

UNIT – II HUMAN ANATOMY AND PHYSIOLOGY

IIA--BODY FLUIDS AND CIRCULATION

Very Short Answer Questions

1. Write the differences between open and closed systems of circulation?

A.

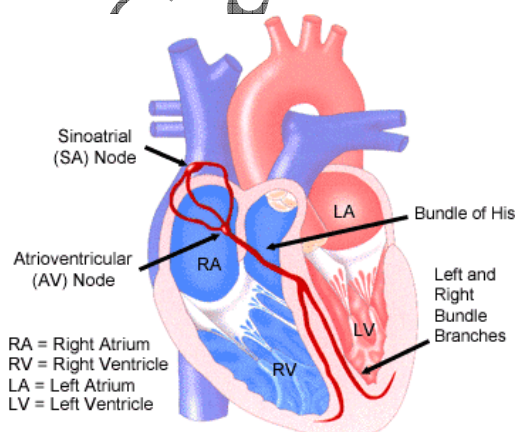
Open Circulatory System	Closed Circulatory System
1. Blood flows from the heart into the arteries and later into large spaces called 'sinuses'	1) Blood flows through series of blood vessels.
2. Organs located in spaces are directly contact with blood	2) Blood vessels carry blood to organs
3. Slow blood flow occurs as there is no blood pressure	3) Blood flows at a high – speed as there is high blood pressure after the blood leaves the heart.
4. It is shown by Leeches, arthropods and molluscs	4) It is found in annelids, cephalopods, cephalochordates and chordates

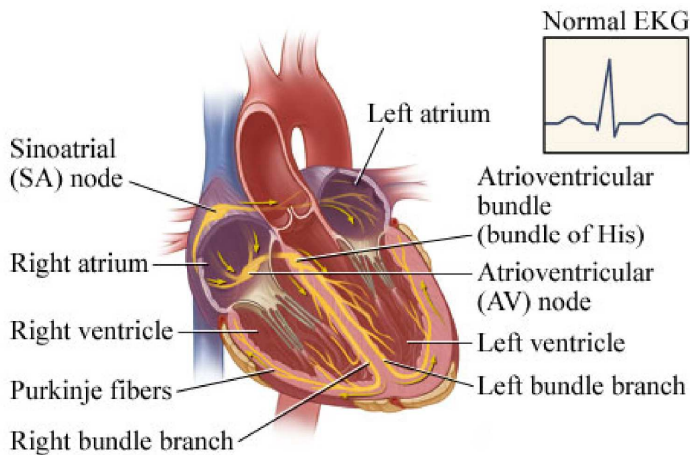
2. Sinoatrial node is called the pacemaker of our heart. Why?

A. Sinoatrial node consists of specialized cardiomyocytes.

SA node has the ability to generate action potentials without any external stimuli.

So SA node is called 'pacemaker' (myogenic).





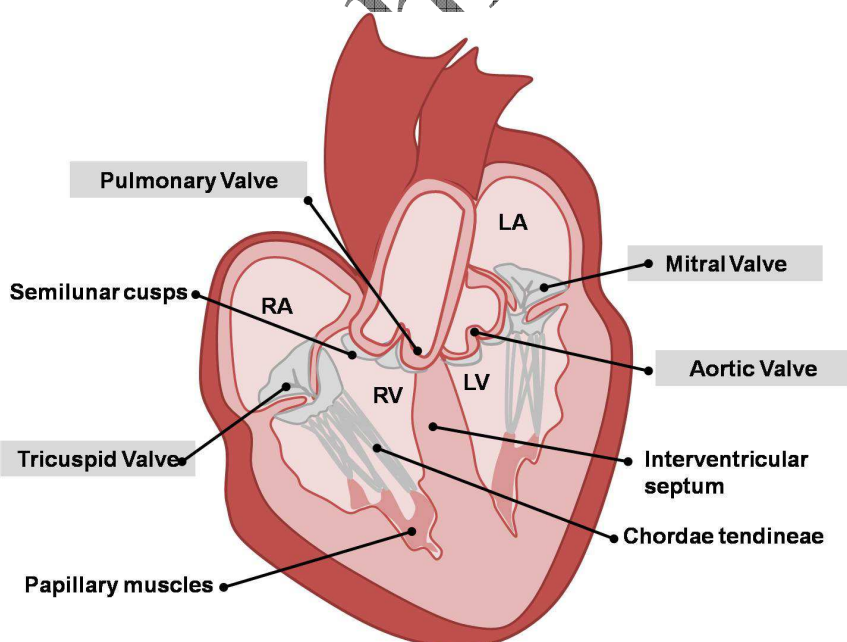
3. What is the significance of atrioventricular node and atrioventricular bundle in the functioning of the heart?

- A. Atrioventricular node and atrioventricular bundle play an important role in the contraction of ventricles.

Aricular contraction initiated by the wave of excitation from sinoatrial node (SAN) stimulates the atrioventricular node from where they are conducted through the bundle of His (atrioventricular bundle), its branches and Purkinje fibers to the entire ventricular musculature. It causes the stimulation of ventricular systole. It lasts about 0.3 sec.

