EXTENSIVE QUESTIONS

28. Draw label and describe the external structure of human heart.

Ans: Structure of Human Heart:

Location:

The Heart is located in the thoracis cavity between the lungs. The heart lies deep, obliquely and slightly to the left of the sternum. The base of heart extends to the second intercostals space and the apex of the heart is in the fifth intercostals space, approximately 9 cm to the left of the midline.

Pericardium:

The pericardium is a closed sac that surrounds heart. It consists of two parts:

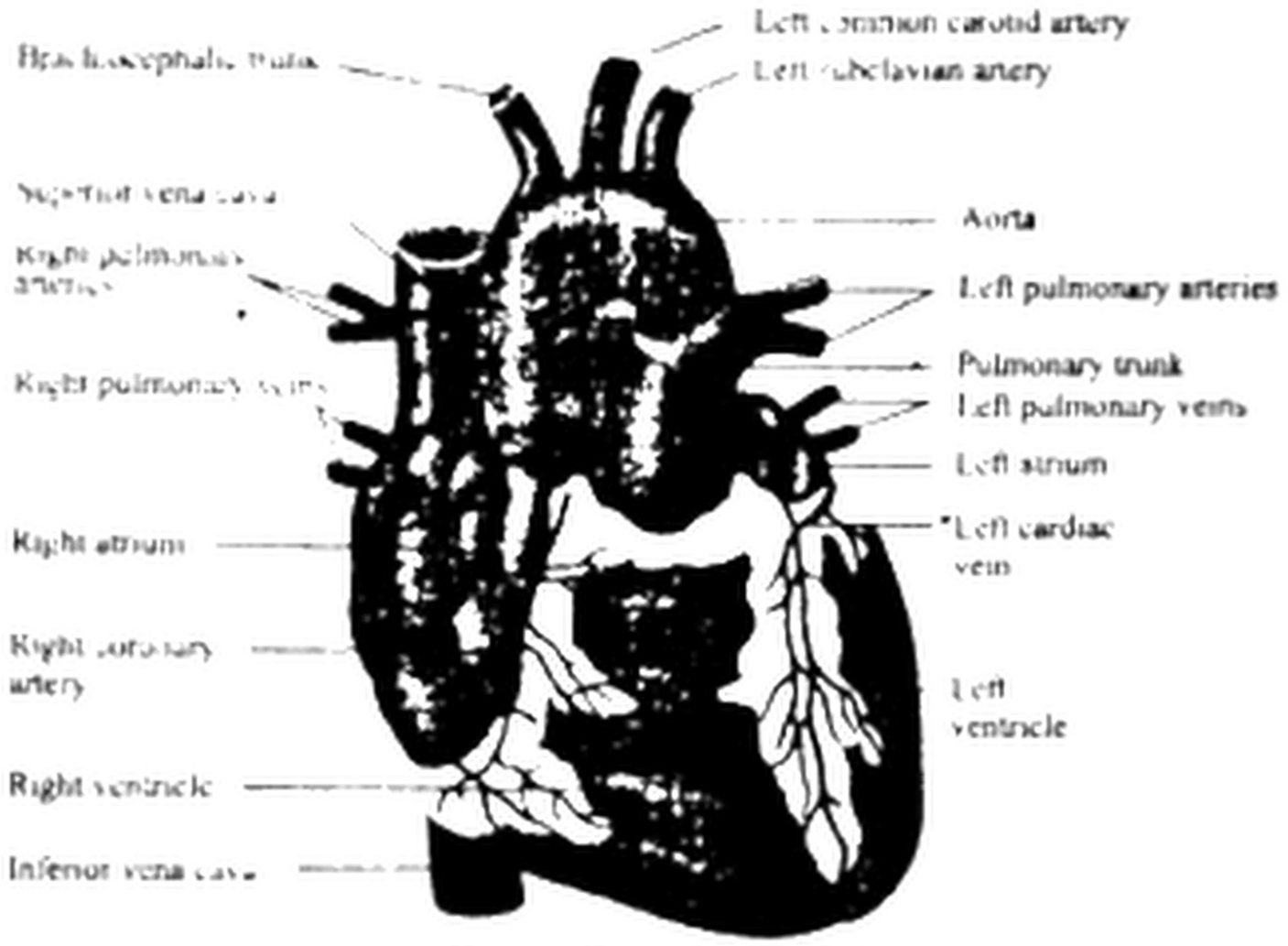
(i) Outer part **(ii) Inner part**

(i) Outer Part:

The outer part consists of inelastic white fibrous tissue.

(ii) Inner Part: The inner part is made up of two membranes. The inner membrane is attached to the heart and the outer one is attached to the fibrous tissue.

Pericardial fluid is secreted between them and reduces the friction between the heart wall and surrounding tissues when the heart is beating. The inelastic nature of the pericardium as whole prevents the heart from being **over stretched or overfilled with blood.**



Human Heart, External view

Chambers of Heart: The heart consists of four chambers:

(i) Two atria **(ii)** Two Ventricles

Atria: Atria (meaning, entrance chamber), The atria lie above the ventricles. The atria are separated from each other by an **interatrial groove.**

Ventricles: Ventricles (meaning belly). The ventricles are separated from each other by an **interventricular groove.** In normal intact heart the sulci (singular *sulcus)* are covered by fat and only after this fat is removed the actual sulci can be seen.

Note: On the surface of the heart **Atria and Ventricles** are separated from each other by an **atrioventricular groove or sulc** (meaning ditch).

29. Draw label and describe the internal structure of human heart.

Ans: The heart wall is composed of the three layers of tissue.

(i) Epicardium **(ii)** Myocardium **(iii)** Endocardium

(i) Epicardium:

The epicardium is a thin **serous membrane** comprising of the smooth outer surface of the heart.

(ii) Myocardium:

The thick middle layer of the heart, the **myocardium**, is composed of cardiac muscle cells.

(iii) Endocardium:

The smooth inner surface of the heart chambers is the **endocardium**, which consists of t

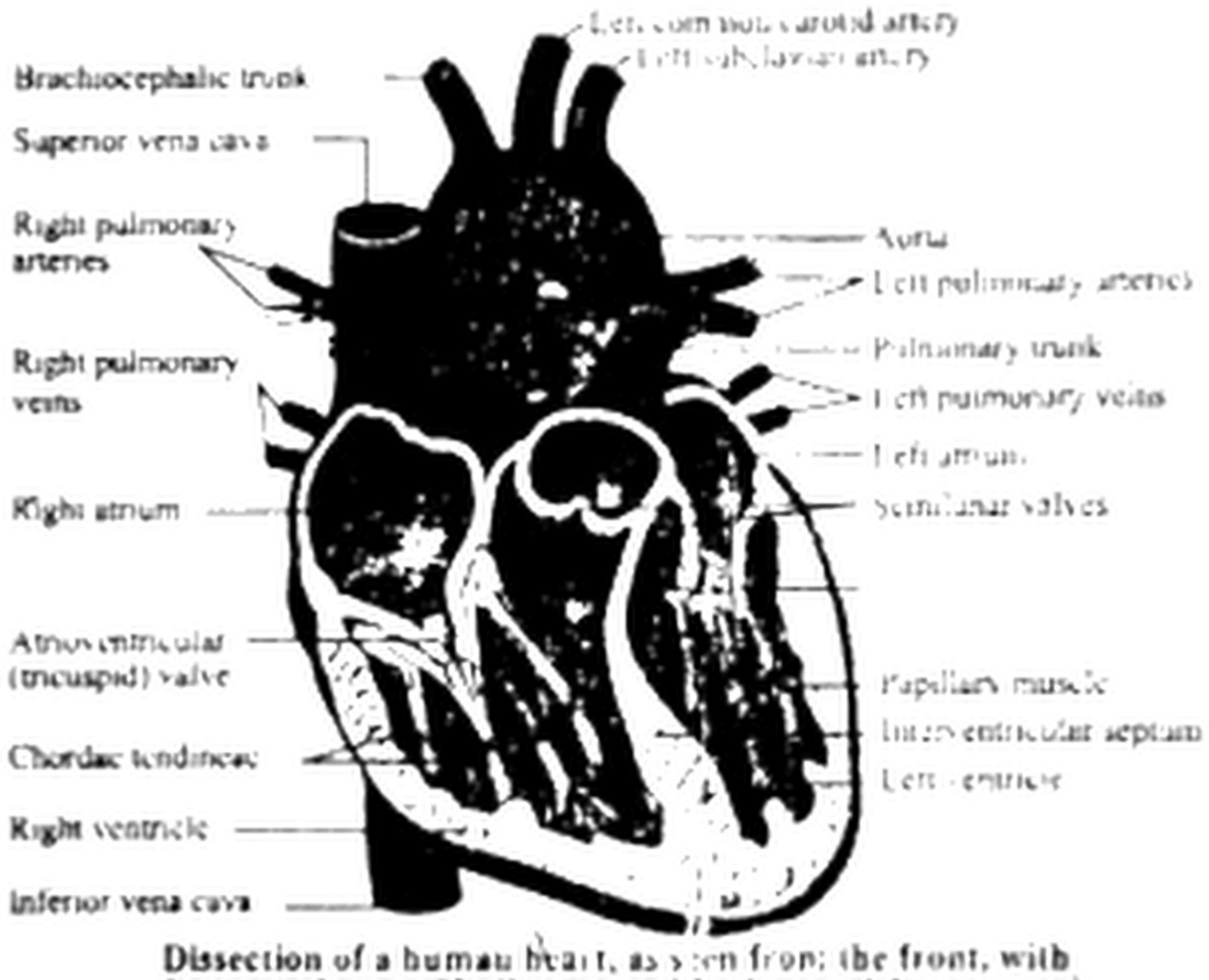
Valves of heart:

The **heart valves** are formed by a fold of the endocardium, making a double layer of endocardium with connective tissue in between.

Comparison of heart valves:

The thickness of the walls of each chamber is different. The right ventricle has thinner walls than the left ventricle in a ratio of 1.3, it pumps blood to the lungs, which ae at a short distance from the heart.

The atria have comparatively thin walls as they only have to force blood into the ventricles and this does not require much power. On the other hand, the ventricles have to face blood out of the heart hence they have relatively thick walls, especially the left ventricle which has to pump blood around the whole body.



Dissection of a human heart, as seen from the front, with the ventral part of both atria and both ventricles removed

The right atrium receives the superior vena cava, the inferior vena cava, and the coronary sinus (the coronary sinus is an additional opening into the right atrium that receives venous blood from the myocardium of the heart itself). **The left atrium** receives the four pulmonary veins. The two atria are separated from each other by the **interatrial septum.** The atria open into the ventricles through **intraventricular canals.** The **right ventricle** opens into the pulmonary trunk and the **left ventricle** open into the aorta. The ventricles are separated from each other by the **interventricular septum.**

An atrioventricular valve is on each atrioventricular canal and is composed of **cusps,** or flaps. The atrioventricular valve between the right atrium and the right ventricle has three cusps and is called the **tricuspid valve.** The atrioventricular valve between the left atrium and left ventricle has two cusps and is therefore, called the **bicuspid or mitral** (meaning, resembling a bishop's miter, a two-pointed hat), **valve.** Each ventricle contains cone-shaped muscle pillars called **papillary** (meaning, pimple-shaped) **muscles.** Thin, strong connective tissue strings called chordate tendineae (meaning, heartstrings) to

the cusps of the atrioventricular valves attach these muscles. The papillary muscles contract when the ventricles contract and prevent the valves from opening into the atria by pulling on the chordate tendineae attached to the valve cusps. Blood flowing from the atrium into the ventricle pushes the valve open into the ventricle, but when the ventricle contract, blood pushes the valve back towards the atrium. The atrioventricular canal is closed as the valve cusps meet. The aorta and pulmonary trunk possess aortic and **pulmonary semilunar** (meaning halfmoon shaped) **valves.** Each valve consists of three pockets like semilunar cusps, the free inner borders of which meet in the centre of the artery to block flow.

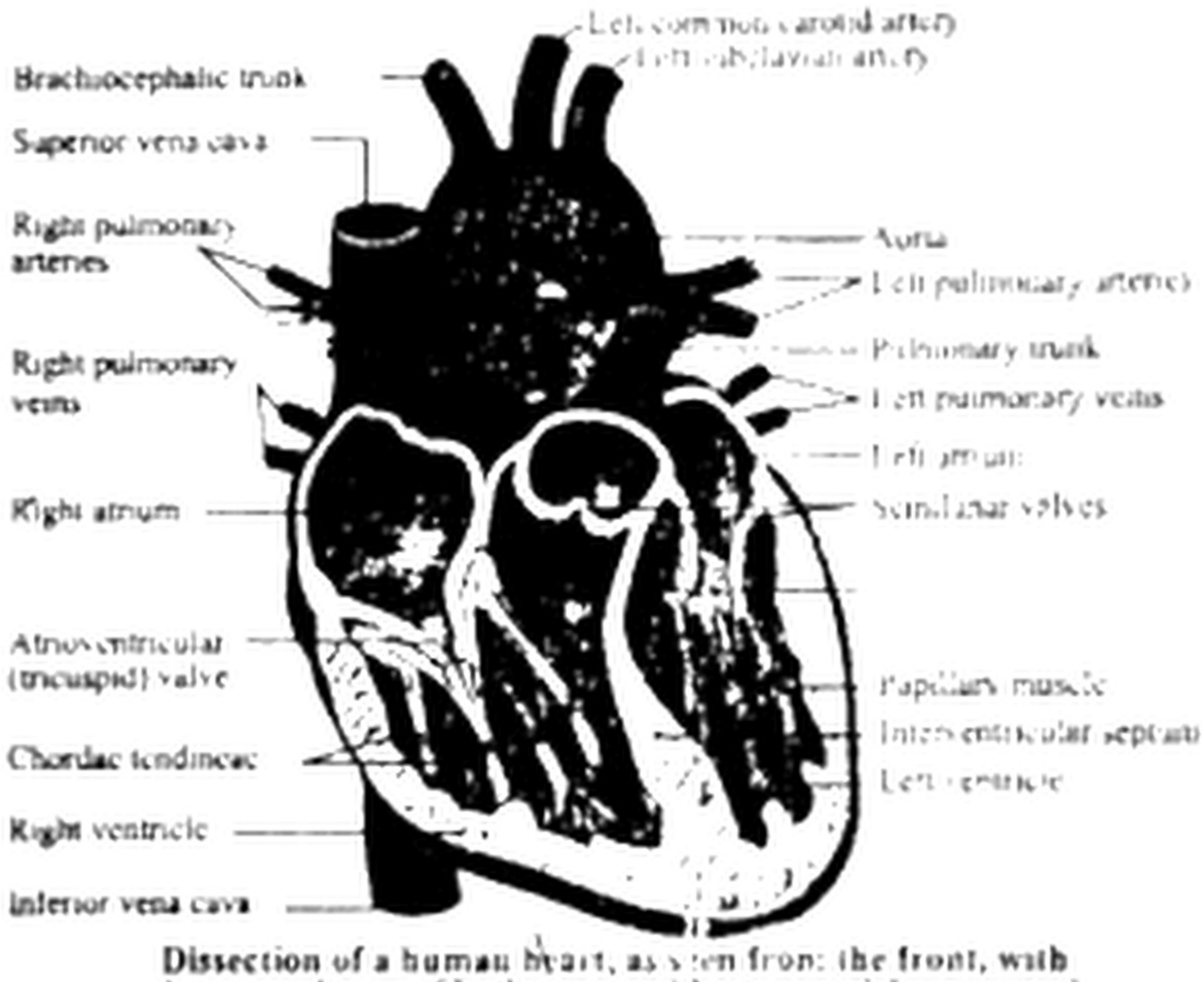
30. Describe the structure of the walls of the human heart and rationalize the thickness of the walls of each chamber.

