The Circulatory System

The circulatory system in humans is a closed type system. It consists of three components.

- A powerful pumping organ heart
- Vessels to transport the compounds.
- Blood medium of transport.

Double Circuit Plan:

Humans circulatory system has a double-circuit plan. That is the heart serves as two pumps.

The right side of the heart pumps blood to the lungs.

The left side of the heart pumps oxygenated blood to the whole body.

Blood Vessels:

Arteries

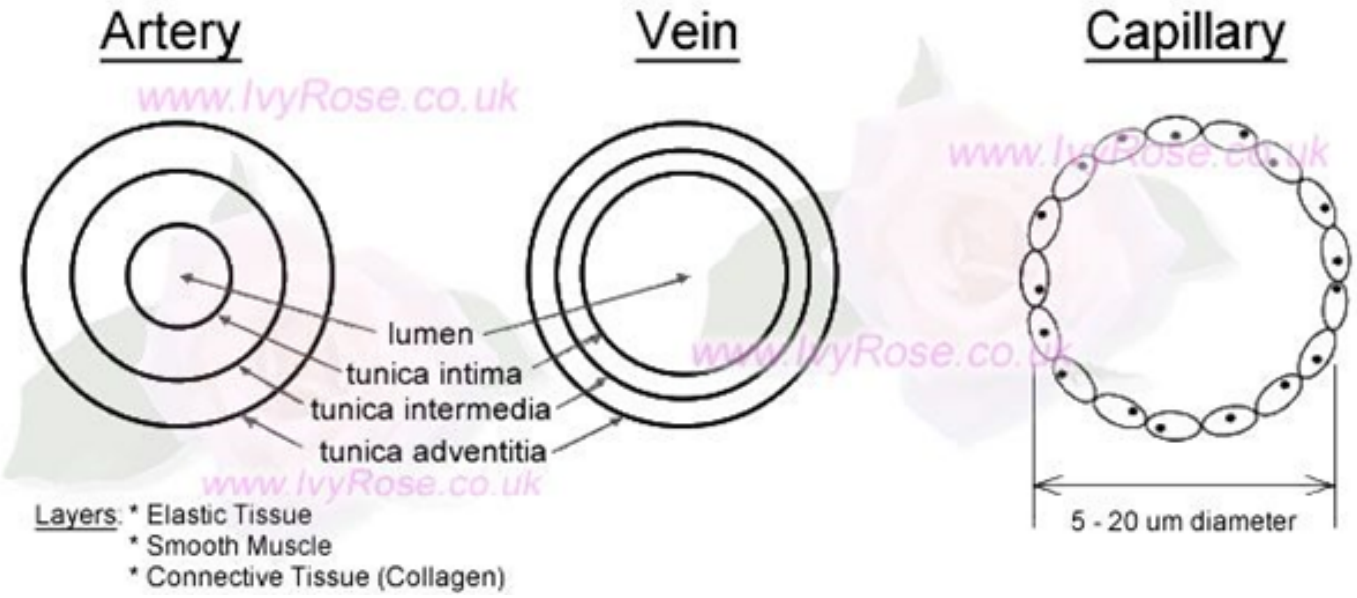
- They carry blood away from the heart.
- They have a smaller lumen and thick walls.
- The blood in the arteries is at high pressure.
- Walls of arteries have elastic fibres that help maintain the pressure inside.
- There are no valves in arteries as the blood is at high pressure.

Capillaries

- Capillaries' wall is just one cell layer thick.
- Thin walls reduce the diffusion distance and help in the transport of substances.
- The pressure in capillaries is low.

Veins

- They carry blood back to the heart.
- They have a large lumen and the walls are thin as compared to arteries.
- Blood in veins is at low pressure.
- Veins have a valve to prevent the backward flow of blood.
- The blood from the lower body is transported in veins through the squeezing action of the muscles of the leg.



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Pressure Changes In The Vessels

The pressure of blood in arteries is high due to the pumping action of the heart. To maintain this pressure the walls of arteries are elastic.

The pressure decreases the blood is moved away from the heart. Thus, capillaries are at low pressure. Their total cross-section is less than arteries which is one reason for low pressure.

The blood in the vein is at the lowest pressure due to the increasing distance from the heart.

Components Of Blood

Blood has two components.

The liquid portion is called plasma which makes up 55% of total blood.

The solid portion consists of blood cells which make up 45% of blood.

Blood Cells Or Corpuscles

Red Blood Cells

> Red blood cells are biconcave cells. This helps them in squeezing out through capillaries. It also increases the surface area for diffusion.

> They contain haemoglobin which transports oxygen.

> RBCs have no nucleus, mitochondria, and other organelles.

White Blood Cells

> They are associated with the defence of the body.

> There are two types of white blood cells. Phagocytes and lymphocytes

Phagocytes

> They remove the harmful organisms by engulfing or phagocytosing them.

> They have a multilobed nucleus.

Lymphocytes

Recognize viruses and bacteria as foreign bodies and initiate a response to remove them.

Platelets

Fragments from large cells.

It helps in blood clotting.

Tissue Fluid And Lymph

At the arteriolar end of the capillaries, the pressure is high. This results in leakage of fluid from the blood into the tissue spaces. This fluid is called tissue fluid.

