

Heart

Page No-1

Vertebrate heart is a hollow muscular organ composed of cardiac muscle fibres. The wall of heart has three muscular layers like epicardium, myocardium and endocardium. Myocardium consists of cardiac muscles, essentially striated muscles structurally and smooth muscles functionally. Cardiac muscles are involuntary in nature. They contract quickly and do not get fatigued. The cardiac muscles help in contraction (systole) and relaxation (diastole) of heart, therefore, vertebrate heart is of myogenic type.

Development - Heart is a mesodermal derivative and develops from the mesenchyme budded off from visceral mesoderm ventral to the ventral gut. The heart is a simple tube in the early stage, then length increases but, being enclosed in a limited pericardial cavity and its two ends being fixed, the tube becomes twisted into a characteristic 'S' shaped curve. The endocardial tube along with myocardium, differentiate into chambers of adult heart.

Human Heart.POSITION, SIZE AND SHAPE →

Human heart is located in the mediastinum. The space in the thoracic cavity between the two lungs, about 12 cm in length and 9 cm in breadth, wt. is about 250-300g with a upper broader part, the base and a lower narrow the apex. Slightly tilted also towards the left.

(2)

The heart is covered by double membrane protective coverings or pericardium, the inner visceral pericardium and outer parietal pericardium. The space between the two layers is called pericardial cavity which is normally filled up by a fluid called pericardial fluid. It protects the heart from external shocks and mechanical injuries and also provides a moist surface for frictionless movement of the heart.

STRUCTURE OF HUMAN HEART -

EXTERNAL STRUCTURE -

The left and right atria are separated externally by a shallow vertical inter-arterial groove, and the ventricles by inter-ventricular sulcus. The left atrium is smaller than the right atrium. The superior vena cava, inferior vena cava and coronary sinus open into the right atrium -

- 1) The superior vena cava carries blood from the body's upper region.
- 2) The inferior vena cava brings the blood from the lower body's region.
- 3) The coronary sinus receives deoxygenated blood from the heart, the coronary sinus vein opens in the coronary sinus.
- 4) The left atrium receives oxygenated blood from the lungs through two pairs of pulmonary veins.

The left ventricle is bigger and thick-walled than the right ventricle. The pulmonary trunk arises from the right ventricle. It divides into left and right pulmonary arteries that carry deoxygenated blood to the lungs. The systemic aorta

arises from the left ventricle. It gives collateral arteries to supply oxygenated blood to head region, the right and left coronary arteries of the heart and descending aorta supply oxygenated blood to thorax, abdomen and lower region of the body.

INTERNAL STRUCTURE - The heart is composed of four types of chamber, the two upper, small, thin walled chambers called Auricles which receives blood from various parts of body (Receiving chambers) and two lower large, thick walled muscular ventricles supplying blood to various body organs also called the distributing chambers.

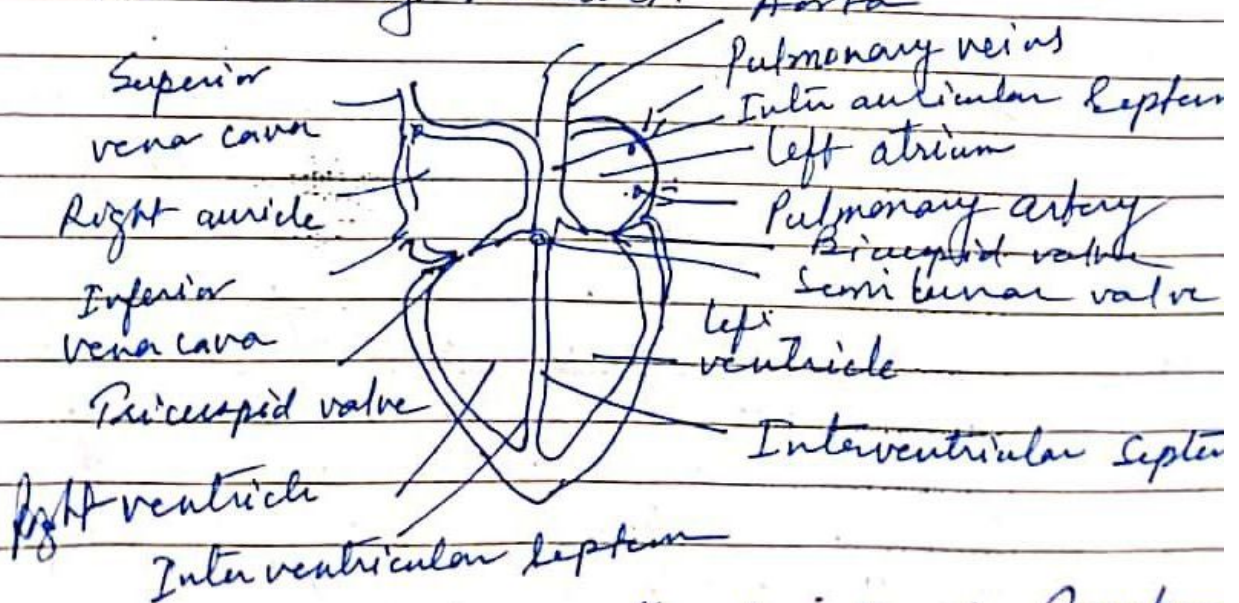
AURICLES → The upper two auricles are separated by interauricular septum. Right auricle receives deoxygenated blood, while the left one receives oxygenated blood. The inner lining of the auricular wall forms a network of low muscular ridges called the musculi Pectinati.