Ans: Valves of Heart:

The **heart valves** are formed by a fold of the endocardium, making a double layer of endocardium with connective tissue in between:

Comparison of heart valves:

The thickness of the walls of each chamber is different. The right ventricle has thinner walls than the left ventricle in a ratio of 1.3, it pumps blood to the lungs, which are at a short distance from the heart. The atria have comparatively thin walls as they only have to force blood into the ventricles and this does not require much power. On the other hand, the ventricles have to force blood out of the heart hence they have relatively thick walls, especially the left ventricle which has to pump blood around the whole body.



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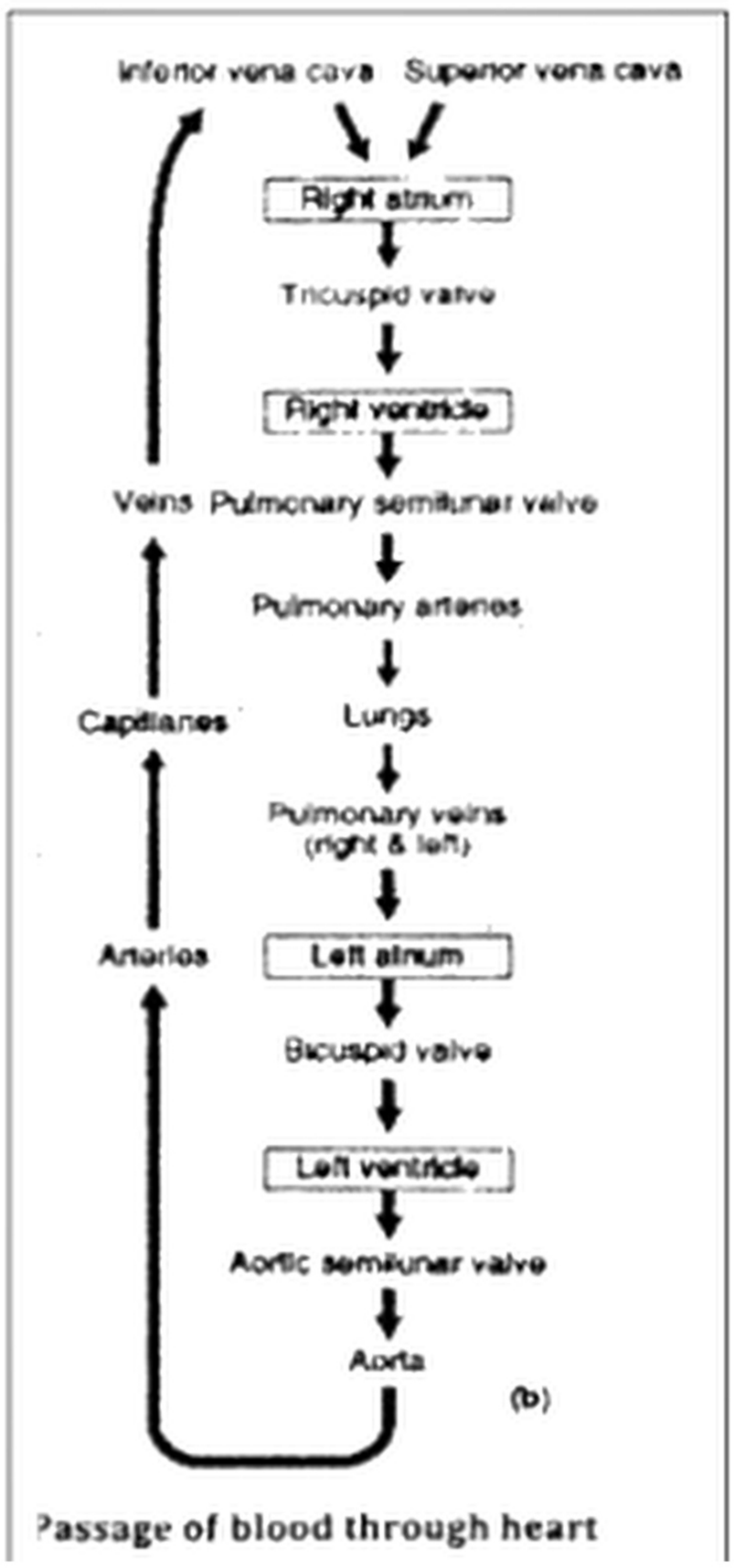
31. Describe the flow of blood through human heart as regulated by the valves.

Ans: Passage of Blood through Heart:

The superior vena cava and the **inferior vena cava**, both carrying deoxygen blood, enter the right atrium. **The right atrium** sends blood though the tricuspid valve to the right ventricle. The right ventricle sends blood through the **pulmonary semilunar valve** into the **pulmonary truck** and the two **pulmonary arteries** to the lungs. Four **pulmonary veins,** carrying oxygenated blood from the lungs, enter the left ventricle. The **left atrium** sends blood through the **bicuspid valve** to the **left ventricle.** The ventricle sends blood through the



Passage of blood through heart

aortic semilunar valve into the **aorta** to the body proper. The heart is a **double pump** because the right ventricle of the heart sends blood to the lungs, and the left ventricle sends blood throughout the body.

32. State the phase heartbeat in man.

Ans: Phase of heartbeat:

Atrial systole:

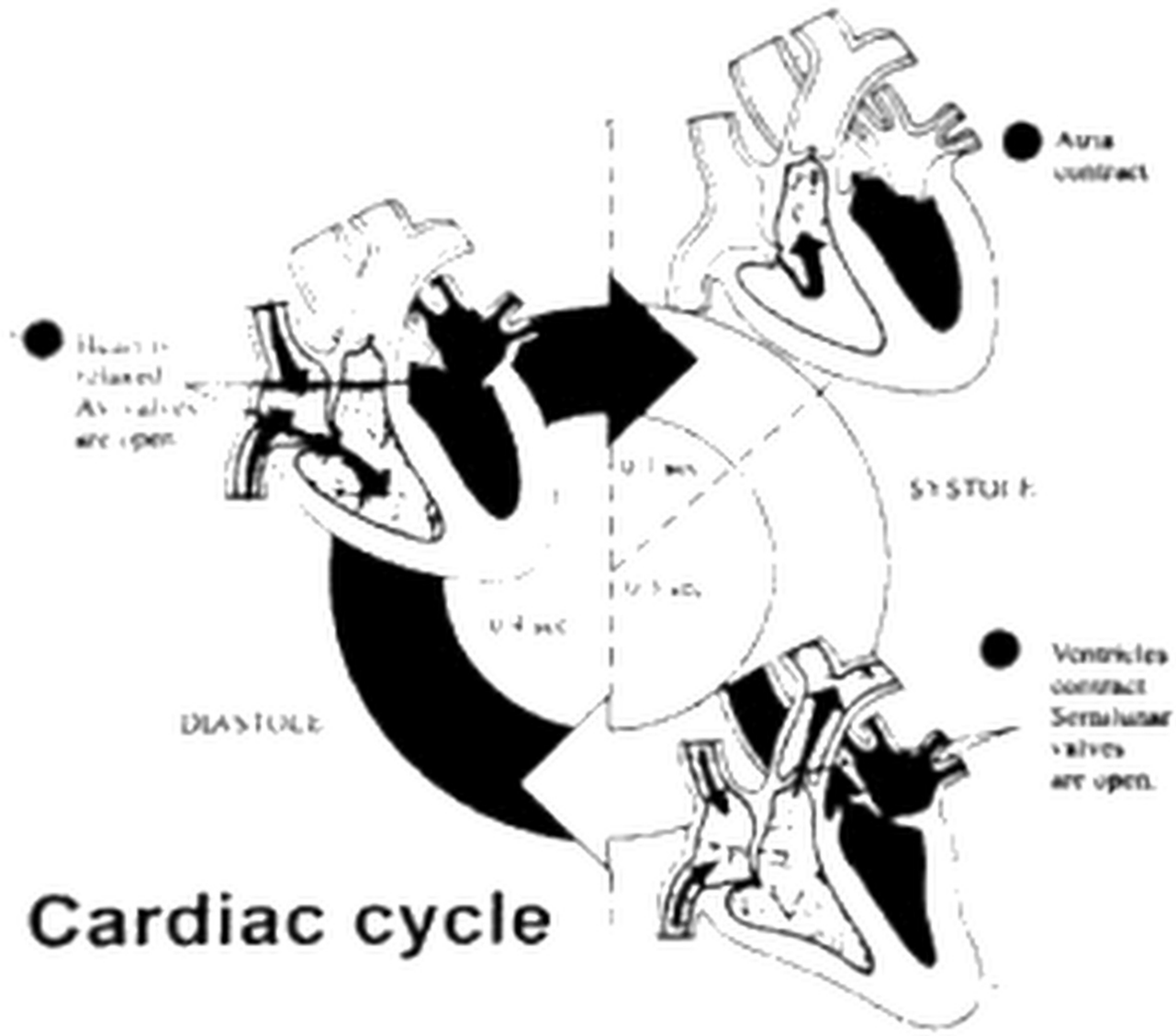
The term systole means to contract and diastole means to dilate. **Atrial systole** is contraction of the atrial myocardium. In **atrial systole** the two atria contract simultaneously and blood is pushed through the atrio-ventricular **valve** into the still relaxed ventricles. At this phase semilunar valve is closed, tricuspid and bicuspid valves are open.

Atrial diastole:

Atrial diastole is relaxation of the atrial myocardium. In **atrial diastole** blood enters the right atrium from the body through the vena cava. At first the bicuspid and tricuspid valves are closed, but as the atria fill with blood, pressure in them rises. Eventually it becomes greater than that in the relaxed ventricles and the valves are pushed opens.

Ventricular systole:

Ventricular systole is contraction of the ventricular myocardium. In **atrial systole** the two atria contract simultaneously and blood is pushed through the atrio-ventricular valve into the still relaxed ventricles. At this phase semilunar valve is closed, tricuspid and bicuspid valves are open.



Cardiac cycle

Ventricular diastole:

Ventricular diastole is the relaxation of the ventricular myocardium. When the word "systole" and "diastole" are used without reference to specific chambers, they mean ventricular systole or diastole. In **ventricular diastole** the high pressure developed in the aorta and pulmonary artery tends to force some blood back towards the **ventricles** and close the **semilunar valves** of the aorta and pulmonary artery.

Hence, back flow in the heart is prevented. In this phase **bicuspid valve** and **tricuspid valve** are open, **aortic semilunar valve**, and **pulmonary semilunar valve** are closed. The normal cardiac cycle is of 0.7 to 0.8 second depending on the capability of cardiac muscle to contract. The heart muscle rests 0.1 to 0.3 second between the beats.

33. Describe the conducting system of human heart.

Ans: Conducting system of the heart:

The heart will go on beating after it has been cut right out of the body Cardiac muscles are **myogenic** *(myo:* muscle, *genie,* giving rise to), i.e. its rhythmic contraction arises from within the muscle itself.

Cardiac muscle has an **intrinsic rhythmicity** that allows the heartbeat to originate in and be conducted through the heart without extrinsic stimulation. Specialized strands of interconnecting cardiac muscle tissue that coordinate cardiac contraction constitute the **conduction system.** The conduction system constitutes the cardiac cycle. The components of the conduction system are:

(a) Sinoatrial node **(b)** Atrioventricular node

(c) Atrioventricular bundle **(d)** Conducting myofibrils

Sinoatrial node:

Sinoatrial node in short is called **SA node**. It consists of specialized plexus of cardiac muscles embedded in the upper wall of the right atrium. It is close to where vena cava enter the atrium. The SA node has been developed from the sinus venosus and has become a part of the atrium, so it is called sinoatrial node.

Atrioventricular node:

There is another specialized group of cardiac muscle fibres called **atrioventricular node.** In short it is called **AV node.** It is present near the junction of right atrium and right ventricle.

Atrioventricular bundle:

AV node is connected to a strand of specialized muscles (in the ventricular septum) known as **atrioventricular bundle** or **bundle of** His (pronounced as "hiss").

Events of Conducting system:

(i) **Bundle of** His passes through a small opening in the fibrous skeleton to reach the **interventricular septum,** where it divides to form right and left bundle branches, which extend beneath the **endocardium** on either side of the interventricular septum to the apices of the **right and left ventricles** respectively.

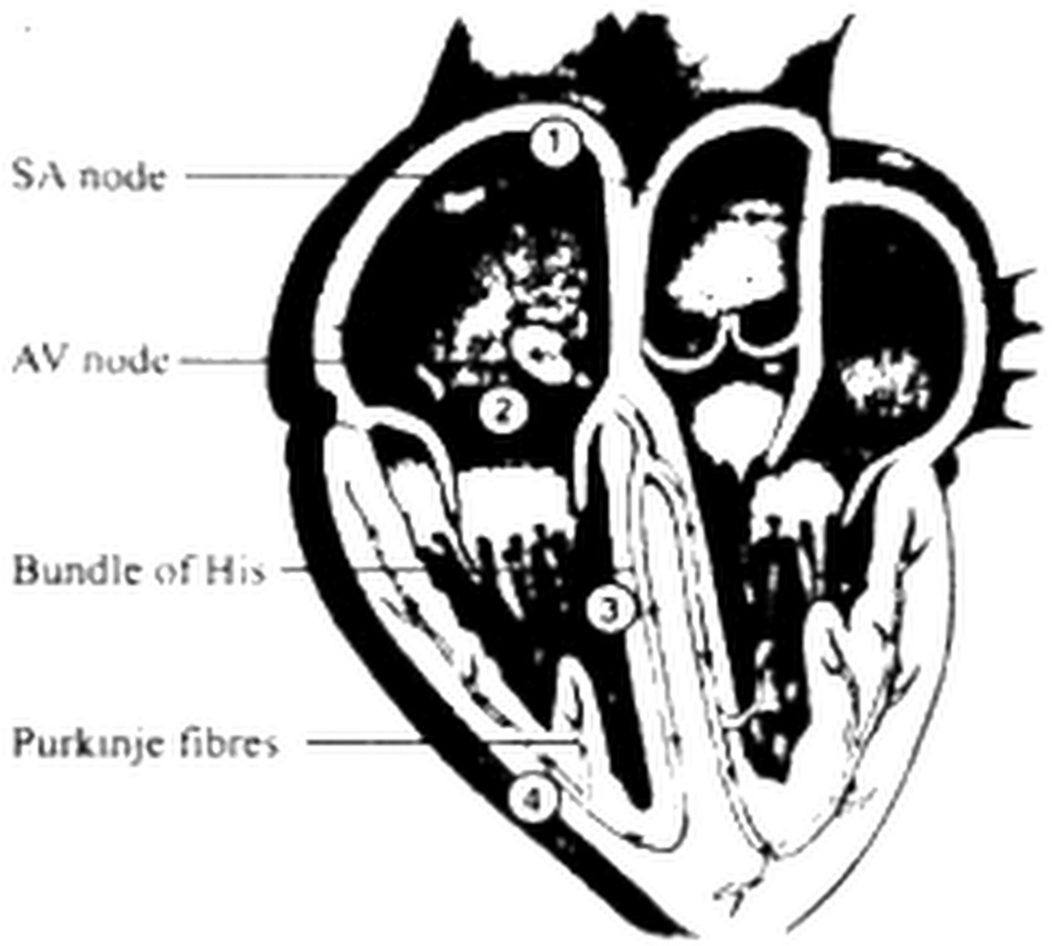
(ii) The inferior, terminal branches of the bundle branches are called **Purkinje fibres,** which are large-diameter cardiac muscle fibres. They have fewer myofibrils than most cardiac muscle cells and **do not contract forcefully.**

(iii) **Intercalated disks** are well developed between the Purkinje fibres and contain numerous gap junctions.