4. Name the valves that guard the left and right atrioventricular apertures in man?

- A. Bicuspid valve (or) Mitral valve – Left atrioventricular aperture.
Tricuspid valve – Right atrioventricular aperture.



5. Where is the valve of Thebesius in the heart of man?

- A. Valve of Thebesius is present at the opening of coronary sinus which collects blood from myocardium into right atrium.

6. Name the aortic arches arising from the ventricles of the heart of man?

- A. Two aortic arches arise from ventricles of the heart of man. They are

- 1) Pulmonary arch – arises from right ventricle
- 2) Left systemic arch – arises from left ventricle

7. Name the heart sounds. When they are produced?

- A. The **Lub – dup** sounds are the heart sounds.

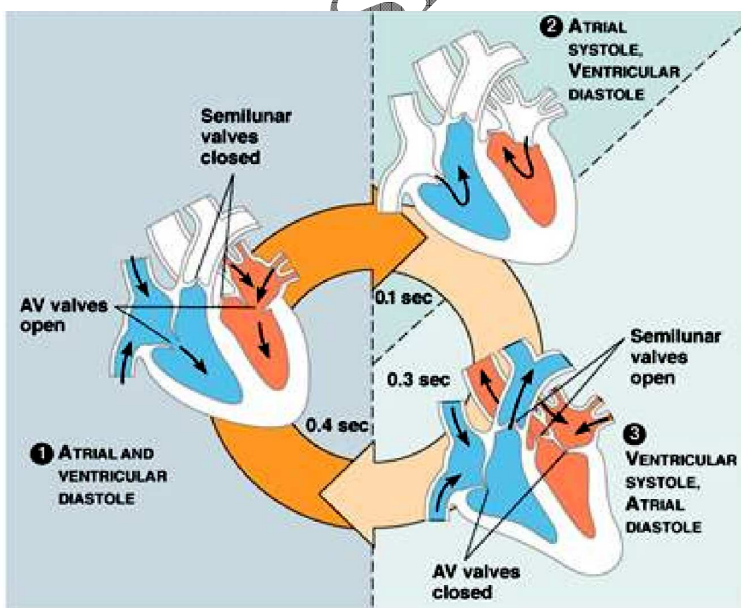
The first sound '**lub**' is caused by **closure of the AV valves** at the beginning of ventricular systole to prevent the back flow of blood.

The second heart sound '**dup**' results from the **closure of the semi-lunar valves** at the beginning of ventricular diastole (relaxation) to prevent the back flow of blood from aortic arches into ventricles.

8. Define cardiac cycle and cardiac output?

- A. **Cardiac Cycle:** Cardiac events that occur from the beginning of one heart beat to the beginning of the next form a cardiac cycle.

Cardiac Output: The volume of blood pumped out by the heart from each ventricle per minute is called as cardiac output. It is approximately 5 liters.



9. What is meant by double circulation? What is its significance?

- A. The double circulation system of blood flow refers to the separate systems of **pulmonary circulation** and the **systemic circulation**. All animals with lungs have a double circulatory system.

In **Pulmonary Circulation**, deoxygenated blood is pumped away from the heart through the pulmonary arch to the lungs and returns oxygenated blood to the heart through pulmonary vein. It is lesser circulation.

In **Systemic Circulation**, the oxygenated blood moves away from heart to the body parts through aorta and returning of deoxygenated blood to the heart through venous system. It is greater circulation.

10. Why the arteries are more elastic than the vein?

- A. The wall of arteries has **two elastic lamina** one on either side of the muscle layer. So Arteries are more elastic and can withstand more pressure of the blood.

The wall of vein has **one elastic lamina** only inner to the muscle layer.