The right atrium receives the openings of superior vena cava, inferior vena cava and coronary sinus. The opening of inferior vena cava is guarded by Eustachian valve while the opening of coronary sinus is guarded by Thebesian valve. The left atrium receives four openings of pulmonary veins.

Each auricle opens into the ventricle of its side through auriculoventricular aperture guarded by valves of connective tissue. The left auriculo-ventricular consists of bicuspid valve or mitral valve. The auriculo-ventricular valve consists of three flaps called tricuspid valve.

VENTRICLES - The right and left ventricles are separated by interventricular septum. The ventricles are pumping chambers made up of thick muscular walls, the inner surface is thrown into a series of muscular ridges called Columnae carnae. The Columnae carnae divide the ventricular cavity into smaller spaces called fessures. Attached to the flaps of bicuspid and tricuspid valves have special fibrous cords called chordae tendinae attached to ventricular wall through special muscles papillary muscles. The chordae tendinae prevent the bicuspid and tricuspid valves from collapsing back into auricles during power ventricular contractions.

Two aortic trunks arise directly from ventricles, Pulmonary aorta from the right side and going to the lungs, and aortic systemic aorta arising from the left ventricle and curving the left side to form the dorsal aorta. A corresponding arch on the right side is represented by the right subclavian artery. Each aorta has semi-lunar valves at its base to prevent the back flow during the diastole of ventricles.



Human Heart internal structure

CIRCULATION OF BLOOD - Physiology of blood

Circulation was first described by William Harvey in 1628. In human beings the circulation of blood is double circulation

The movement of blood follows a complicated course as the systemic circulation and the pulmonary circulation.

PULMONARY CIRCULATION - It begins with right ventricle, continues along the pulmonary artery and all its branches, then along the pulmonary arterioles, capillaries and veins and terminates in pulmonary veins which empty it into the left auricle.

SYSTEMIC CIRCULATION - The systemic circulation starts at the left ventricle of the heart passes to the aorta, to the arteries originating from it, arterioles, capillaries and veins of the whole body, and finally into the right auricle through two vena cavae.

CARDIAC CYCLE -

During each heart-beat, the chambers of heart contract and relax in a regular co-ordination. The contraction of a chamber decreases its volume and forces the blood out of it, whereas its relaxation brings it back to its original size to receive more blood. Two ventricles contract simultaneously. The heart beat lasts for about 0.8 seconds which passes through 3 phases known as cardiac cycle -

- (a) auricular systole, (b) Ventricular systole
- (c) Joint diastole or complete cardiac diastole (relaxation of auricle and ventricles)

1) Auricular Systole - contraction of auricles drive the blood into the ventricles and after about 0.1 second, after this time the auricles relax to receive blood from superior and inferior vena cava.

