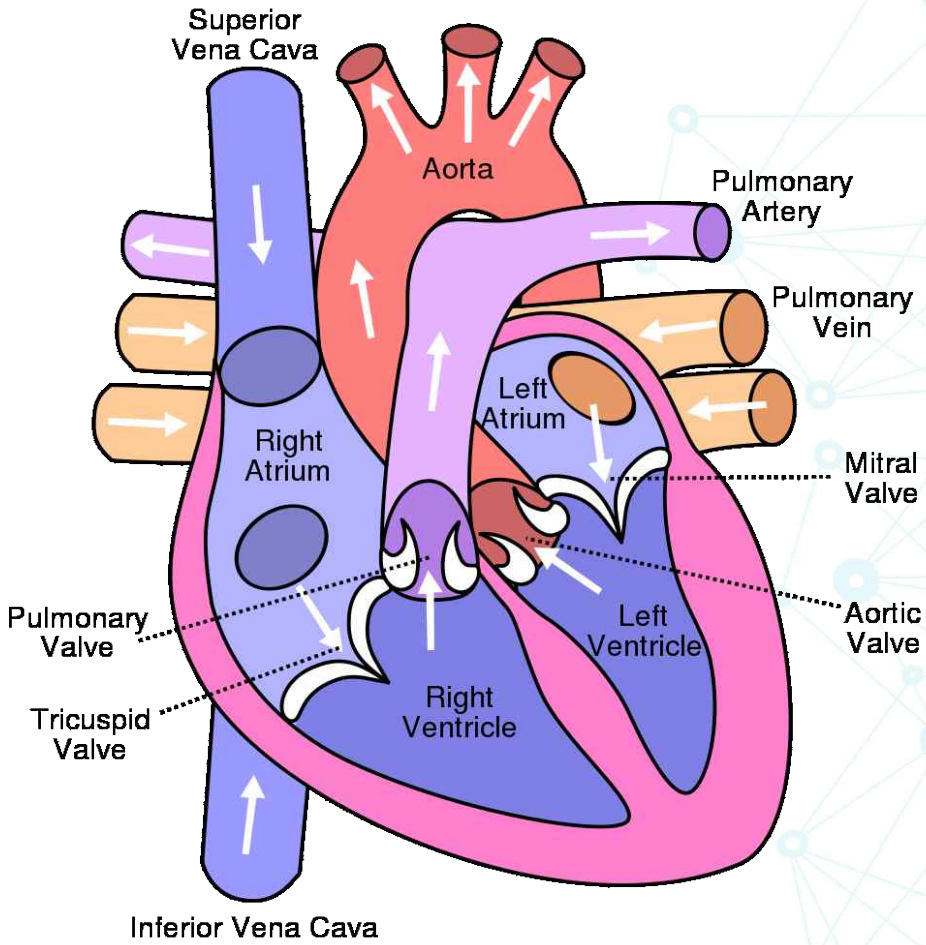
BIOLOGY

Live eBook

01. Human Heart

The average size of adult human heart is about 12 cm. It gets fully developed between the age of 17-20 years. The weight of heart is about 0.45% of body weight, i.e. 280-340 gm in males and about 0.40%, i.e. 230-280 gm in females. It is situated in the space of thoracic cavity called **mediastinum** present between two lungs. It is mesodermal in origin and is slightly tilted to the left side of the body.



External Structure :

Externally, human heart is covered by a double- walled membranous covering called **pericardium.** this covering is made up of an inner visceral and an outer parietal membrane. Between these two membranes lies a narrow space, the pericardial cavity, filled with a watery **pericardial fluid.** It protects the heart from shocks and mechanical injuries and allows free movements of the heart. When the heart is exposed on removal of the pericardium, a four-chambered heart with a distinct transverse groove is observed. It divides the heart into a smaller anterior atrial part and a posterior ventricular part. This groove is known as **atrioventricular groove** or **coronary sulcus.** Two grooves that mark the boundary between the right and left ventricles are anterior inter ventricular and posterior interventricular sulcus. Two major arterial trunks, i.e. pulmonary and aortic arch, along with two major venous trunks, i.e. superior and inferior vena cave are also seen in intimate association with heart.

Internal Structure

Heart is made up of cardiac muscles. *The wall of heart is made up of following three layers from outside to inside*

(a) **Epicardium** (visceral pericardium) It is the outermost layers. It is made up of simple squamous epithelium

(b) **Myocardium** It is the middle layer. It is thickest and made up of cardiac muscles, which are striated but involuntary.

(c) **Endocardium** It is the innermost layer. It is again made up of simple squamous epithelium.

Structure of heart chambers

The four- chambered human heart is divided into two auricles or atria and two ventricles.

(a) **Auricles or atria** This part is vertically divisible into right and left auricles. Out of these the left auricle is smaller then the right auricle. Each auricle extends behind into a swollen flap, i.e. the auricular appendix. It slightly covers the ventricle of each side. Both right and left auricles are separated completely by a thin septum called **interatrial septum** or **interauricular septum.** It prevents mixing of oxygenated and deoxygenated blood. An oval depression, called **fossa ovalis** is present on its posterior part. It is remnant of **foramen ovale** present in foetal stage which closes at birth. The internal lining of the auricular wall forms a network of low muscular ridges called **musculi pectinati.**

(b) **Ventricles** This part of heart is broad, more muscular and of light colour. The walls of the ventricles are internally raised into a number of thick, muscular, column-shaped projections called **columnar carnae** or **trabeculae carnae.** A few large muscular elevations called **papillary muscles** or musculi papillares, which are two in left ventricles and three in right ventricle are also seen. The interventricular septum separates the right and left ventricles. Also, the two auricles and two ventricles are separated by an auriculoventricular septum. The right ventricle pumps deoxygenated blood to lungs and left ventricle pumps oxygenated blood throughout the body. Fine tendinous cords called **chordae tendinae** are found attached to the ventricular surface of the valves on one side and to the papillary muscles on the other side. These structure prevents inversion of valves.