Short Answer Type Questions

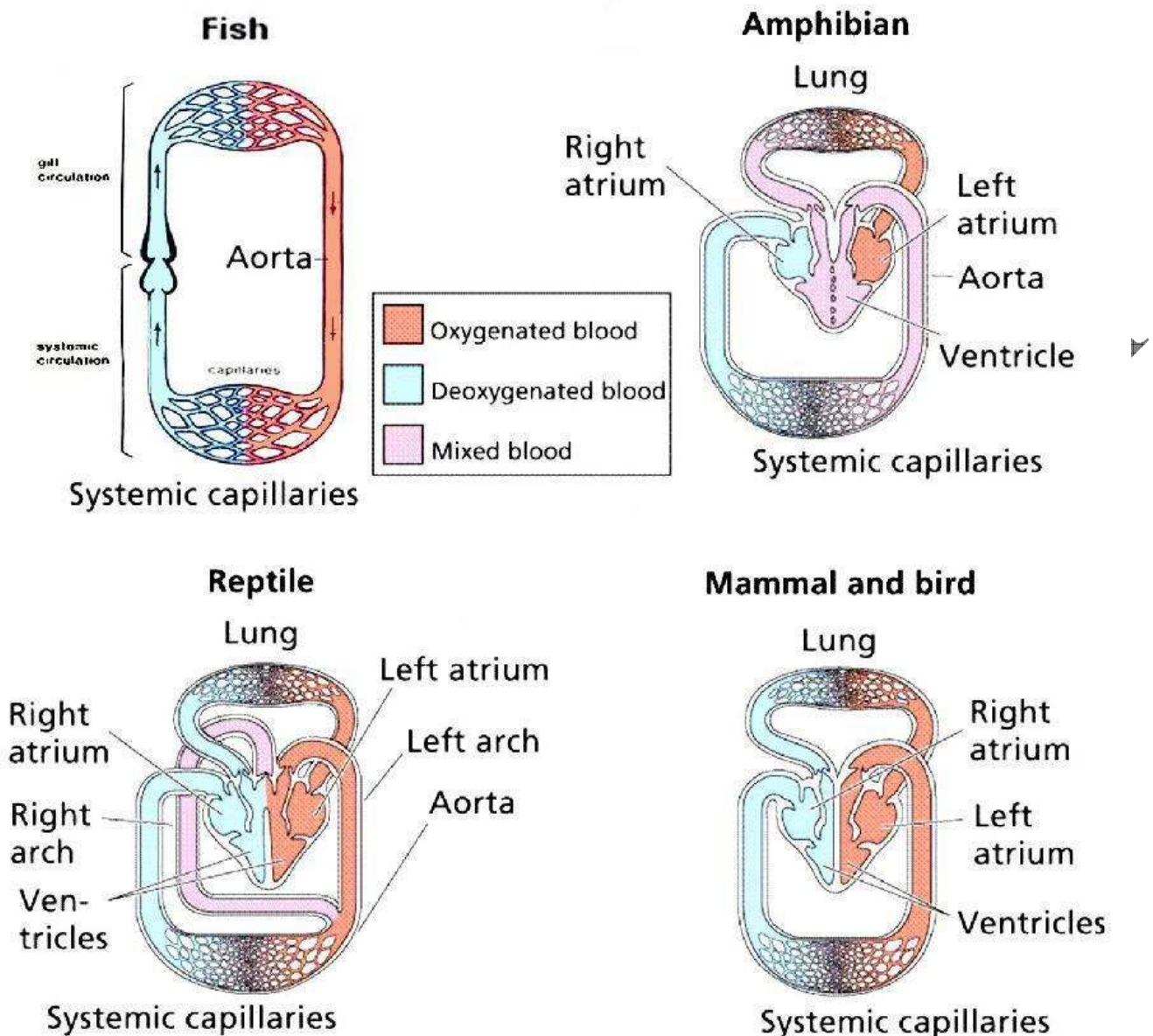
1. Describe the evolutionary change in the structural pattern of the heart among the vertebrates?

A. Evolutionary Changes in the structural pattern of the heart among the vertebrates occur in the following manner.

1) **Fishes.** They have 2 – chambered hearts with an atrium and a ventricle. Blood passes through the heart only once in a complete circuit hence called **Single Circulation**. This means there is no separate circulation for oxygenated and deoxygenated blood.

2) **Amphibians...** 3 – Chambered Heart with two atria and one ventricle, which further evolved in reptiles, have two atria and an incompletely divided ventricle in which left atrium receives oxygenated blood from the gills / lungs / skin and right atrium receives blood from the other parts of the body. The two types of blood get mixed in the single ventricle, which pumps out mixed type of blood. Thus these animals show **incomplete double circulation**.

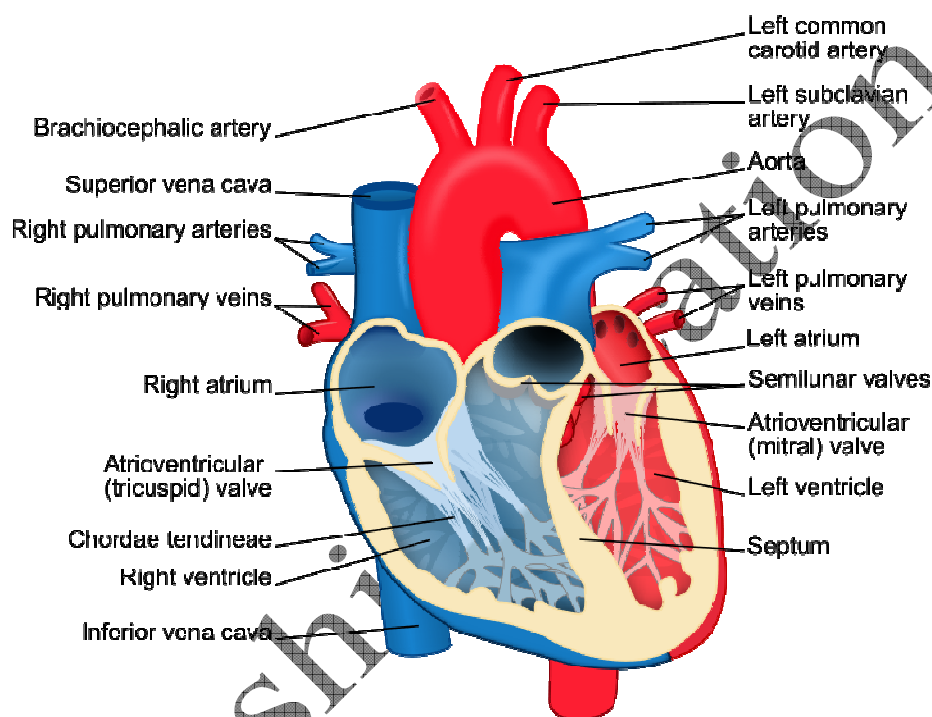
3) Birds and mammals they have 4 – chambered heart with two atria and two ventricles. In these animals the oxygenated and the deoxygenated types of blood received by left and right atria, passes on to the left and right ventricles, respectively. The ventricles pump the blood out without any mixing of the oxygenated and deoxygenated types of blood. Hence these animals are said to be showing **double circulation** namely **systemic and pulmonary circulations**.