(iv) As a result of these structural modifications, **action potentials** travel along the **Purkinje fibres** much more rapidly than through other cardiac muscle tissue. Cardiac muscle cells have the capacity to generate spontaneous action potentials, but cells of SA node do so at a **greater frequency.**

(v) As a result, the SA node is called the **pacemaker** of the heart. When the heart beats under resting conditions, approximately **0.4 second** is required for action potentials to travel **from the SA node to the AV node.** Within the AV node action potentials are propagated slowly compared with the remainder of the conducting system.

(vi) As a consequence, there is a delay of **0.11 second** from the time action potentials reach the AV node until they pass to the AV bundle. The total delay of **0.15 second allows** completion of the atrial contraction before ventricular contraction begins.



Conducting System of the Heart

1. Action potentials originate in the sinoatrial (SA) node and travel across the wall of the atrium (arrows) from the SA node to the atrioventricular (AV) node.

2. Action potential pass through the AV node and along the atrioventricular (AV) bundle, which extends from the AV node through the fibrous skeleton into the interventricular septum.

3. The AV bundle divides into right and left bundle branches, and action potentials descend to the apex of each ventricle along the bundle branches.

4. Action potentials are carried by the Punkinje fibres from the bundle branches to the ventricular walls.

34. Explain the role of SA node, AV node and Punkinje fibres in controlling heartbeat.

Ans: Role of SA node, AV node and Punkinje fibres in controlling heartbeat:

The conduction system constitutes the cardiac cycle. The components of the conduction system are the:

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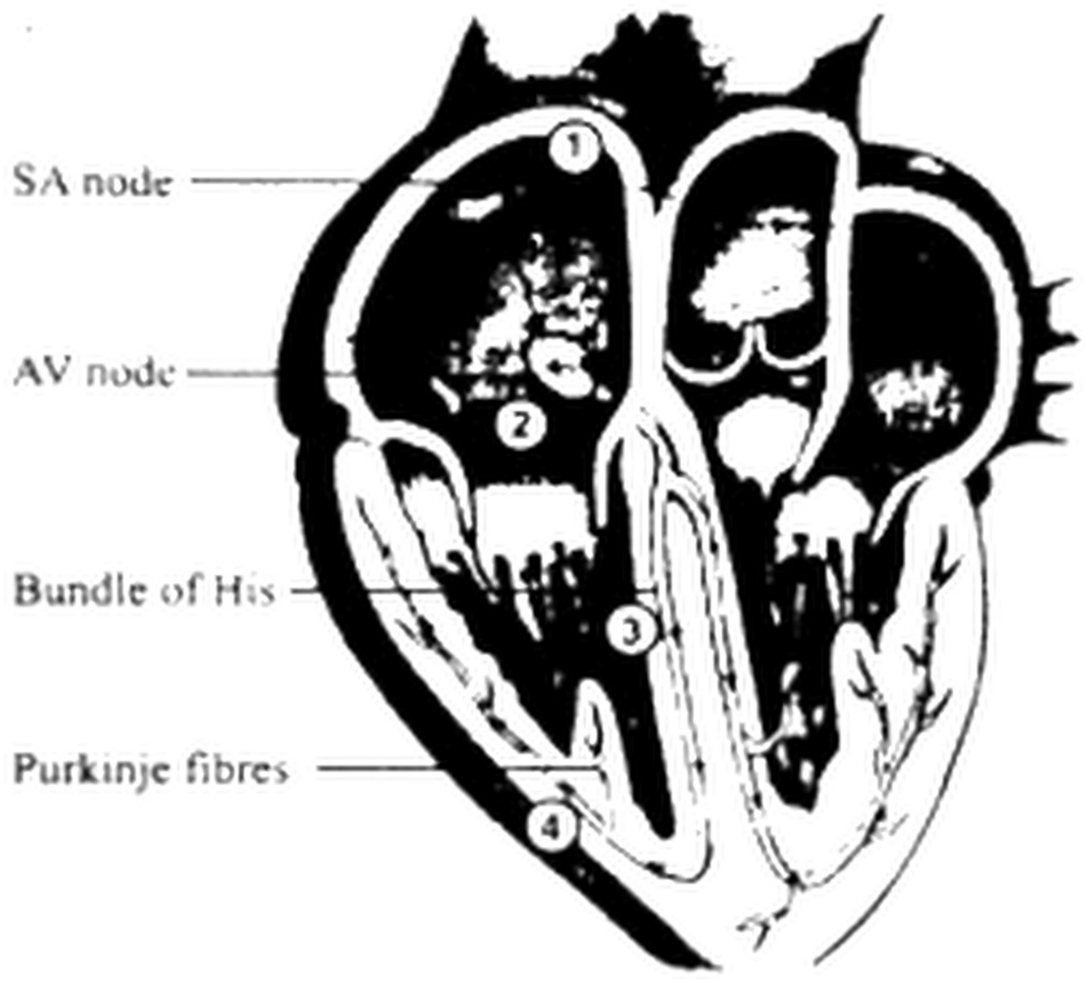

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3. The AV bundle divides into right and left bundle branches, and action potentials descend to the apex of each ventricle along the bundle branches.

4. Action potentials are carried by the Punkinje fibres from the bundle branches to the ventricular walls.

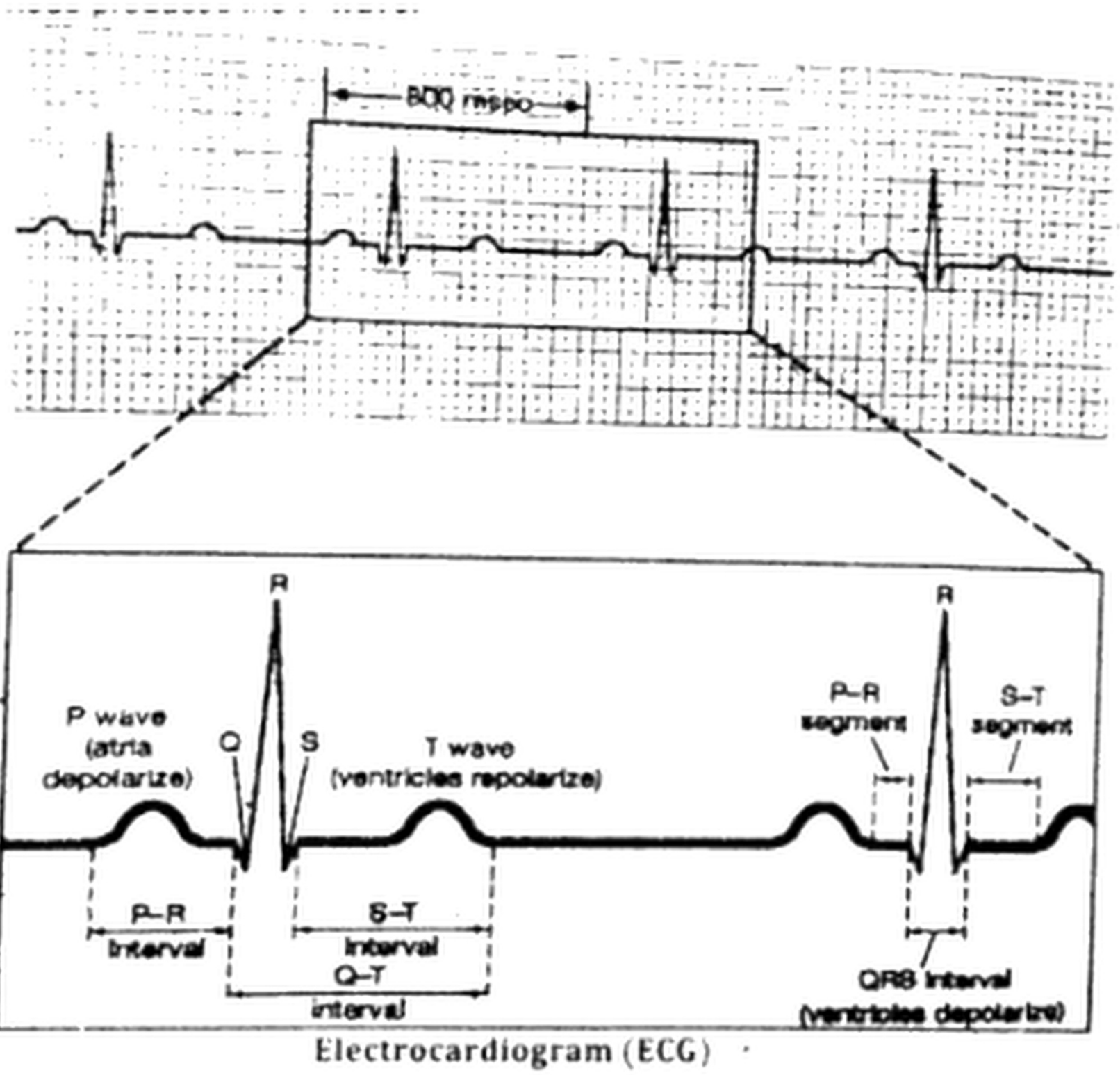
35. Explain electrocardiogram with the help of diagram.

Ans: Electrocardiogram:

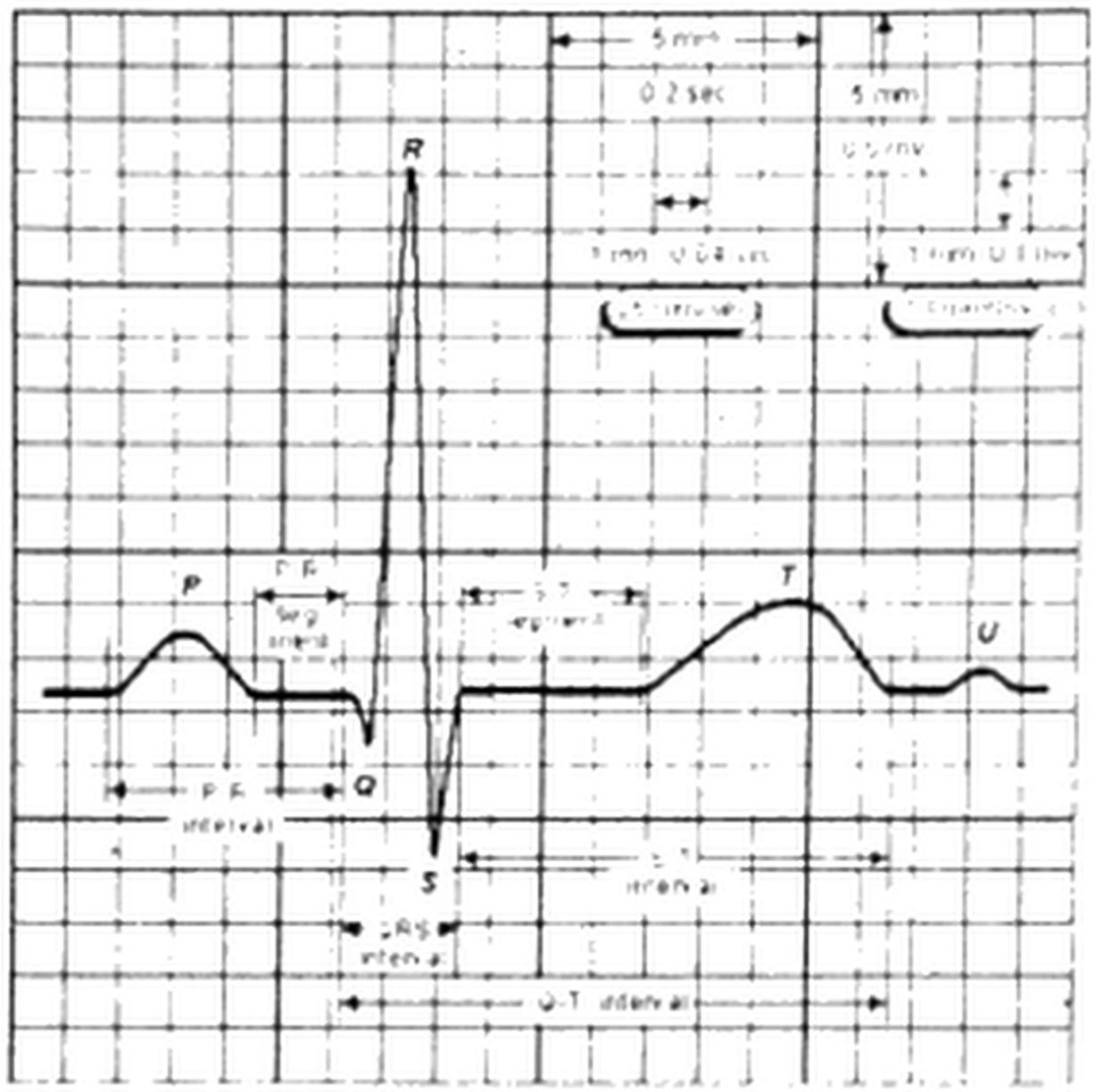
(i) The electrical impulses that pass through the conduction system of the heart during the cardiac cycle can be recorded as an electrocardiogram (ECG).

(ii) The electrical changes result from depolarization and repolarization of cardiac muscle fibres and can be detected on the surface of the skin using an instrument called the electrocardiograph.

(iii) The wave deflections, designated P, QRS, and T, are produced as specific events of the cardiac cycle occur. Depolarization of the atrial fibres of the SA node produces the P wave.



Electrocardiogram (ECG)



(iv) The ventricles of the heart are in diastole during the expression of the P wave. On the ECG recording, the P-R interval is the period of time from the start of the P wave to the beginning of the QRS complex.

(v) This interval indicates the amount of time required for the SA depolarization to reach the ventricles.

(vi) The QRS complex begins as a short downward deflection (Q), continues as a sharp upward spike (R), and ends as a downward deflection (S).

(vii) The QRS complex indicates the depolarization of the ventricles. During this interval, the ventricles are in systole and blood is being ejected from the heart.

(viii) The time duration known as the S-T segment represents the period between the completion of ventricular depolarization and initiation of repolarization. The T wave is produced by ventricular repolarization.

Uses of electrocardiogram:

(i) ECG is used to detect cardiac arrhythmias (irregular heartbeat) and conduction defects. It is used to diagnose and localize myocardial hypertrophy (increase in size of heart) ischemia (a deficiency of blood in a body part) or infarction (decrease in oxygen content). It may also give information about electrolyte imbalance and toxicity of certain drugs.