2) Ventricular Systole - The contraction of the two ventricles occurs simultaneously. The pressure of ventricles closes the (bicuspid and tricuspid) valves producing the first heart sound called Lubb (systolic sound). 0.14 seconds) Blood from ventricles is pushed into the great arteries (Pulmonary and systemic aorta) at the end of ventricular systole, the ventricles go into relaxation lasting about 0.5 second. To prevent back flow of blood from arteries, the semilunar valves close sharply and produces a second heart sound called dub or diastolic sound. (0.11 seconds)

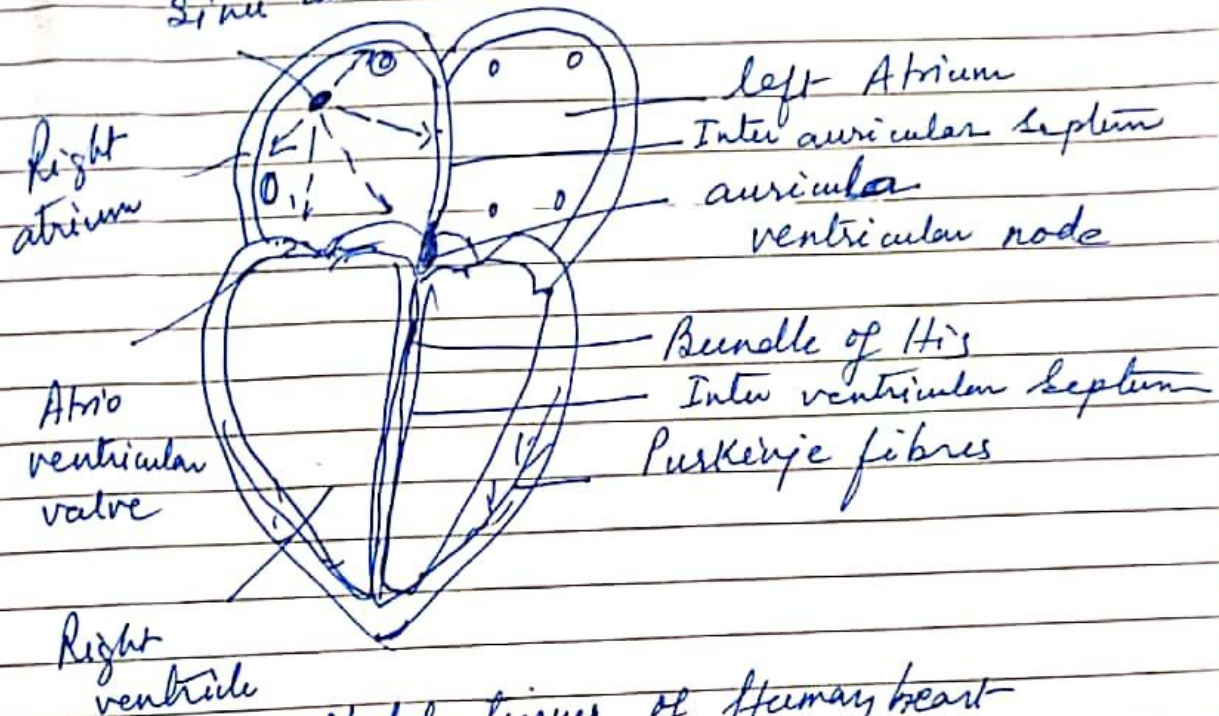
3) Joint diastole → During this phase, both auricles and ventricles are in relaxed state, the blood from great veins flows into the auricles and a new cardiac cycle begins.

Heart Beat → Human heart is a myogenic heart in which the contraction is initiated by special node of modified heart muscle, the Sino-atrial (SA) node located in the right atrium. This node can generate a wave of contraction and is therefore called the pacemaker. The signals given by pacemaker travel to the whole heart muscle over a conducting system comprising of auriculo ventricular (AV) node, Bundle of His and Purkinje fibres. The AVN is located in the right auricle, in the interauricular septum near the fibrous ring separating the right auricle and ventricle. It gives rise to

Bundle of His a muscular bridge conducting stimulation from auricles to ventricles. It gives rise to Purkinje fibres on each entering the ventricle along the interventricular septum, it divides into two branches on right and left side as a network of Purkinje fibres which penetrate into the myocardium.

In a normal resting man the rate of heart beat is 72/minute. one heart beat lasts about 0.8 seconds.

Sino auricular node



Nodal tissues of Human heart

Cardiac output - The amount of blood ejected from the left ventricle into aorta per minute is called heart or cardiac output. Heart beats 72/min and pumps out about 70ml of blood during each beat.

$$\text{Cardiac output} = \text{Stroke volume} \times \text{ventricular Systole /min}$$

$$= 70 \text{ ml} \times 72/\text{min}$$

$$= 5040 \text{ ml/min} = \text{about } 5 \text{ ltr/min}$$

Total amount of blood present in the body is 5-6 litres.

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