2. Describe atria of the heart of man?

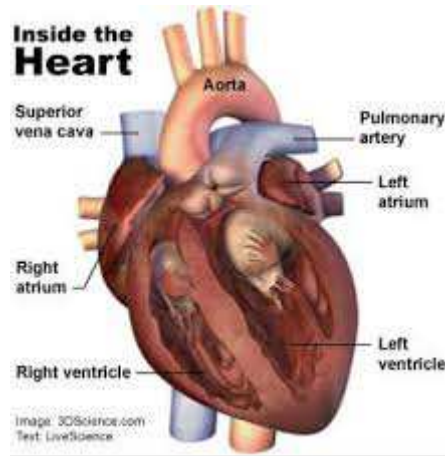
- Atria are thin walled receiving chambers which form the anterior part of the heart. The right atrium is larger than the left, they are separated by interatrial septum.
- Interatrial septum has small pore in embryonic stage known as **Foramen Ovale** in foetal heart. Later it is closed and appears as a depression in the septum known as **Fossa ovalis**. If the foramen ovale does not close properly, it is called as **patent foramen ovale**.
- Right atrium receives deoxygenated blood from different parts of the body (except the lungs) through caval veins like two precaval veins and one post caval vein. The right atrium also receives blood from the walls of the heart through the coronary sinus, whose opening into the right atrium is guarded by the **valve of Thebesius**.

- Opening of the postcaval vein is guarded by the **valve of inferior vena cava or Eustachian valve**. It directs the blood to the left atrium through the foramen ovale, in the fetal stage, but in the adults it becomes non functional.
- The openings of the precaval veins into the right atrium have no valves. The left atrium receives oxygenated blood from lungs through a pair of pulmonary veins, which opens into the left atrium through a common pore.
- Atrioventricular septum separates atria and ventricles. It has right and left atrioventricular apertures.
- Tricuspid valve guards the right atrioventricular aperture and bicuspid valve (mitral valve) guards the left atrioventricular aperture.

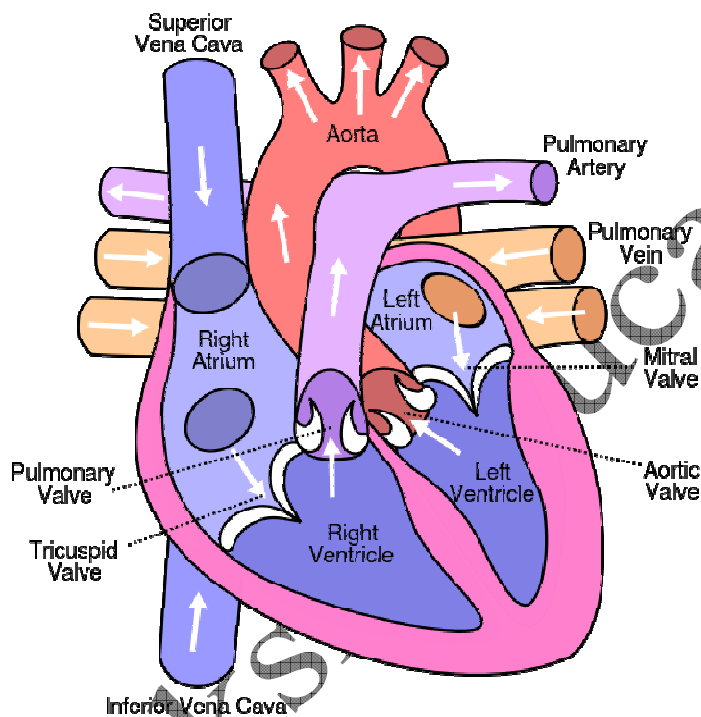


3. Describe the ventricles of the heart of man?

- A. Two ventricles right and left form the posterior part of the heart. These are the thick walled blood pumping chambers, separated by interventricular septum. The wall of the left ventricle is thicker than that of the right ventricle. The inner surface of ventricles is raised into muscular ridges or columns known as columnae carneae projecting from the inner walls of the ventricles. Some of them are large and conical and known as papillary muscles. Collagenous cords are known as chordae tendineae are present between atrioventricular valves and papillary muscles. They prevent the cusps of the atrioventricular valves from bulging too far into atria during ventricular systole.