(ii) A normal ECG indicates that the heart is functioning properly. The P wave represents excitation and occurs just prior to contraction of the atria. The second wave, or the QRS complex, occurs just prior to ventricles relax contraction. The third, or T, wave occurs just before the ventricles relax.

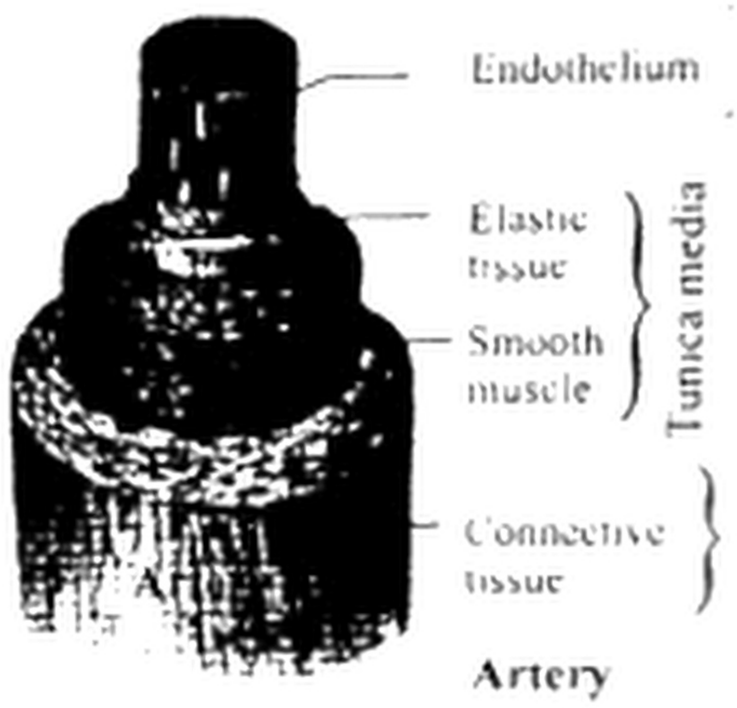
36. Describe the structure of blood vessels in man.

Ans: Blood Vessels:

There are three types of blood vessels, the **arteries** (and arterioles), which carry blood away from the heart, the veins, which return blood to the heart, and **capillaries**, which permit exchange of materials with the tissues.

Arteries:

Arteries carry blood away from the heart. Arteries are pink in colour and are situated within the muscles. Arteries vary in size. Arteries branch into **arterioles and capillaries.** The lumens of arteries have no valves. The wall of an artery consists of three coats or tunics, tunica adventitia,



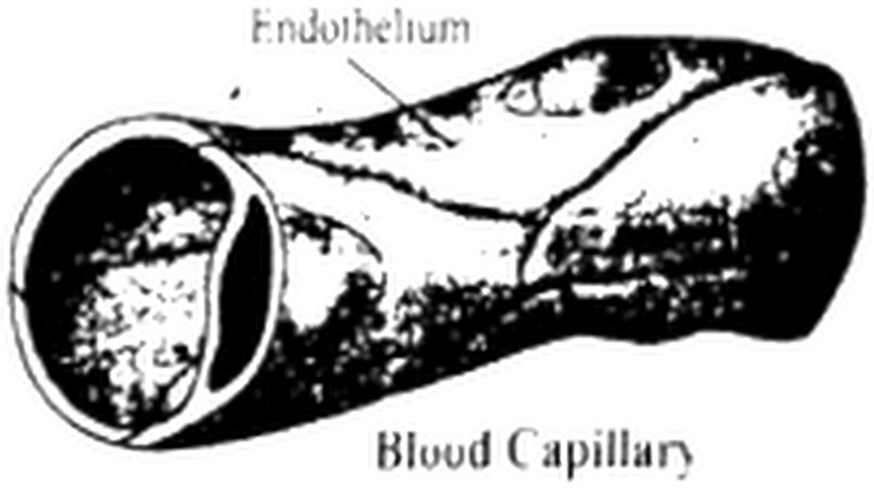
tunica media and tunica intima.

The outermost layer is called **tunica** adventitia. It is composed of while fibrous connective tissue. The middle layer is called **tunica media**, and has variable amount of elastic fibres. It is many layered in thickness. It consists of one or two layers of circular smooth muscle cells. The innermost layer of the artery is called **tunica intima.**

It is composed of simple squamous epithelium and elastic fibres composed of elastin. Arterioles transport blood from small arteries to capillaries. Aorta is approximately 23 mm and arterioles are about 0 2 mm in diameter.

Capillaries:

The capillary wall consists primarily of endothelial cells. Most capillaries range from 7 to 9 um in diameter, and thus branch without a change in their diameter. Capillaries are approximately 1 mm long. Red blood cells flow through most of capillaries in a single file.

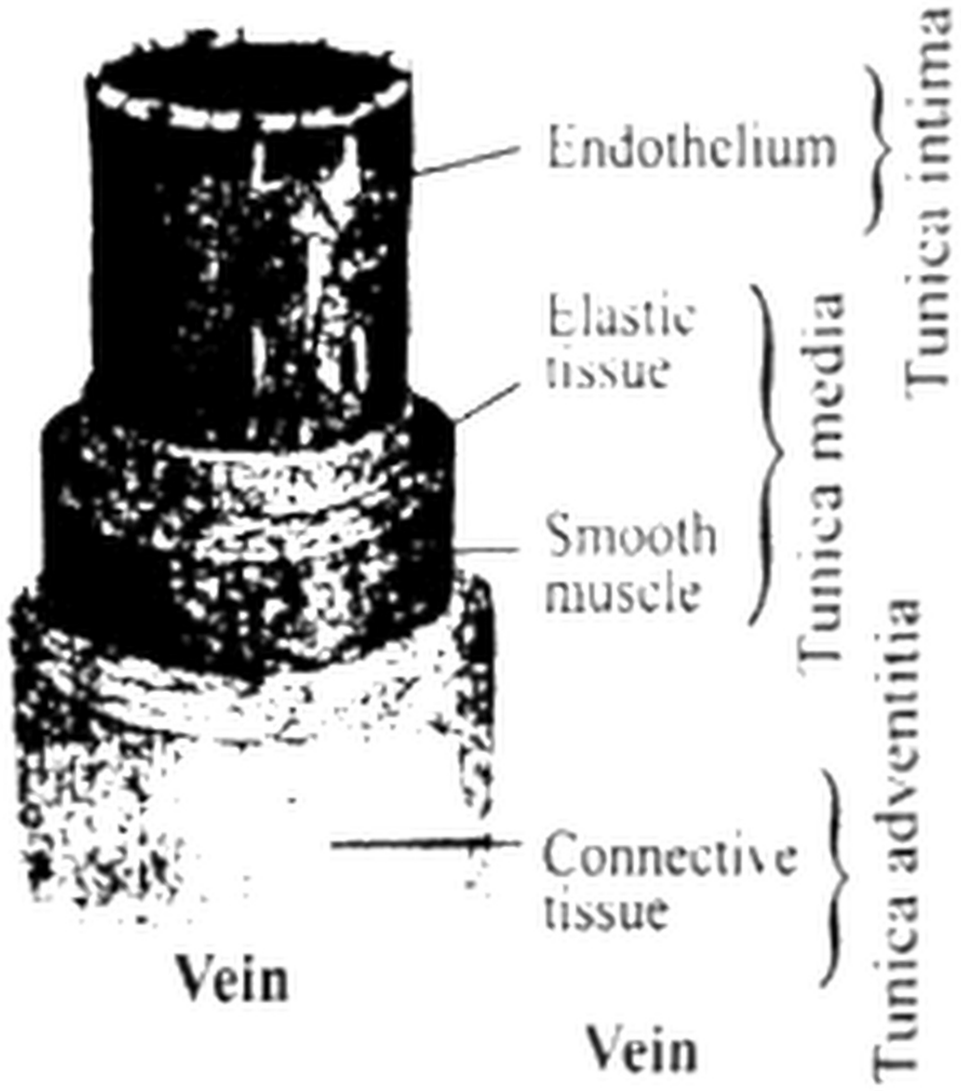


Blood Capillary

Veins:

The blood vessels that bring blood back to the heart are called veins. Veins are relatively not deep in the muscles. Veins can be seen as blue vessels under the skin. A vein also consists of tunica adventitia, tunica media and tunica intima. **Tunica adventia** is composed of collagenous connective tissue. **Tunica media** is composed of a thin layer of circularly arranged smooth muscle cells, collagen fibres and a few sparsely distributed elastic fibres. **Tunica** intima is a smooth muscle and consists of endothelial cells, thin layer of elastic fibres.

Venules with a diameter of 40 ro 50 pm are tubes composed of endothelium. The venules collect blood from the capillaries and transport it to the small veins.



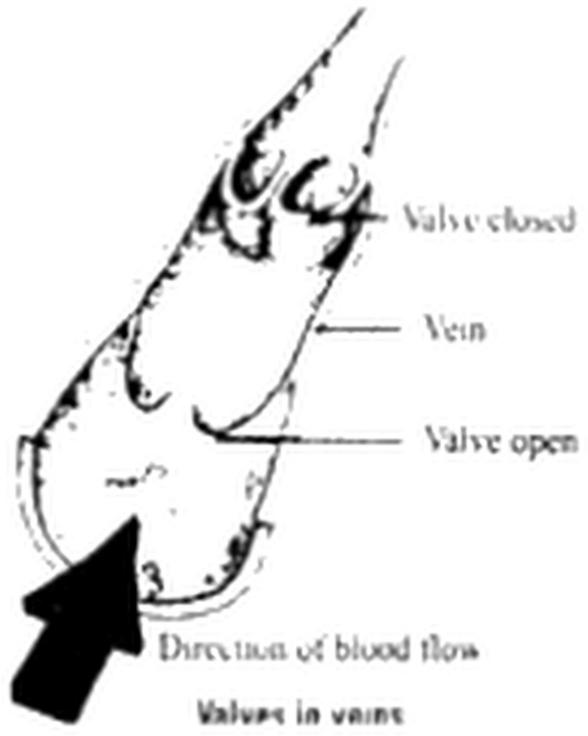
37. What is the role of arterioles in vasodilatation and vasoconstriction?

Ans: Role of arterioles in vasodilatation and vasoconstriction:

The amount of blood flowing through a blood vessel can be regulated by contraction or relaxation of smooth muscle in the tunica media.

Vasoconstriction:

A decrease in blood flow results from vasoconstriction, a decrease in blood vessels diameter caused by smooth muscle contraction. Blood circulation is also controlled by hormones (vasoconstriction agents) acting on arterioles. Norepinephrine is an especially powerful vasoconstriction hormone, and epinephrine is less.



Vasodilation:

An increase in blood flow is produced by vasodilation (vasodilatation) an increase in blood vessel diameter because of smooth muscle relaxation.

Several substances called **kinins** (vasodilator agents) can cause powerful vasodilation are formed in the blood and tissue fluids of some organs, e.g. histamine. Most of the prostaglandins are vasodilator agents.

Note: Though some of the prostaglandins are vasoconstrictor.

38. What is the role of precapillary sphincter?

Ans: Precapillary sphincter:

Blood Flow in the capillaries is regulated by smooth muscle cells called **precapillary sphincter**, which are located at the origin of the branches.

Arterioles:

Arterioles supply blood to each capillary network, blood then flows

through the capillary network and into the venules.

Metarterioles:

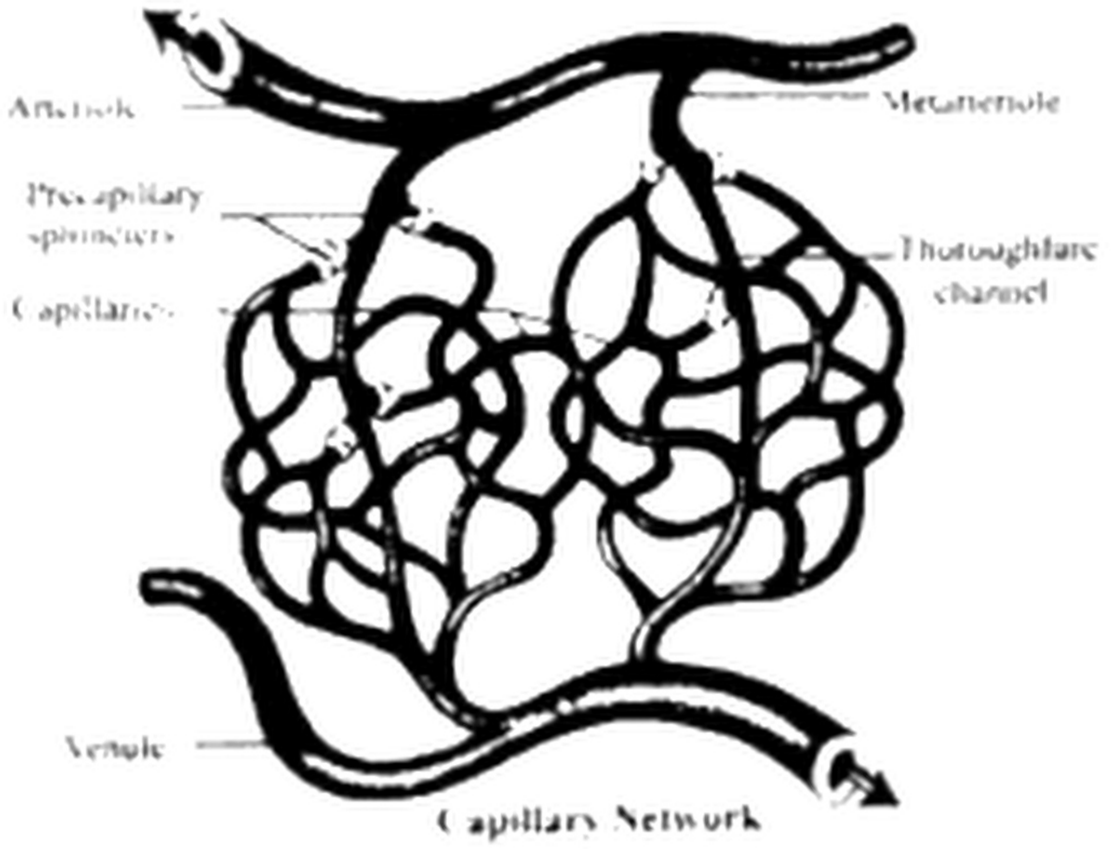
The branch that originates from arterioles is called **metarterioles** that open into **thoroughfare channel.** Blood flows from arterioles through metarterioles.

Thoroughfare channel:

From a metarteriole blood flows into a **thoroughfare channel.** Several capillaries branch from the thoroughfare channels. **Precapillary sphincter** can open and close the entrance to the capillary.

Role of precapillary sphincter:

Precapillary sphincters are normally either completely open or completely closed, and the degree of constriction of the metarteriole also varies. The precapillary sphincters and metarterioles often open and close cyclically several times per minute, with the duration of the open phases being about proportional to the metabolic needs of the tissue. The cyclic opening and closing is called vasomotion.