Tissue fluid has the same composition as blood. The difference is that it does not contain blood cells and albumin.

It bathes the cells. Substances are diffused from the blood into the tissue fluid and then diffuse into the cells.

At the venular end, the pressure is low. Thus the fluid seeps back into the veins. Although a small amount is left behind.

This leftover fluid then enters the lymphatic vessels as lymph. Lymph moves through the lymphatic system and is transported back to the blood.

Difference Between Blood Tissue Fluid And Lymph

Blood is the suspension of blood cells in the plasma.

Tissue fluid is the fluid component of blood leaked through filtration.

Lymph is the tissue fluid that enters the lymphatic system for drainage.

Haemoglobin And Oxygen Transport

Each haemoglobin molecule has four polypeptide chains. Each chain has a haem group that has Fe+2 iron. This iron can bind with 2 oxygen atoms.

Each chain can carry 2 oxygen atoms thus each haemoglobin molecule carries 8 oxygen atoms.

Oxygen concentration is measured as partial pressure or pO2.

At high pO2 oxygen binds with more oxygen than it does at low pO2. Thus, at high pO2 haemoglobin is completely saturated.

The Bohr Effect

The amount of haemoglobin saturation not only depends on pO2 but also on the pH of the blood.

The decrease in pH causes a decrease in haemoglobin saturation. Thus, oxygen is released from the haemoglobin.

An increase in Co2 causes an increase in H+. Thus decreases the pH.

Thus in areas of blood where CO2 is high, the haemoglobin will lose oxygen. This release of oxygen is called the Bohr effect.

Haemoglobin also helps in mopping up extra H+ ions thus they act as buffers.

CO2 Transport

About 85% of carbon dioxide enters the red blood cells. Here they react with water to form carbonic acid in the presence of carbonic anhydrase.

5% of carbon dioxide dissolves in the plasma.

The rest of the carbon dioxide also enters red blood cells but instead of forming carbonic acid, they combine with haemoglobin to form carbaminohaemoglobin.

Adaptation To High Altitude

At high altitudes the pO2 is low and the air is less dense. Thus haemoglobin saturation is decreased. To counter this after some time the red blood cells in the blood are increased. Thus, the

oxygen-carrying capacity of blood is increased although each haemoglobin is carrying less oxygen.

The Heart

The human heart consists of two pumps:

Deoxygenated blood is received by the right side of the heart from the body and is then pumped to the lungs for oxygenation.

This oxygenated blood from the lungs is then received by the left side which pumps it to the body via the aorta.

The deoxygenated blood is again received by the right atrium via the superior vena cava and inferior vena cava.

Structure Of Human Heart

External Structure

There are four chambers in a mammalian heart. Two atria and two ventricles.

Coronary artery and veins are present in the groove.

The superior and inferior vena cava enters the right atrium.

Four pulmonary veins enter the left atrium.

From the centre portion of the heart, the aorta arises along with the

pulmonary artery and its branches.

Internal Structure

A muscular septum divides the heart into four chambers.

The upper two chambers are called atria. They have a thin wall.

The lower two chambers are called the ventricle. They have thicker walls as they are acting as a pump.

The chambers are lined by a layer of endocardium.

The walls of the heart are formed by the myocardium.

The Wall of the left ventricle is thicker than the right ventricle as it needs high pressure to pump blood around the body.

Cardiac Cycle

Definition

The sequence of one heartbeat is called the cardiac cycle. It consists of two phases:

Systole - contraction of heart muscles.

Diastole - relaxation of the heart muscle.

Atrial Diastole:

During atrial diastole, blood is filled in both atria.

The atrioventricular valve is closed.

Atrial Systole:

During atrial systole the atria contract.

This creates pressure inside the atria.

Thus the atrioventricular valve opens and blood flows from the atria to the ventricles.

Ventricular Systole:

When the ventricle is filled with blood this distends the heart wall.

This causes contraction of the ventricle and initiates ventricular systole.

The atrioventricular valve shuts and the blood is pushed into the aorta and pulmonary vessels.

The closure of the atrioventricular valve produces the first heart sound LUB.

Ventricular Diastole:

During ventricular diastole, the ventricle relaxes. The pressure inside the ventricles falls.

The blood is filled inside the aorta and pulmonary vessels. This causes an increase in pressure in the

vessels.

This causes the closure of aortic and pulmonary valves which produces a second heart sound DUB.

Initiation Of Cardiac Cycle

Cardiac muscles are myogenic that is the impulse for contraction is generated with the cardiac tissue. Thus, it does not depend upon the electrical stimuli from nerves.

Sinoatrial Node

At the top of the atrium, a patch of tissue is presently called a sinoatrial node or SA node. The cells in the SA node contracts create an action potential. The potential travels down from the SA node. This causes contraction in the atrium.

AV Node

Below the SA node at the interventricular septum, another tissue is presently called the AV node. The impulse generated at the SA node reaches the AV node. The impulse is delayed here for a while. This ensures that the ventricular contraction begins after the atrial contraction ends.

Bundle Of His And Purkinje Fibres

From the AV node, the action potential travels along the septum and the wall of the ventricle through a bundle of His and Purkinje fibres.

This causes the contraction of the ventricles.

When this cycle ends the contraction of the SA node is delayed for

a while. This is the phase of diastole.