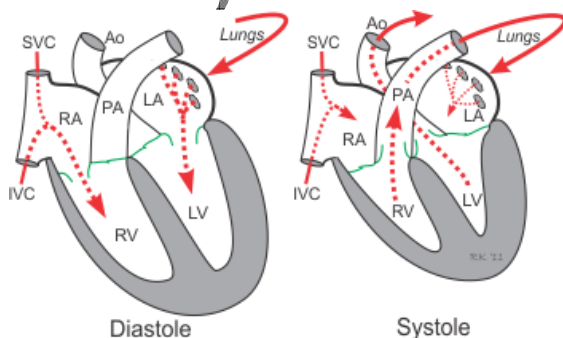


4. Draw a labelled diagram of the L.S. of the heart of man?



A.

5. Describe the events in a cardiac cycle, briefly?



A. The cardiac events which occur from the beginning of one heart beat to the beginning of the next, is called cardiac cycle.

Cardiac cycle consists of three phase's namely atrial systole, ventricular systole and cardiac diastole.

i) Atrial Systole: It lasts about 0.1 seconds

→ The SAN generates an action potential which stimulates contraction of atria that helps in the flow of blood into ventricles by about 30%. The remaining blood flows into the ventricles before the atrial systole.

ii) Ventricular Systole: It lasts about 0.3 seconds

→ Ventricles contract and atria relax during this phase.

→ Contraction of ventricles raises the pressure in ventricles due to which AV valves are closed. It causes the first heart sound "Lub".

→ When pressure in ventricles exceeds the pressure in aortic arches, semilunar valves open. It results the flow of blood from ventricles into aortic arches.

iii) Cardial Diastole: It lasts about 0.4 seconds

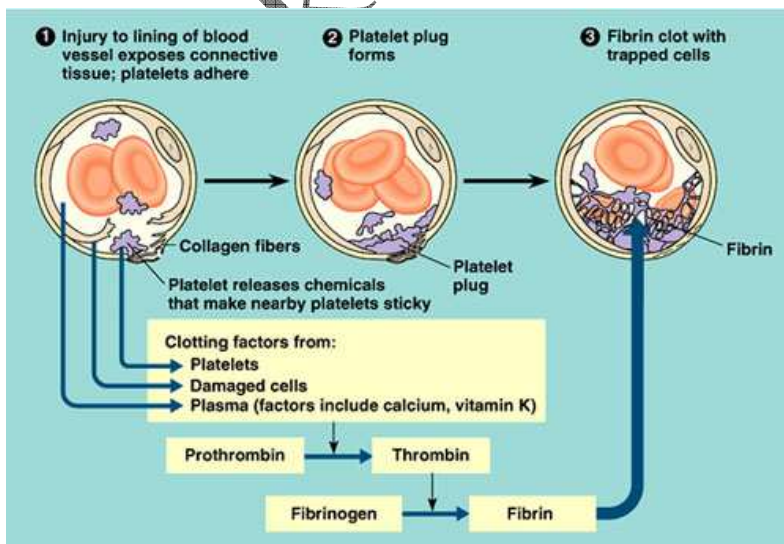
→ The ventricles now relax; atria are also in diastolic condition.

→ When pressure in ventricles falls below that in aortic arches, semilunar valves are closed.

→ It causes the second heart sound "dup".

When pressure in ventricles falls below atrial pressure AV valves open and ventricular filling begins. The total cycle takes about 0.8 seconds. This gives a heart rate of about 75 beats per minute.

6. Explain the mechanism of clotting of blood?



- A. When a blood vessel is injured a number of physiological mechanisms are activated that promote hemostasis and stops bleeding. Blood clots within 3 – 6 minutes after damage of a blood vessel.

Mechanism of blood clotting: Blood clotting takes place in three essential steps.

i) Formation of Prothrombin Activator: It is formed by two pathways with cascade of chemical reactions.

a) Intrinsic Pathway: It occurs when the blood is exposed to collagen of injured wall of blood vessel. This activates factor XII (Hageman's factor), and in turn it activates another clotting factor, which activates yet another reaction, which results in the formation of prothrombin activator.

b) Extrinsic Pathway: It occurs when the damaged vascular wall or extra vascular tissue comes into contact with blood. This activates the release of tissue thromboplastin (factor III), from the damaged tissue. It activates the factor VII (proconvertin). As a result of these cascade reactions, the prothrombin activator is formed finally.