39. Describe pulmonary circulation and systemic circulation.

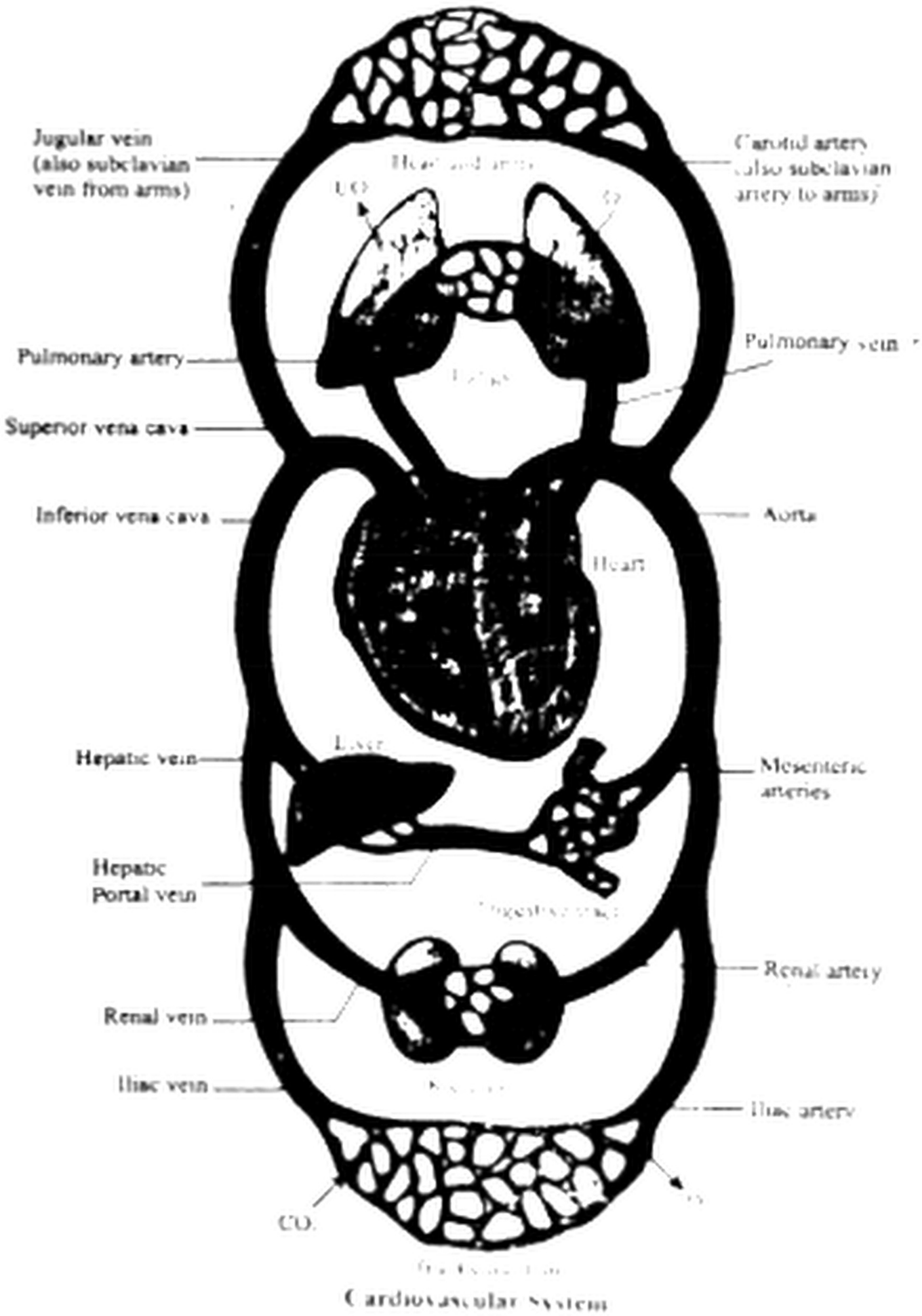
Ans: Vascular Pathway:

Cardiovascular system includes two circuits, the **pulmonary circuit, which circulates blood through lungs,** and **systemic circuit, which** circulates blood to all other parts of the body. **Pulmonary circulation:**

The left atrium receives oxygenated blood from the lungs through a pair of **pulmonary veins,** which open by common aperture into it. From left atrium the blood flows into the left ventricle. The superior and inferior vena cavae bring deoxygenated blood and open into the right atrium. From right atrium blood flows into the lungs for oxygenation by a **pulmonary arch** or **trunk, which** divides into two **pulmonary arteries,** each going to the lung of its own side. This part of circulation is called **pulmonary circulation** or **circuit**. The pulmonary arteries carry deoxygenated blood and pulmonary veins carry oxygenated blood.

Systemic circulation:

The systemic circuit includes all the **arteries** and **veins** other than involved in pulmonary circuit.



Cardiovascular System

The largest artery in the systemic circuit is the **aorta.** The largest veins are the **superior** and **inferior venae cavae.** The path of systemic blood to any organ in the body beings in the **left ventricle**, which pumps blood in the aorta.

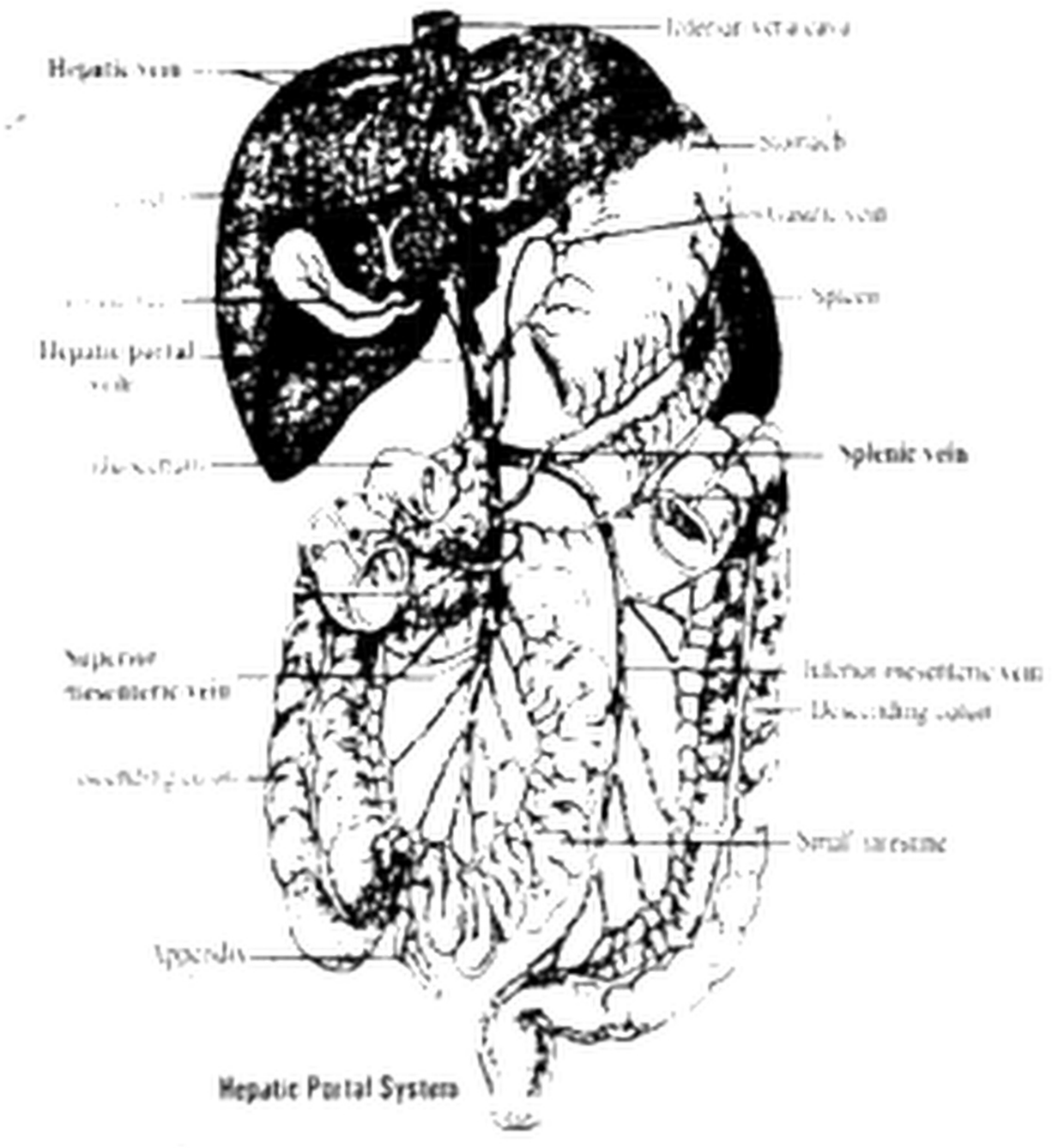
Branches from **aorta** go to the organs and major body regions. The **superior vena cava** collects blood from the head the chest and the arms. The **inferior vena cave** collects blood from the lower body regions. Both enter the right

atrium. The aorta and the venae cavae are the major pathways in the systemic circuit. In most instances, the artery and the vein that serve the same organ are given the same name.

40. Describe hepatic portal system.

Ans: Hepatic portal system:

A portal (meaning door) system is vascular system that begins and ends with capillary beds and has no pumping mechanism such as the heart. The **portal system** that begins with capillaries in the viscera and ends with the sinusoidal capillaries in the liver is the hepatic (meaning relating to the liver) portal system.



Hepatic portal vein:

(i) The hepatic portal vein, the largest vein of the system, is formed by the union of the superior mesenteric vein, which drains the small intestine and the splenic vein, which drains the spleen.

(ii) The splenic vein receives the inferior mesenteric and pancreatic veins, which drain the large intestine and pancreas respectively.

(iii) The hepatic portal vein also receives gastric veins before entering the liver. Within the liver the blood flows through a series of dilated capillaries, called sinusoids.

(iv) Blood from the liver sinusoids is collected into central veins, which empty into hepatic veins.

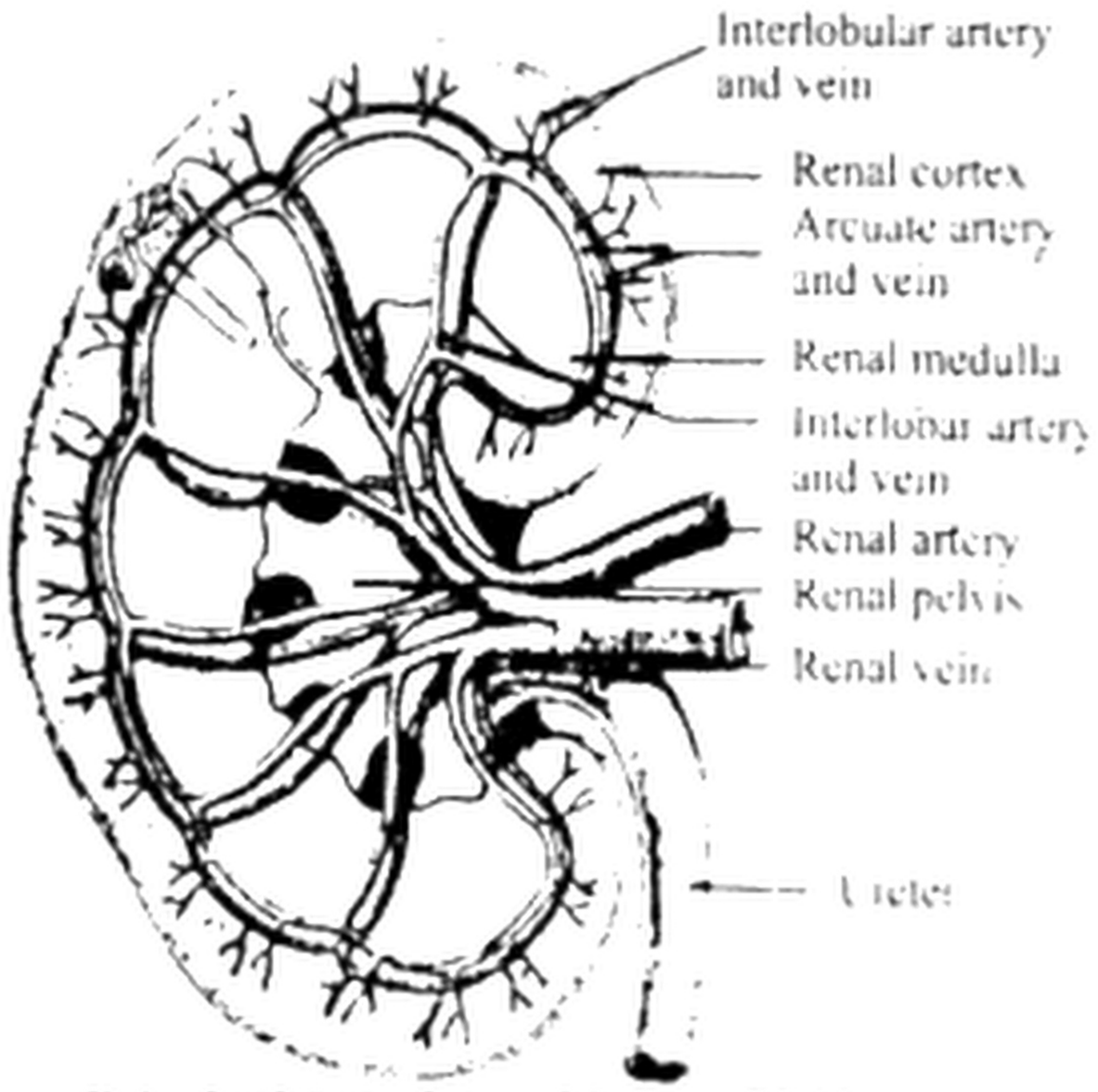
(v) Blood from the gallbladder is collected by the cystic veins also enters the hepatic veins

(vi) The hepatic vines join the inferior vena cava.

41. Describe renal circulation.

Ans: Renal circulation:

Arterial blood enters the kidney at the hilum through **renal artery**, which divides into **interlobar arteries** that pass between the renal pyramids through renal column **Arcuate arteries** branch from the interlobar arteries at the boundary of renal cortex and renal medulla. Small **interlobular arteries** radiate from the arcuate arteries and project into the renal cortex. Microscopic **afferent glomerular arterioles** arise from the branches of the interlobular arteries. From here, blood enters the peritubular either **capillaries** or **vasa recta.** From these capillary networks, the blood is drained into interlobular veins, arcuate veins and interlobar vein. The interlobar veins descend between the renal pyramids converge, and leave the kidney as a single renal vein that empties into the inferior vena cave.



Principal Arteries and Veins of Kidney.

42. Give an account of blood pressure in man.

Ans: Blood Pressure:

Blood pressure is the force exerted by the blood against any unit area on the inner walls of the blood vessels.

Standard reference: The standard reference for the blood pressure is the mercury (Hg) manometer, which measures pressure in millimeters of mercury (mm Hg). If the blood pressure is **100 mm Hg** the pressure is great enough to lift a column of mercury 100 mm.

Systolic pressure and Diastolic pressure:

When the ventricles of the heart contract the arterial, blood pressure is the highest. It is called **systolic pressure.** When the ventricles of the heart relax, the arterial blood pressure is the lowest. It is **called diastolic pressure.**

Baroreceptors:

Baroreceptors can be divided into two categories based on the type of blood vessel in which they are located: high-pressure arterial baroreceptor and low-pressure baroreceptors or volume receptors.

High-pressure arterial baroreceptors:

These are mechanoreceptors located in the walls of the aorta and carotid sinus in the carotid **artenes.** They sense the blood pressure and relay the information to the brain, so that a proper blood pressure cans be maintained.