Major Blood Vessels Associated with Heart

The chambers of heart are directly connected with the following major blood vessels

(i) **Systemic aorta or Systemic arch** It is originated from left ventricle. It distributes oxygenated blood to various body parts except lungs.

(ii) **Pulmonary arch or Pulmonary trunk** It is originated from right ventricle and gets divided into two pulmonary arteries. These carry deoxygenated blood to lungs.

(iii) **Superior vena cava or Precaval** It brings deoxygenated blood from head and upper parts of the body into the right auricle.

(iv) **Inferior vena cava or Postcaval** It brings deoxygenated blood from lower parts of the body into the right auricle.

(v) **Pulmonary veins** These are four in number (i.e. two form each lung). These bring oxygenated blood from lungs to left auricle.

(vi) **Coronary veins or Coronary sinus** These returns deoxygenated blood from heart wall into the right auricle.

Heart Valves

To prevent the back flow of blood or to maintain unidirectional flow of blood, following specialised valves are present in heart

Table Types of heart valves their location and action

Heart valve	Location	Action
Tricuspid valve	Between right atrium and right ventricle	During ventricular contraction, it prevents blood back flow from right ventricle into right atrium
Pulmonary value (semilunar)	At the initial point of pulmonary artery	During ventricular relaxation, it prevents back flow of blood from pulmonary trunk into right ventricle
Mitral value (bicuspid value)	Between left atrium and left ventricle	During ventricular contraction, it prevents back flow of blood from left ventricle into left atrium
Aortic value	At the initial point of aorta	During ventricular relaxation, it prevents blood back flow from aorta into left ventricle

Conducting System of Human Heart

Sinoatrial node or SA Node : It is also called **node of Keith** and **Flack.** It is a mass of self excitatory specialised cells, present in the wall of the right atrium near the opening of superior vena cave. Functionally, it is called as the **pacemaker** of heart. This is so because the initiation of heart beat impulses is done within this node. Secondary, it initiates the impulses more rapidly than any other neuromuscular cell of heart. Its initiation rate is 70-80 impulses or beasts per minute.

Atrioventricular Node or AV Node

It is also called **node of Twara** and **Aschoff**. It is also a small mass of self-excitatory neuromuscular tissue situated in the wall of atrial septum near the atrioventricular valves. Normally, it works on stimulation by SA node, but it is capable of initiating its own impulses too. However, its initiation rate is lower, i.e. 40-60 impulses per minute as compared to SA node. Functionally, it is called as the **pacesetter** of heart.

Bundle of his or Atrioventricular Bundle

These are mass of specialised fibres originating from AV node. It separates atria and ventricle. At the upper end of ventricular septum, it is divided into left and right bundle branches.

Purkinje fibres

These are the fine fibres of AV bundle in the ventricular myocardium. Both AV bundle end purkinji fibres convey impulse of contraction from AV node to the apex of myocardium and brings on ventricular contraction.

Cardiac Cycle

It refers to the repeating pattern of systole (contraction) and diastole (relaxation) of the heart. Each cycle of atrial and ventricular systole and diastole is of 0.8 second. In auricles systole lasts only for 0.1 sec and diastole remains for 0.7 sec. On the other hand ventricles have a longer systole, i.e. of 0.3 sec due to their highly muscular walls. Thus, the diastole in ventricles lasts for 0.5 sec only.

The main characteristics of human cardiac cycle are listed below

(i) At th onset of ventricular systole, the AV valves close thus producing the first heart sound. The interval between the closing of the AV valves and opening of the semilunar valves, is called the isometric contraction period (0.05s). During this period, ventricles contract as closed cavities and intraventricular pressure steeply rise.

(ii) During ejection period, blood is pumped out of the ventricles.

(iii) At the beginning of ventricular diastole, the semilunar valves close producing the second sound. These is a brief interval between the beginning of diastole and the closure of the semilunar valves. It is known as the **protodiastolic period (**0.04s). Second sound occurs actually after this period.

(iv) As the ventricles relax, intraventricular pressure falls below that of atria and AV valves open. This is called **isometric relaxation** (0.08 s). As a result of this, atrial blood rushes into the ventricles, i.e. producing the third sound. This indicates the beginning of ventricular filling.

(v) The first of filling is vary rapid, being known as the first rapid filling phase (0.113 s). The intermediate part of filling is vary slow and is known as **diastasis** or **slow inflow phase.** Although, this is the longest phase (0.167 s), yet the amount of filling is minimum. During this phase blood directly enters from vena cava to ventricles.

(vi) This last rapid filling phase (0.1 s) is responsible for the last part of ventricular filling. It occurs in overlapping with arterial systole. Infact, the rapid flow of blood during this phase is due to increased arterial pressure only. Due to rapid rush of blood, another sound is produced, i.e. the so called fourth sound of heart. Here, ventricular diastole ends and systole commences again. In this way, the cycle continues.

All the above. written events along with the presences, blood volumes and heart sounds are summariesd in the following figure