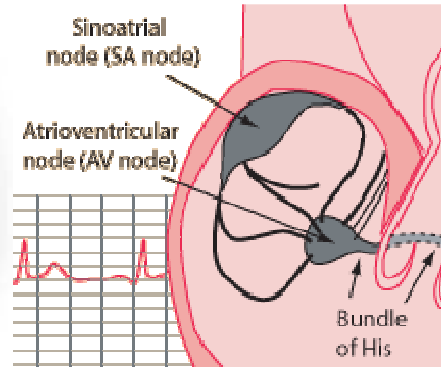
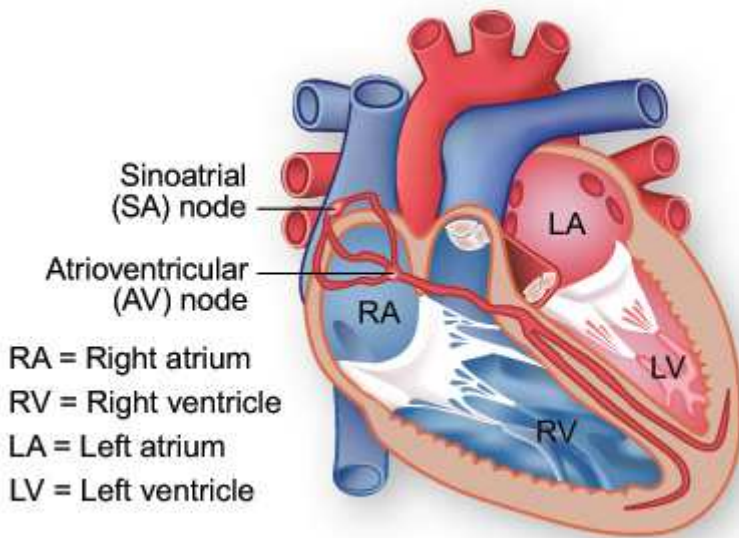
ii) Activation of Prothrombin: The prothrombin activator in the presence of sufficient amount of Ca^{2+} ions causes the conversion of inactive prothrombin to active thrombin.

iii) Conversion of Soluble Fibrinogen into Fibrin: Thrombin converts the soluble protein fibrinogen into soluble, fibrin monomers, which are held together by weak hydrogen bonds. The factor XIII (fibrin stabilizing factor) replaces hydrogen bonds with covalent bonds and cross links the fibers to form a meshwork and prevents the loss of blood further.

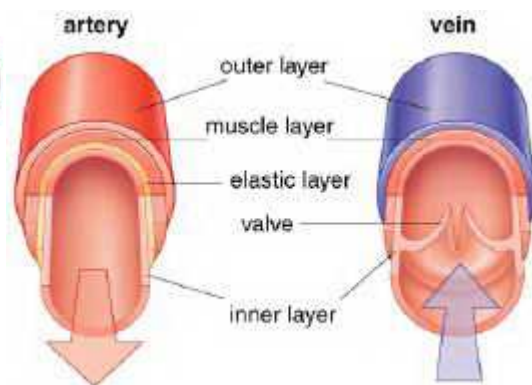
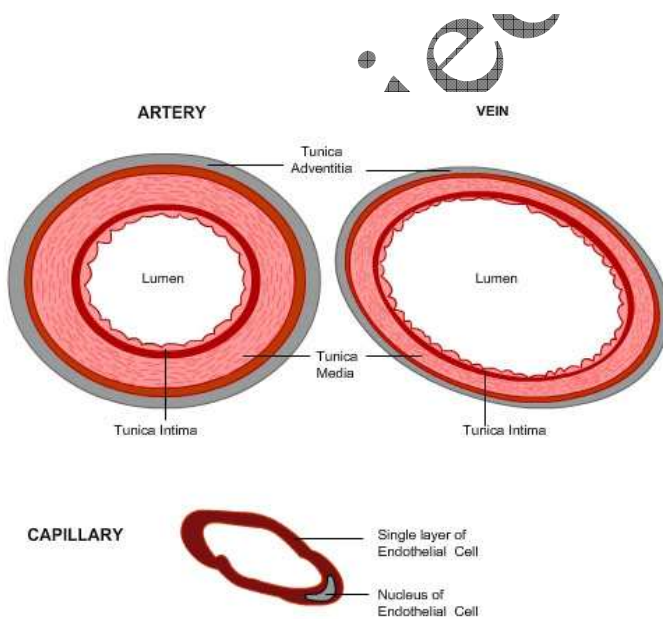
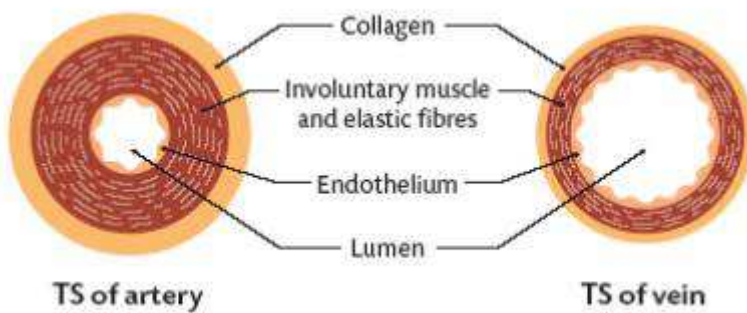
7. Distinguish between SAN and AVN?

- A. **Sinoatrial node (SAN):** It is present in the right upper corner of the right atrium. It is called pacemaker as it has the ability of generation of action potentials without any external stimuli (myogenic).