(i) Vasodilatation:

Stimulation of parasympathetic nerves in these areas caused cardiac output, produces vasodilatation throughout the body and consequent reduction in blood pressure as well as a slowing the heart rate.

(ii) Vasoconstriction:

The opposite occurs when blood pressure is low. In this case, a fall in blood pressure increases nerve impulse transmission along **sympathetic nerves.** This causes body-wide vasoconstriction and a rise in blood pressure. Baroreceptors act immediately as part of a negative feedback system called the **baroreflex.**

Volume receptors:

Low-pressure baroreceptors or volume receptors are found in the atria of the heart and carotid arteries. When these receptors detect a blood, volume decrease in the atria, a signal is transmitted from the receptors to the hypothalamus in the brain. The hypothalamus, in turn, increases the production of vasopressin. These receptors also produce renal vasodilation, resulting in increase of the water amount in the glomerular filtrate, which, combined, with the increased production of vasopressin by the hypothalamus, will cause water retention in urine. This increases the blood volume, resulting in the increase of blood pressure.

Comparison of the rate of blood flow through arteries, arterioles, capillaries, venules and veins:

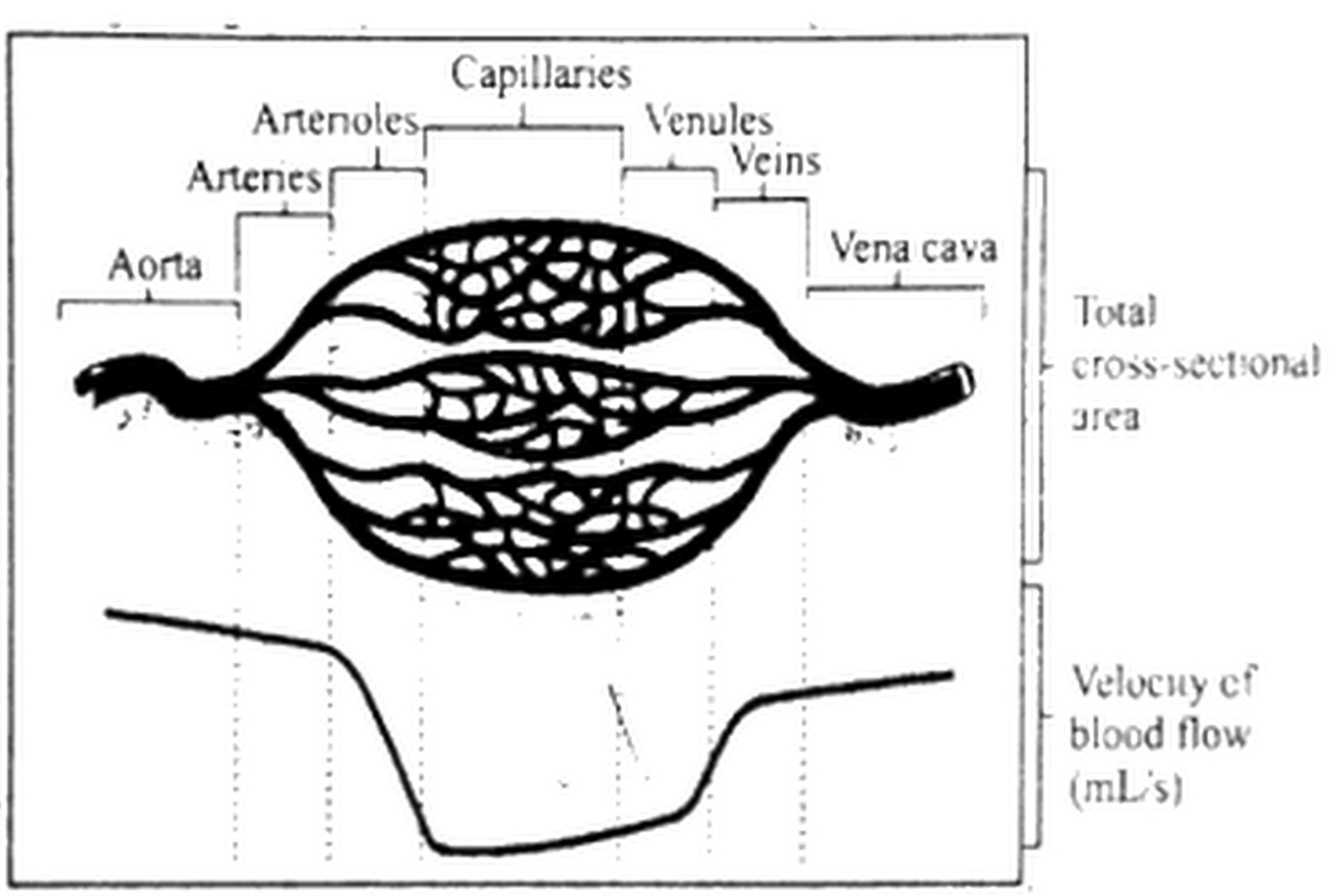
(i) Blood travels over a thousand times faster in the aorta, i.e. about 30cm/sec on average than in capillaries i.e. about **0.26 cm/sec.**

(ii) It is the total cross-sectional area of capillaries that determines flow rate.

(iii) Each artery conveys blood to such an enormous number of capillaries that the total cross-sectional area is much greater in capillary beds than in any other part of the circulatory **system.** For this reason, the blood slows substantially as it enters the arterioles from arteries and slow further still in the capillary beds.

(iv) As blood leaves the capillaries, enters the venules, and veins it speeds up again as a result of the reduction in total cross-sectional area.

(v) The carotid sinus and aortic arch baroreceptor reflexes are important in regulating blood pressure moment to moment.



Explanation of diagram:

Blood vessel types and velocity of blood flow: Total cross-sectional area for each of the major blood vessel types is the space through which blood flows, measured in square centimeters. The cross-sectional area of the aorta is about 2.5 crri2. The cross sectional area of each capillary is much smaller but there are so many that the total cross-sectional area is more than that of the aorta. The line at the bottom of the graph shows that blood velocity drops dramatically in arterioles, capillaries, and venules. As the total cross-sectional area increases the velocity of blood flow decreases.

43. Compare the rate of blood flow through arteries, arterioles, capillaries, venules & veins.

Ans: Comparison of the rate of blood flow through arteries, arterioles, capillaries, venules and veins:

(i) Blood travels over a thousand times faster in the aorta, i.e. about 30cm/sec on average than in capillaries i.e. about **0.26 cm/sec.**

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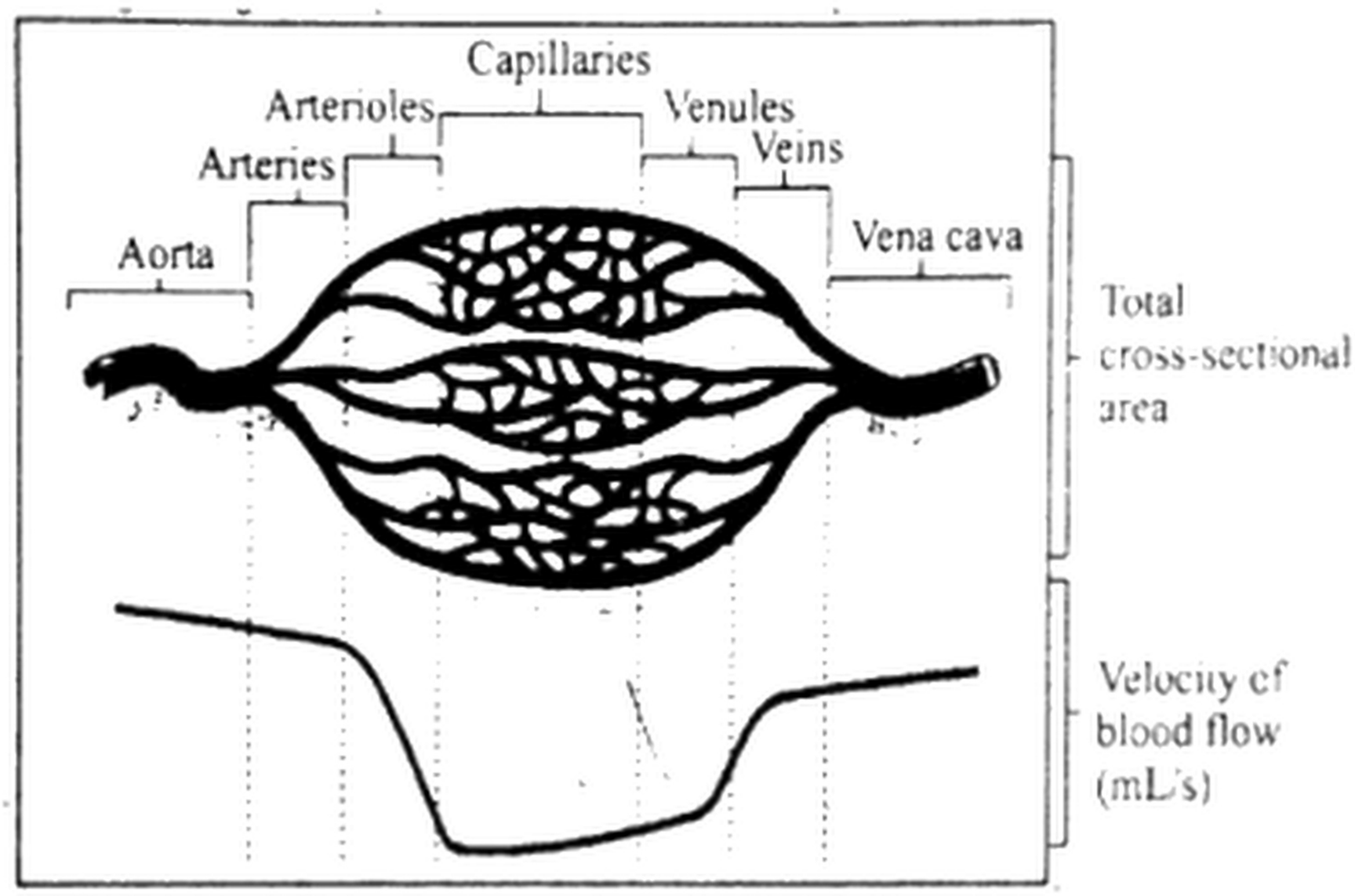

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44. Describe the following:

(a) Thrombosis **(b) Atherosclerosis**
(c) Angina pectoris **(d) Heart attack**
(e) Heart failure

Ans: (a) Thrombosis:

The formation of a clotted mass of blood within a vessel or the heart

during life in called **thrombosis.** The clotted mass of blood within a vessel or the heart during life is called **thrombus.** The occlusion (a closing of an opening) of some part of the cardiovascular system by any mass transported to the site through the blood stream is called embolism. **Embolus** is a detached intravascular solid, liquid or gaseous mass that is carried to a site distant from its point of origin. About 99% emboli arise from dislodgement of thrombi and are therefore, called **thromboembolic.** Thrombus and embolus cause death.

(b) Atherosclerosis:

Atherosclerosis is characterized by formation of yellow fatty streaks containing high proportion of cholesterol in the intima of large and medium sized arteries resulting in the narrowing of the vascular lumen. Later fibres are deposited in the cholesterol and these often start to calcify and become hard a process known as **arteriosclerosis.** The deposits are called **atheromatous plaques.**

As a plaque increases in size it protrudes into the lumen of the lumen of the artery and beings to block it. The plaque first forms thrombus and may form embolus.

Major factors that cause atherosclerosis:

The major factors that cause atherosclerosis and arteriosclerosis are:

(i) Hypercholesterolemia (hyperlipidemia)

(ii) Hypertension

(iii) Cigarette smoking

(iv) Diabetes mellitus

Minor factors that cause atherosclerosis:

Minor risk factors are:

(i) Increasing age

(ii) Lack of exercise

(iii) Stressful competitive life

(iv) Obesity

(c) Angina pectoris:

Due to atherosclerosis a person may fee, occasional chest pain, a condition known as **angina pectoris** (Latin *angere* to choke and *pecto breast).*

Angina is most likely to occur when the heart is laboring hard because of physical or emotional stress. Angina is a signal that part of the heart is not receiving a sufficient supply of oxygen and that part of the heart attack could occur in future.

(d) Heat attack:

Many heart attacks occur without warning. A blood clot may completely block a coronary artery, or atherosclerosis may reach a critical level causing massive damage to the heart muscle.

Symptoms:

All of a sudden, the person feels a heavy squeezing ache or discomfort in the center of the chest.

The pain my radiate to shoulder, arm neck or jaw. Other symptoms may include sweating nausea, shortness of breath and dizziness or fainting. The whole process is called **myocardial** (heart muscle) **infarction** (death due to lack of oxygen).

After effects:

When heart muscles die, they are not replaced because cardiac muscles do not divide. When a person survives a heart attack scar tissue (a type of connective tissue) grows into the areas where the heart muscles have died. The scar tissue cannot contract as cardiac muscle. As a result, the damaged heart is permanently weakened.

(e) Heart failure:

Congestive heart failure is a clinical syndrome resulting from deficient cardiac stroke volume, relative to body need, with inability of the cardiac output to keep pace with the venous return i.e. heart is unable to pump all the blood coming to it.

Congenital heart problem:

(i) It is related to malfunctioning of cardiac valves.

(ii) **Valvular stenosis** results from scaring of the valve leaflets, may cause reduction in diameter of the valve orifice.

(iii) Severe destruction of valve apparatus cause valve ring dilation, with thickening and shortening of chordate tendinea resulting in **regurgitation** of blood through the valve when it is closed i.e. Valve closure is incomplete.

