BODY FLUIDS AND CIRCULATION
DOUBLE CIRCULATION

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Double circulation means that the blood passes through the heart twice for each circuit of the body. It includes pulmonary and systemic circulation.

(i) Pulmonary Circulation

The deoxygenated blood pumped into the pulmonary artery is passed on to the lungs from where the oxygenated blood is carried by the pulmonary veins into the left atrium. This pathway is known as pulmonary circulation.

$$\underset{\text{(Right Ventricle)}}{\text{Heart}} \longrightarrow \underset{\text{(Oxygenation)}}{\text{Lungs}} \longrightarrow \underset{\text{(Left atrium)}}{\text{Heart}}$$

(ii) Systemic Circulation

The oxygenated blood entering the aorta is carried by a network of arteries, arterioles and capillaries to the tissues from where the deoxygenated blood is collected by a system of venules, veins and vena cava and emptied into the right atrium. This is the systemic circulation. Thus, the systemic circulation provides nutrients, oxygen and other essential substances to the tissues and takes CO_2 and other harmful substances away for elimination.

$$\underset{\text{(Left Ventricle)}}{\text{Heart}} \longrightarrow \underset{\text{(Oxygenation)}}{\text{Lungs}} \longrightarrow \underset{\text{(Right atrium)}}{\text{Heart}}$$

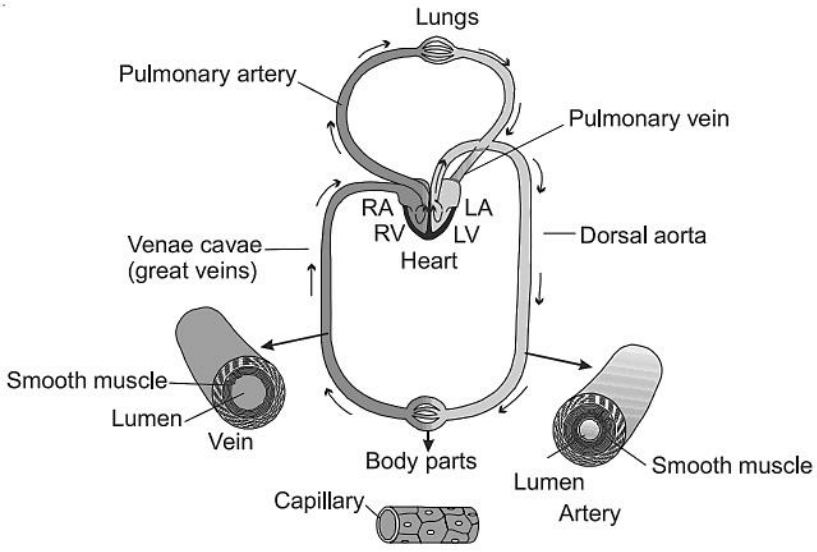


Fig. : Schematic plan of blood circulation in human

The systemic circulation has numerous small muscular arteries and arterioles that offer greater resistance to blood flow than those in the pulmonary circulation. Despite the differences in resistance, the rate of blood flow through the systemic circulation must be matched to the flow rate of the pulmonary circulation. As the amount of work performed by the left ventricle is greater than that performed by the right ventricle, so the musculature wall of the left ventricle is thicker than that of the right ventricle.

Circulation through Special Regions

A portal vein is a vein which does not carry blood directly to heart but forms a network of capillaries in another or intermediate organ before reaching the heart. A portal vein together with small veins through which it receives blood and capillaries constitutes the portal system. A portal system is named after the organ to which it carries blood.

(i) Renal Portal System: The function of the renal portal system is to supply blood to renal tubules when glomerular filtration is absent or down regulated. Its main channel is renal portal vein. Which brings blood from tail and groin to kidney. In fishes and amphibians, renal portal system is found which is reduced in reptiles and birds but absent in mammals, lampreys and hag fish.

(ii) Hypophyseal portal system: A hypophyseal portal vein collects blood from hypothalamus and enters the anterior lobe of pituitary.