AtrioVentricular Node (AVN): It is seen in the lower left corner of the right atrium close to AV septum. AV node is a relay point that relays the action potential received from the SA node to the ventricular musculature through the bundle of His, its branches and Purkinje fibers.



8. Distinguish between arteries and veins?



A.

Arteries	Veins
<ol style="list-style-type: none">1. Arteries carry oxygenated blood, away from the heart except pulmonary artery.2. These are bright red in colour.3. Arteries are mostly deeply seated in the body.4. Arteries are thick walled as the tunica media is thick with elastin and smooth muscles.5. They have narrow lumen.6. Non-valvular.7. Blood in the arteries flow with more pressure and by jerks.8. Arteries end in capillaries.	<ol style="list-style-type: none">1. Veins carry deoxygenated blood towards the heart except the pulmonary veins.2. These are dark red in colour.3. Veins are generally superficial.4. Veins are thin walled with thin tunica media with few elastin fibres. and slightly muscular.5. They have wide lumen.6. Valvular.7. Blood in the veins flow steadily with relatively low pressure.8. Veins start with capillaries.

Long Short Answer Questions

1. Describe the structure of the heart of man with the help of neat labeled diagram?

- A. Human heart is a thick walled, muscular and pulsating organ situated in **mediastinum** between lungs. It is about the size of a closed fist.

The heart is covered by double walled pericardium, with outer fibrous pericardium and inner serous pericardium. The serous pericardium is double layered with outer parietal layer and inner visceral layer. Parietal layer is fused with fibrous pericardium whereas the visceral layer adheres to the surface of heart and forms epicardium. These two layers are separated by pericardial space, which is filled with pericardial fluid. This fluid reduces friction between the two membranes and allows free movement of the heart.

Human heart has four chambers with two smaller upper chambers called atria and two larger lower chambers called ventricles. Atria and ventricles are separated by a deep transverse groove called coronary sulcus.

i) Atria:

- Atria are thin walled receiving chambers. The right one is larger than the left.
- The two atria are separated by thin inter-atrial septum. It has a small pore known as '**Foramen Ovale**' in fetal stage. Later it is closed and appears as depression (oval patch) known as '**Fossa ovalis**'.
- If the foramen ovale does not close properly it is called a **patent foramen ovale**.
- The right atrium receives deoxygenated blood from different parts of the body, through three caval veins like two precaval veins and one postcaval vein.
- The right atrium also receives blood from wall of the heart through coronary sinus, whose opening into the right atrium is guarded by the **Valve of Thebesius**.
- Opening of the postcaval vein is guarded by the **Eustachian valve**. It is functional in fetal stage and directs the blood from postcaval vein into left atrium through foramen ovale. But it is non-functional in adult.
- The openings of the precaval veins into the right atrium have no valves.
- Left atrium receives oxygenated blood from lungs through a pair of pulmonary veins, which open into the left atrium through a common pore.
- Atrioventricular septum separates atria and ventricles. It has right and left atrioventricular apertures.

→ **Tricuspid valve** guards the right atrioventricular aperture.

Bicuspid valve guards the left atrioventricular aperture.

ii) Ventricles:

→ These are the thick walled blood pumping chambers, separated by an interventricular septum. The wall of the left ventricle is thicker than that of the right ventricle as the left ventricle.

→ The inner surface of the ventricles is raised into muscular ridges called **columnae carneae** or **trabeculae carneae**. Some of them are large and conical and known as **papillary muscles**.

Chordae tendineae are present between atrioventricular valves and papillary muscles. They prevent the cusps of valves from bulging too far into atria during ventricular systole.

Nodal Tissue: A specialized cardiac musculature called the nodal tissue is also distributed in the heart.

1) **Sino Atrial Node (SAN)** – Present in the right upper corner of right atrium

2) **Atrio Ventricular Node (AVN)** – Present in the lower left corner of right atrium. It continues from AVN into the inter-ventricular septum. It divides into right and left bundle branches. They give Purkinje fibres which extend throughout the ventricular musculature.

iii) **Aortic arches:** Human heart has two aortic arches.

1) **Pulmonary Arch:** it arises from the left anterior angle of the right ventricle. It carries deoxygenated blood to lungs. Its opening from right ventricle is guarded by **pulmonary valve** made with 3 semi-lunar valves.

2) **Left Systemic Arch:** it arises from the left ventricle to distribute oxygenated blood to various parts in the body. Its opening is also guarded by **aortic valve** made with a set of 3 semi-lunar valves.

A fibrous strand, known as **ligamentum arteriosum** is present at the point of contact of the systemic and pulmonary arches. It is the remnant of the **ductus arteriosus**, which connects the systemic and pulmonary arches in the embryonic stage.

2. Write notes on the working of the heart of man?

- A. The human heart is an organ that provides a continuous blood circulation through the cardiac cycle.

Special conducting tissues of heart: Human heart is myogenic. It contains a specialized cardiac musculature called the nodal tissue.