45. Explain the following:

(a) Principle of angiography **(b) Coronary bypass**

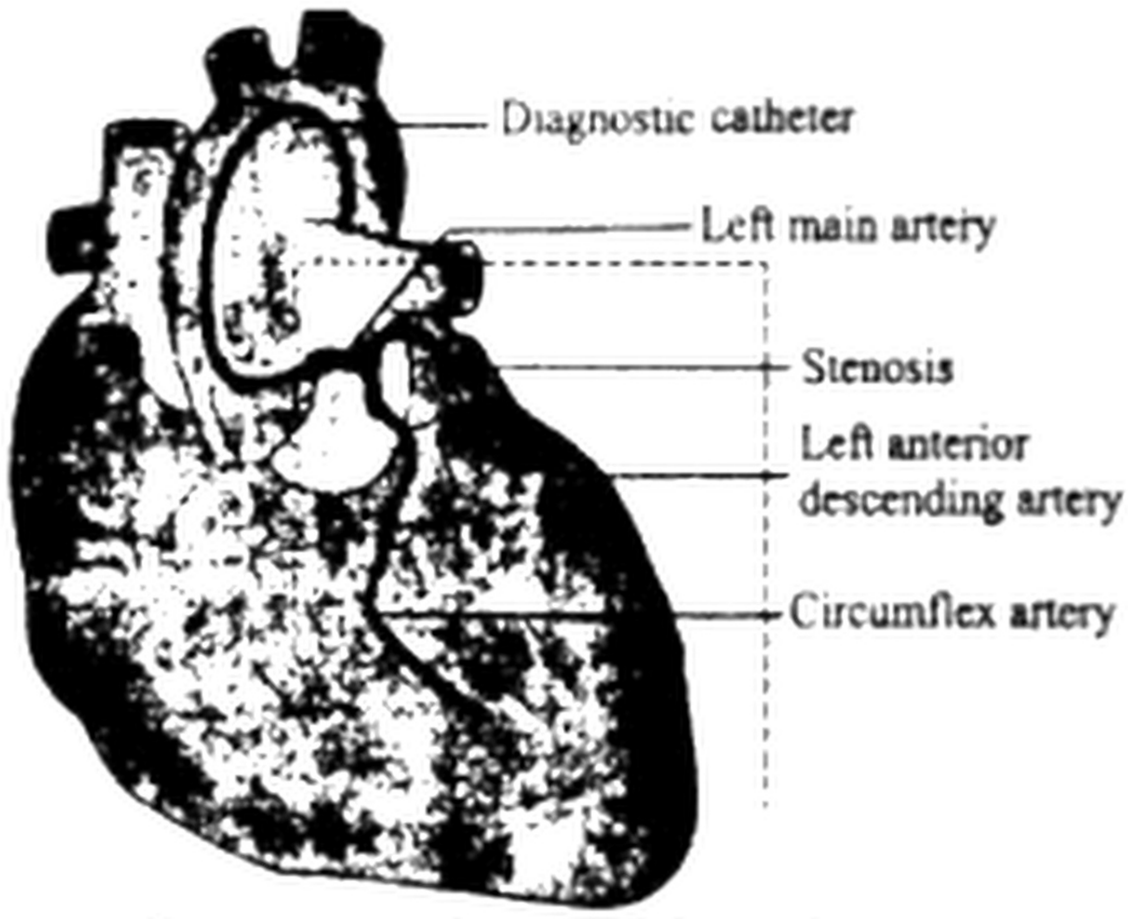
(c) Angioplasty **(d) Open heart surgery**

Ans: (a) Principle of angiography:

(i) Cardiac catheterization is a technique in which specially designed catheter is inserted into a vein or artery and advanced into the heart under **radiographic fluoroscopic guidance.**

(ii) This allows the operator to obtain **angiograms** by injecting contrast media into an area of interest. It is used to **evaluate disease** of the mitral valve, **aortic valve and aorta,** to determine the size and function of the left ventricle.

(iii) Coronary angiography is used to **detect stenosis** (constriction, narrowing of a tube or passage) and guide **revascularization** procedures such as balloon **angiography and stenting.**



Coronary Angiogram-Schematic of the Vessels and Branches

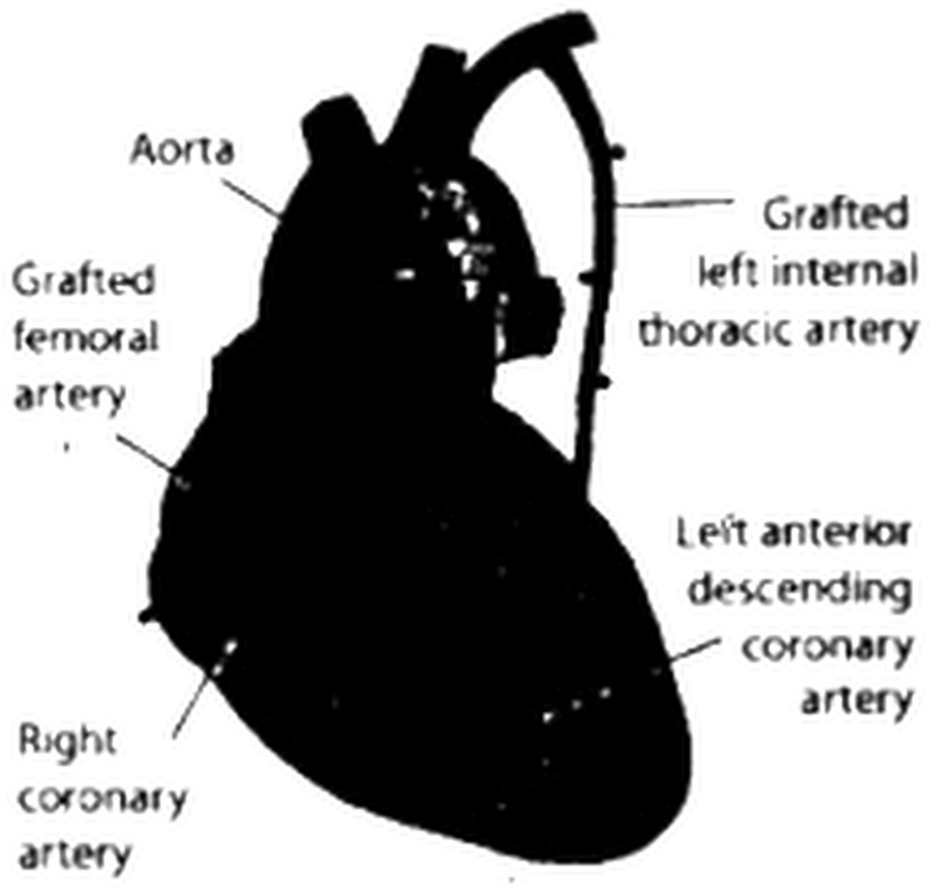
(b) Coronary bypass:

(i) A coronary bypass is a surgical procedure that relieves the effects of obstruction in the **coronary arteries.**

(ii) The technique involves taking healthy segments of blood vessel from other parts of the patient's body usually a vein from the leg called **great saphenous vein** and an artery of thorax called **internal thoracic artery** and using them to bypass obstructions in the **coronary arteries.**

(iii) The technique is common for those who suffer from severe occlusion of parts of the **coronary arteries.**

A triple Coronary Artery Bypass Graft Operation (shown by arrows)



(c) Angioplasty:

Working:

In angioplasty, a cardiologist threads a plastic tube into an artery of an arm or a leg and guides it through a major blood vessel toward the heart.

When the tube reaches the region of plaque in coronary artery a balloon is attached to the end of the tube is **inflate forcing the vessel open.**

Stents:

The artery may not remain open, so slotted tubes called **stents** are expanded inside the artery to keep the artery open. Stents are coated with **heparin** to prevent blood clotting and chemicals to prevent arterial closing.

(d) Open heart surgery:

Introduction:

This is a surgery in which the patient's chest is opened. The surgery is performed on the heart. The term "**Open**" refers to the chest, not to the heart itself. The heart may or may not be opened depending on the particular type of surgery. Heart surgery is used to correct heart problems in children and adults.

Working:

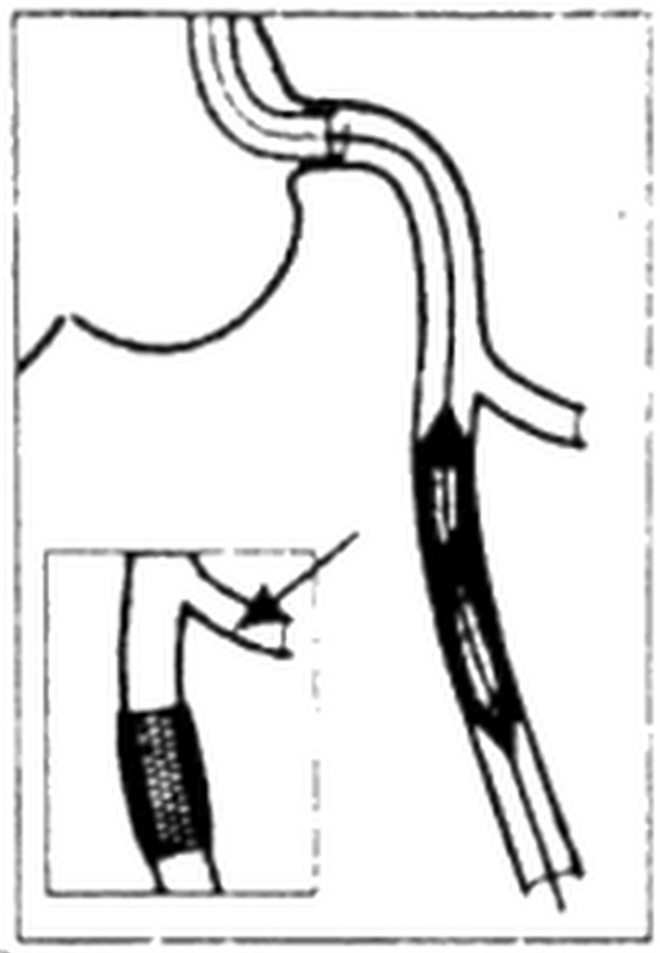
(i) An incision is made through the breastbone (sternum) while the patient is under general anesthesia. Tubes are used to re-route the blood through a special pump called a **heart-lung bypass machine.**

(ii) This machine adds **oxygen to the blood** and keeps the blood warm and moving through the rest of the body while the surgeon is repairing the heart.

(iii) Using the machine allows the **heart to be stopped.** Stopping the **heart makes** it possible to repair the heart muscle itself, the **heart valves,** or the blood vessels outside the heart.

(iii) After the repair is done, the heart is started again and the machine is removed.

(iv) The breastbone and the skin incision are then closed.



Coronary Angioplasty and Stenting

46. Explain hypertension and hypotension. What are the factors that regulate blood pressure?

Ans: Hypertension:

Introduction:

"Hypertension is defined as blood pressure high than 140/90 mmHg (millimeters of mercury)".

Blood pressure is the force of blood against your blood vessels as it circulates. This force is necessary to make the blood flow, delivering nutrients and oxygen throughout your body. High blood pressure also called "**hypertension,**" is a serious medical condition.

Reason:

It happens when the force of the blood pumping through your arteries is too strong. When our heart beats, it pushes blood through our arteries to the rest of our body. When the blood pushes harder against the walls of our arteries, our arteries, our blood pressure goes up. **Fluctuations in the Blood Pressure**:

Our blood pressure may be different at different times of day. It is usually higher when we first wake up, after we exercise, or when we are under stress. A diagnosis of hypertension may be made when one or both readings are high **120/80 mmHg** is normal blood pressure. Modem lifestyle factors are responsible for a growing burden of hypertension: physical inactivity, stress, salt-rich diets with processed and fatty foods, alcohol and tobacco use. Hypertension can strain the heart damage blood vessels, and increase the risk of heart attack stroke kidney problems and death.

Factors regulating blood pressure:

Factors that regulate blood pressure are heart rate stroke volume resistance to blood flow by the blood vessels, strength of the heartbeat, and vasomotor centre in the medulla. The factors that can lead to hypertension

include intake of alcohol, lack of exercise, age and history of high blood pressure in the family.

Postural hypotension:

Hypotension is defined as blood pressure lower than 90/60 mmHg (millimeters of mercury).

Causes and symptoms:

In some individuals, sudden standing or after eating causes a fall in blood pressure, dizziness, dimness of vision, and even fainting. Hypotension occurs primarily in adults older than 65.

Factors:

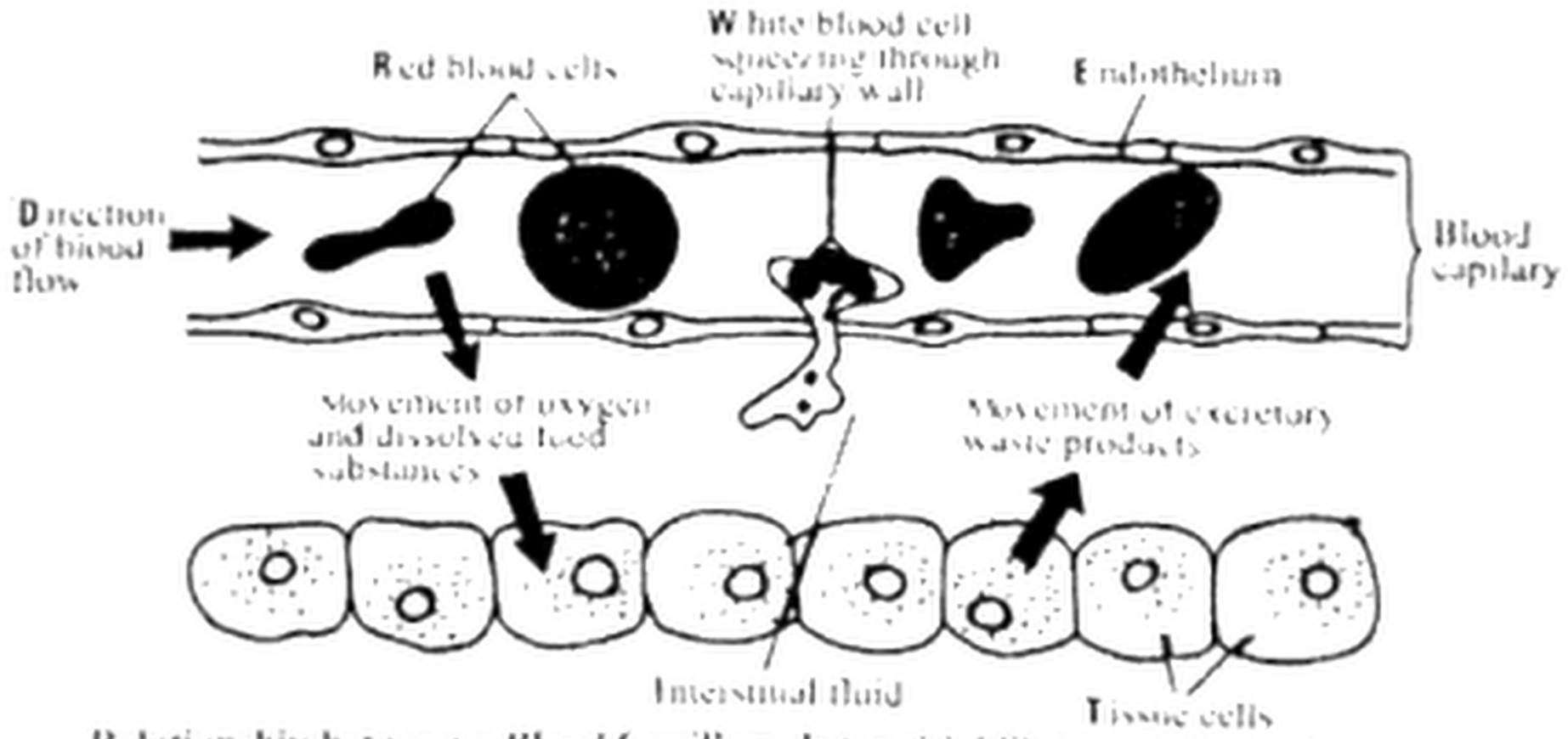
Factors include high blood pressure, medications like alpha blockers, some heart conditions, heat exposure can cause sweating, bed rest and pregnancy as woman's circulatory system expands rapidly during pregnancy. It also occurs in diseases such as diabetes, syphilis, and Parkinson's disease.

47. Describe the formation, composition and function of intercellular fluid.

Ans: The lymphatic system includes lymph, lymphocytes, lymphatic vessels, lymph nodes, tonsils, spleen and thymus gland. About one sixth of the body consists of spaces between the cells, which collectively are called the **interstitium.** The fluid in these spaces is the **interstitial fluid or intercellular fluid.**

Formation:

The fluid in the interstitium is derived for filtration and diffusion from the capillaries.