(iii) Hepatic portal system: There is a unique vascular connection between the digestive tract and liver called hepatic portal system. Liver receives blood from two sources. The hepatic artery supplies oxygenated blood to the liver and the hepatic portal vein brings deoxygenated blood from the digestive organs to the liver. The flow of deoxygenated blood from the digestive organs to the liver before returning to the systemic circulation is called hepatic portal circulation.

Importance of hepatic portal circulation:

(1) The blood which comes from the alimentary canal contains absorbed food like glucose and amino acids. The excess of glucose is converted into glycogen which is stored in the liver for later use. When the body of an individual feels deficiency of food, the glycogen is converted into glucose and is transferred to the blood stream via hepatic veins.

(2) Harmful nitrogenous waste like ammonia is converted into urea which is later removed by kidneys. Thus, blood is detoxified (purified) of harmful nitrogenous waste.

(3) Liver produces blood proteins which are released into blood circulation.

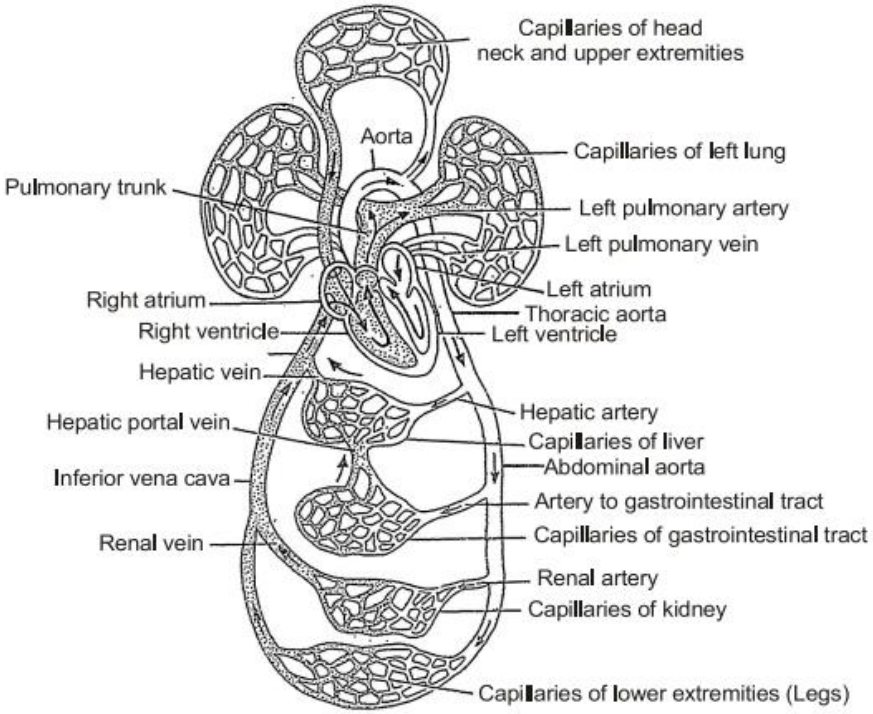


Fig. : Showing systemic circulation, pulmonary circulation and hepatic portal circulation

(iv) Coronary circulation: The flow of oxygenated blood from the ascending aorta to the heart muscles and the return of deoxygenated blood from the heart muscles to the right atrium is called coronary (cardiac) circulation. From the ascending aorta, the right and left coronary arteries arise which supply oxygenated blood to the heart muscles. The deoxygenated blood from the heart wall is carried by the coronary veins that join to form coronary sinus. The coronary sinus carries deoxygenated blood to the right atrium.

Blood Vessels

Blood vessels form a tubular network throughout the body that allows blood to flow from the heart to all the living cells of the body and then back to the heart. Blood from the heart passes through vessels of progressively smaller diameters, known as arteries, arterioles, capillaries, venules and veins.

The walls of arteries and veins consist of three coats or 'tunics'.

(i) Tunica externa: The outermost layer is the tunica externa and is composed of fibrous connective tissue with collagen fibres.

(ii) Tunica media: The middle layer is the tunica media and is composed primarily of smooth muscles and elastic fibres.

(iii) Tunica intima or interna: The inner layer is the tunica interna. It consists of two parts.