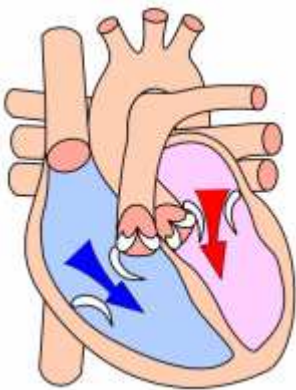
Nodal Tissue: A specialized cardiac musculature called the nodal tissue is also distributed in the heart.

- 1) **Sino Atrial Node (SAN)** – Present in the right upper corner of right atrium.
- 2) **Atrio Ventricular Node (AVN)** – Present in the lower left corner of right atrium. It continues from AVN into the inter-ventricular septum. It divides into right and left bundle branches. They give Purkinje fibres which extend throughout the ventricular musculature.

Cardiac Cycle: Cardiac cycle consists of the sequence of the cardiac events that occur from the beginning of one heart beat to the beginning of next. At beginning of cardiac cycle all the four chambers of the heart are in relaxed state. Cardiac cycle is divided into three phases, namely

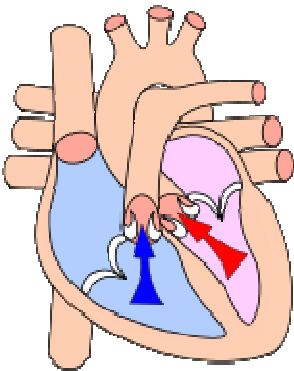
- 1) Atrial Systole
- 2) Ventricular Systole
- 3) Cardiac Diastole

1) **Atrial Systole:** It lasts about 0.1 seconds. SAN now stimulate an action potential which stimulates both the atria to contract simultaneously causing the atrial systole. It increases the flow of blood into the ventricles by about 30%, the remaining blood flows into the ventricle before the atrial systole.



Atrial Systole

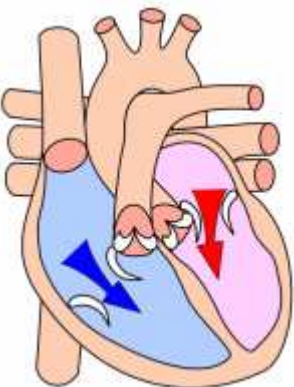
2) **Ventricular Systole:** It lasts about 0.3 seconds. The action potential from the SAN reaches the AVN, from where they are conducted through the bundle of His, its branches and the Purkinje fibers to entire ventricular musculature. This causes the simultaneous ventricular systole. The atria undergo relaxation coinciding with ventricular systole. Ventricular systole increases the pressure causing closure of AV valves preventing the back flow of blood, results in the production of first heart beat sound 'Lub'. When pressure in ventricles exceeds the pressure in aortic arches, semi-lunar valves open. It results in the flow of blood from ventricles into aortic arches.



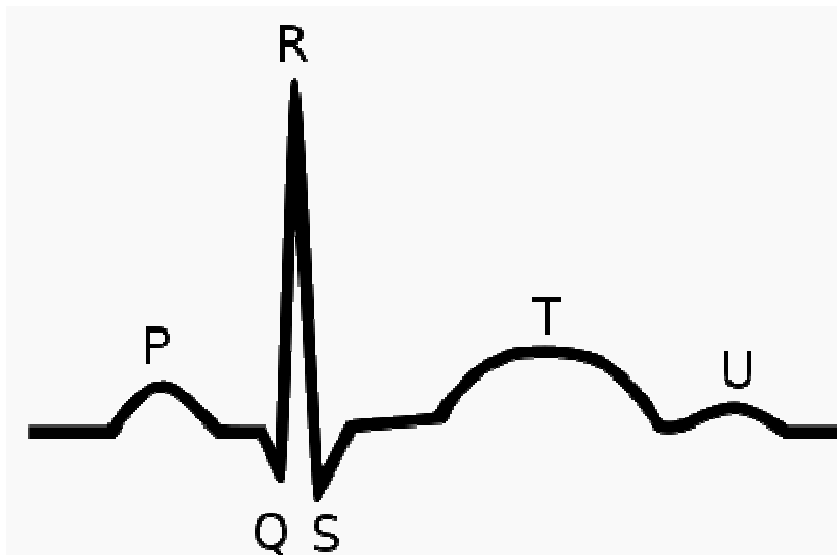
Ventricular Systole

3) **Cardiac Diastole:** It lasts about 0.4 seconds. The ventricles now relax and ventricular pressure falls causing the closure of the semi-lunar valves which prevent the back flow of blood. It results in the production of second heart sound known as 'Dup'.

When pressure in ventricles falls below the atrial pressure, AV valves open and ventricular filling begins. All the chambers are now again in relaxed state. Soon another cardiac cycle sets in.



Cardiac Diastole



P wave- indicates that the atria are electrically stimulated (depolarized) to pump blood into the ventricles.

QRS

QRS complex- indicates that the ventricles are electrically stimulated (depolarized) to pump blood out.

ST

ST segment- indicates the amount of time from the end of the contraction of the ventricles to the beginning of the T wave.

T

T wave- indicates the recovery period (re-polarization) of the ventricles.

U

U wave- rarely seen, and thought to possibly be the re-polarization of the papillary muscles

Sakshie