Relationship between a Blood Capillary, Interstitial Fluid and Tissue Cells

Composition:

Interstitial fluid contains almost the same constituents are plasma except for much lower concentrations of proteins because proteins do not pass outward through the walls of the capillaries with ease. This fluid is mainly entrapped in the minute space among the proteoglycan filaments. This combination of proteoglycan filaments and the fluid entrapped within them has the characteristics of gel and therefore, is called **tissue gel.**

Function: Instead of flowing, interstitial fluid mainly **diffuses** through the get. This diffusion allows rapid transport of the interstitium of water molecules electrolytes, nutrients, cellular excreta, oxygen, carbon dioxide etc., through the interstitium. Materials are exchanged between the blood and interstitial fluid and between the interstitial fluid and the body cells. In other words, to get from the blood to body cells or vice, versa, materials must pass through the interstitial fluid.

48. Describe the lymphatic system of man.

Ans: Lymphatic system of man:

The lymphatic system includes lymph, lymphocytes, lymphatic vessels, lymph nodes, tonsils, spleen and thymus gland. About one sixth of the body consists of spaces between the cells, which collectively are called the **interstitium.** The fluid in these spaces is the **interstitial fluid or intercellular fluid.**

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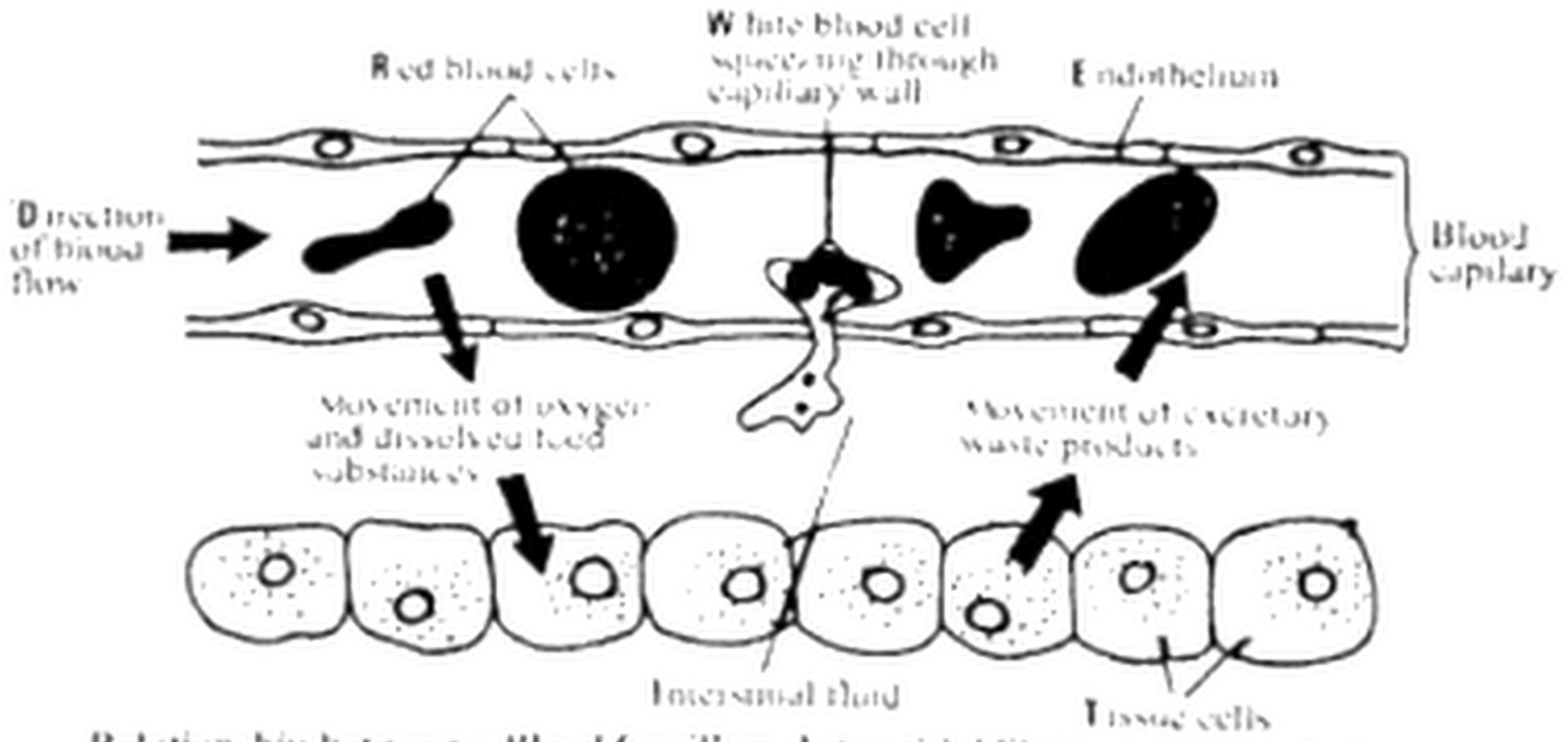


Relationship between a Blood Capillary, Interstitial Fluid and Tissue Cells

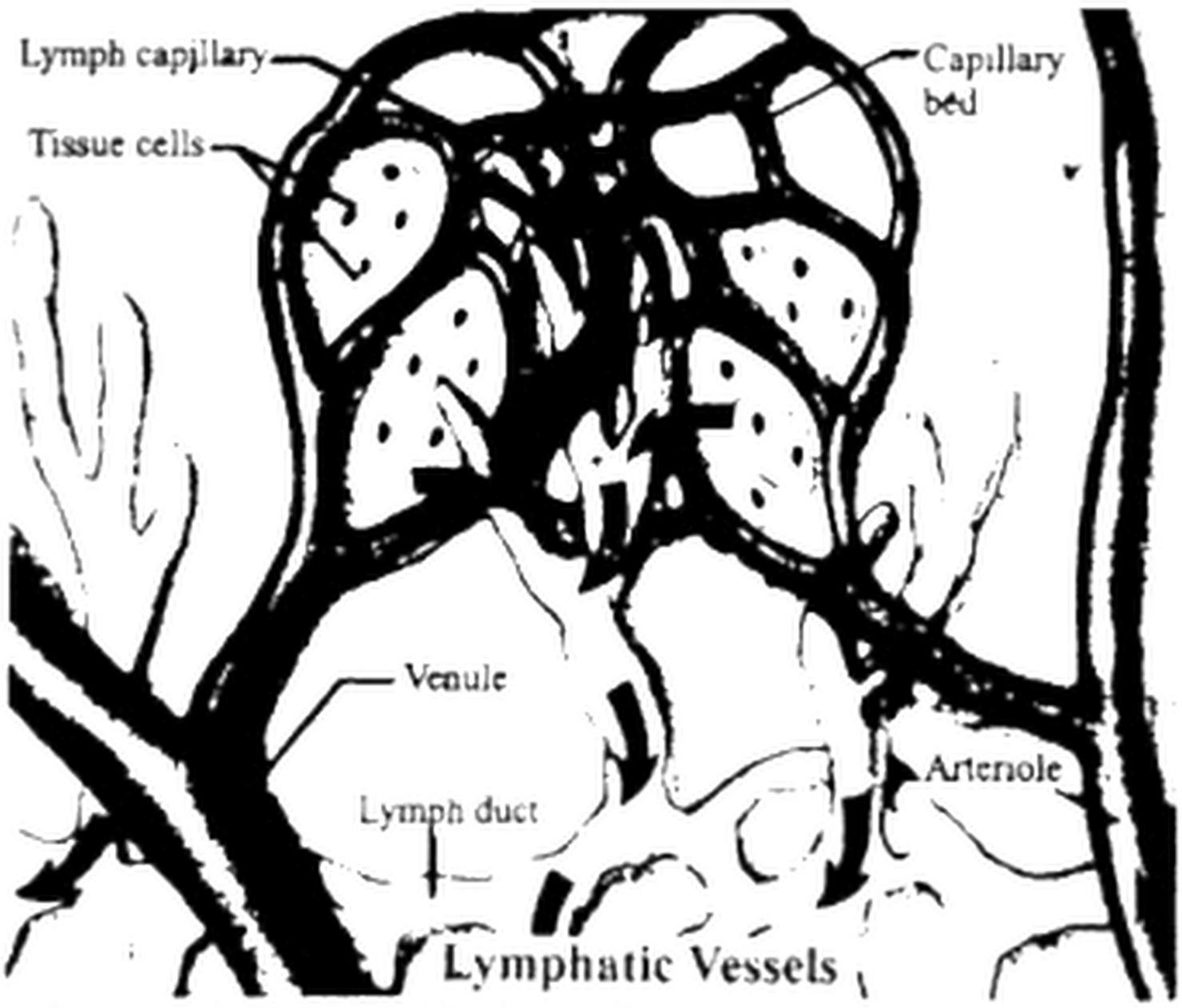
Comparison of the composition of interstitial fluid and lymph:

Approximately 30 litres of fluid pass from the blood capillaries into the interstitial space each day, whereas only 27 litres pass from the interstitial space back into blood capillaries. The remaining 3 litres of fluid enters the lymphatic capillaries, where the fluid is called **lymph** (meaning clear spring water) and passes through the lymphatic vessels back to the blood. In addition to water lymph contains solutes such as ions, nutrients, gases and some proteins, hormones, enzymes and waste products.

Lymphatic vessels:

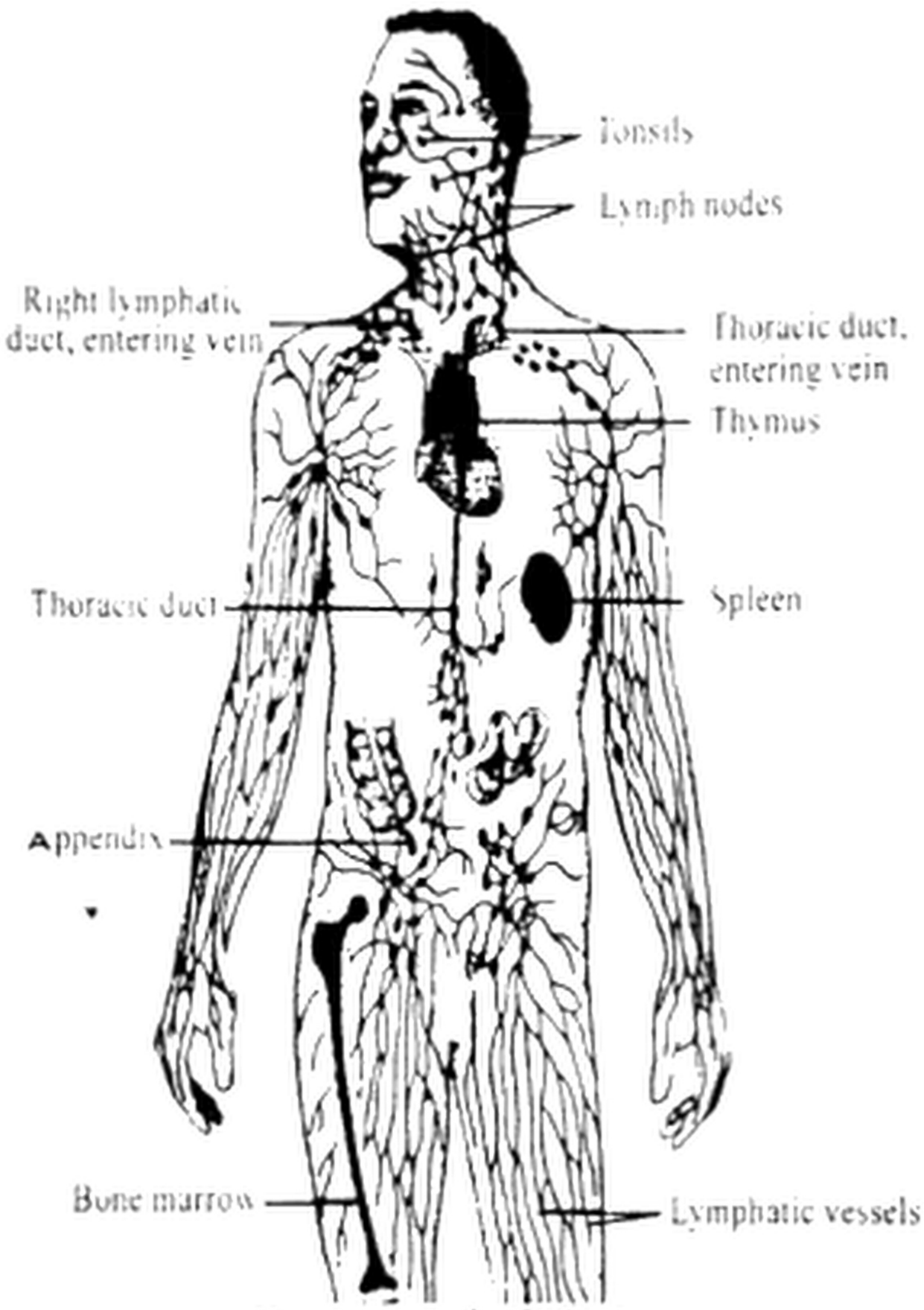
The lymphatic system unlike the circulatory system only carries fluid away from tissue. The lymphatic system begins in the tissues as **lymph capillaries,** which differ from blood capillaries as they lack a basement membrane. The lymph capillaries are far more permeable than blood capillaries and nothing in the interstitial fluid is excluded from the lymph capillaries. The lymph capillary but functions as a series of one-way valve that allows fluid to enter the capillary but prevent it from passing back into the interstitial spaces.The lymph capillaries join to form larger lymph vessels that resemble small veins. Small lymphatic vessels have a beaded appearance because of the presence of one-way valves

along their lengths that are similar to the valves of veins. Lymph nodes are round, oval, or bean-shaped bodies distributed along the various lymphatic vessels. The lymph nodes function to filter lymph.



Lymphatic Vessels

The thoracis duct drains the lower limbs, abdomen, the left thorax, the left upper extremity, and the left side of the head and neck. The duct ends by entering the left subclavian vein. The right lymphatic duct is much short and smaller in diameter than the thoracic duct. It drains the right thorax, right upper limb, and right side of the head and neck and opens into the right subclavian vein.



Human Lymphatic System

Role of lacteal present in the villi:

Each villus contains a **lymph capillary** called **lacteal.** The lymphatic system absorbs fats and other substances from the digestive tract. Fat enters the lacteals and pass through these lymphatic vessels to venous circulation. The lymph passing through these lacteals has milky appearance because of its far contents. **Chylomicrons** (these are proteins, triglycerol 90% phospholipids 4% and cholesterol 5% enter the lacteal Chylomicrons enter the lymph capillaries

because lymph capillaries lack basement membrane and are more permeable to large particles.

Lymph nodes are small, round or bran-shaped structures, ranging in size from 1 to 25 mm long, and are distributed along the curse of the lymphatic vessels. They filter the lymph, remove bacteria and other materials. In addition, lymphocytes congregate (assemble), function and proliferate within lymph nodes.

Spleen:

The spleen is located in the upper left abdominal cavity just beneath the diaphragm. It is a lymphoid organ. The spleen detects and responds to foreign substances in the blood, destroys worn-out erythrocytes, and acts as a blood reservoir, and to make blood available in times of low blood pressure or when the body needs extra oxygen-carrying capacity.

49. Describe the role of lymph vessels (lacteals) present in villi.

Ans: Role of lacteal present in the villi:

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50. Describe the function of lymph nodes and state the role of spleen as containing lymphoid tissue.

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