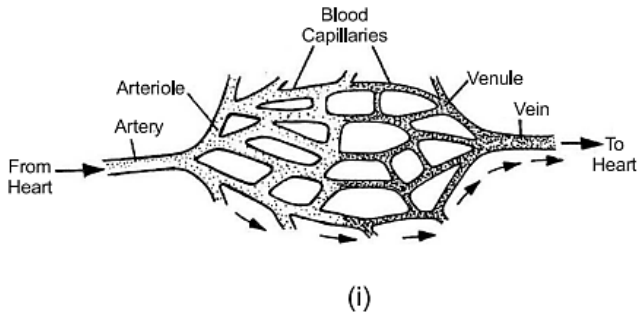
(a) Elastic membrane: This membrane is made up of elastic tissue of yellow fibres (bundles of elastin protein). It is thicker in artery.

(b) Endothelium: It is made up of flattened squamous epithelial cells lining the lumen. Its cells are more elongated in an artery.

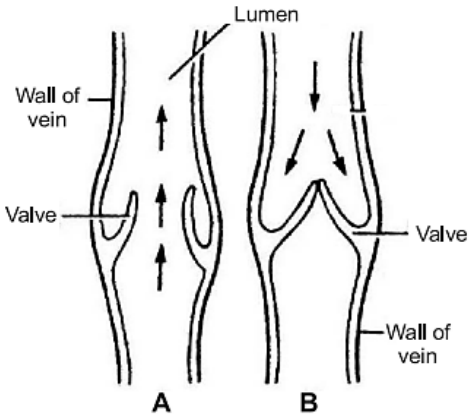
Arteries	Veins
1. Arteries distribute blood from the heart to the different parts of the body.	1. Veins collect blood from different parts of the body and pour it into the heart.
2. Tunica media is thick, having more muscle fibres.	2. Tunica media is thin, having fewer muscle fibres.
3. Tunica interna has strong elastic membrane and more elongated endothelial cells.	3. Tunica interna has simple, elastic membrane and elongated endothelial cells.
4. The walls of the arteries are thick and muscular.	4. The walls of the veins are thin.
5. Arteries are not collapsible as they have thick walls.	5. Veins are collapsible because they have thin walls.
6. Arteries have no valves.	6. Veins have valves which prevent backward flow of blood.
7. The flow of the blood is fast as the blood in them is under great pressure.	7. The flow of blood in veins is not so fast because the blood in veins is under low pressure.
8. Except the pulmonary arteries all the arteries carry oxygenated blood.	8. Except pulmonary veins all the veins carry deoxygenated blood.

Capillaries

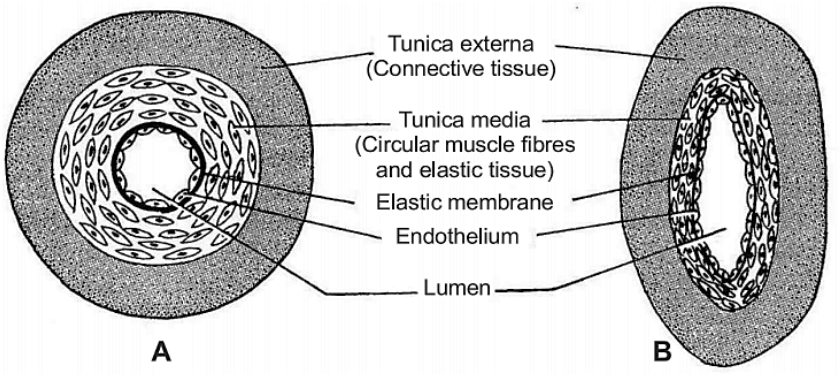
These are the narrowest blood vessels, through which the exchange of gases and nutrients between the blood and the tissue fluid occurs. The walls of capillaries are composed of just one cell layer a simple squamous epithelium or endothelium. This permits a more rapid exchange of materials between the blood and the tissues.



(i)



(ii)



(iii)

Fig. : (i) Diagram showing the end of an artery and beginning of a vein.
(ii) Veins cut open to show the valves preventing the backward flow of blood.
(iii) **A -** T.S. artery, **B -** T.S. vein