | separates the ascending part of the aorta from the pulmonary trunk. After i forming the interventricular and aorta — pulmonary septums, the embryo has a four — chamber heart. The small oval hole connects both atria. It closes only after the birth, when the pulmonary circle of blood circulation i starts functioning. The sinus venosus narrows and turns to the sinus coro-i narius together with the left common cardiac vein, which partially disap-) peared.

Age **Peculiarities of the Heart and the Pericardium**

A newborn child has a round heart. It settles down upper than an *j* adult's one (because of the high position of the diaphragm) and it lies almost horizontally. Its length is approx. 3.0-3.5 cm, the width is approx. 2.7-3.9 cm the mass of the heart composes 0.89% of the mass of the body (adults have 0.52%). During the first 15 days after birth, the mass of the heart becomes smaller and then it increases. Between the atria a newborn child has an oval hole, which is closed with a valve. At the age of 2-6 years both the atria and the ventricles grow very intensively. The mass of the heart increases three times by 4-5 years and five times by 9-10 years. By the age of 10, the mass of the heart is five times more that the newborn child has. After 10 years the ventricles grow faster than the atria. During the sexual ripening the heart grows more actively. The growth of the myocardium mass this time begins earlier in female organism, but it is less intensive and shorter than in males. At the age of 15-16 the heart mass is ten times more than in a newborn child. At the age of 20-25 the folds of the atrio — I ventricular valves gradually lose their elastic qualities, become uneven. In the age of 30-40 the share of connective tissue in the myocardium -' increases. Fat cells appear. Gradually fat tissue is accumulated under Lflie epicardium.

Variants and anomalies of the Heart--,
and the Pericardium __ -•..

The location of the heart changes according to breathing process. During inspiration it moves down, during expiration it goes up. The obese people in the senile age have the higher location of the heart than normal. The location of the heart depends upon the type of the constitution. The people' ! of the brahimorphal type have almost horizontal position of the heart. The! people of dolimorphal constitution have vertical allocation of the heart. The size of the heart and its mass have tendency to increase as a result of different sport exercises.

The heart can often have an oval foramen in interatrial septum, which is not inosculated (or half— inosculated). The amount of the papillary muscles and the tendon chords may vary. Sometimes on the free folds 6-8 small nodes could be found. They consist of close fibrosus connective tissue. Sometimes the semilunar valves of the aorta and the pulmonary trunk have two or four folds instead of three. The valve of the inferior vena cava and the valve of the coronary sinus can be connected with each other by means of a narrow bridge of the endocardium. The arterial ductus sometimes stays unclosed. In the interventricular septum opening can be found.

The left atrio — ventricular opening can be doubled. In the area of the apex of the heart an unusual deep hollow can take place. The heart can be extremely, large or small. Sometimes the heart can have only one or two cavities with an opened or narrowed aorta and the pulmonary trunk at the places where they are to begin. Heart valves can be absent, but in very rare cases. Very rare case is the location of the heart on the right side (dextrocardia). Also the cases of the absence of the heart and its misallocation were described. The pericardium often grows together with the periostium of the third vertebra via the chord, passing above the arch of the aorta. In the part of the pericardium adjoined to the breastbone in 10% of cases some bundles of the cross striated muscles can be found. Also the partial absence of the pericardium or alteration of its size and shape can take place.