

Cardiovascular System Summary Notes

The cardiovascular system includes:

The heart, a muscular pump

The blood, a fluid connective tissue

The blood vessels, arteries, veins and capillaries

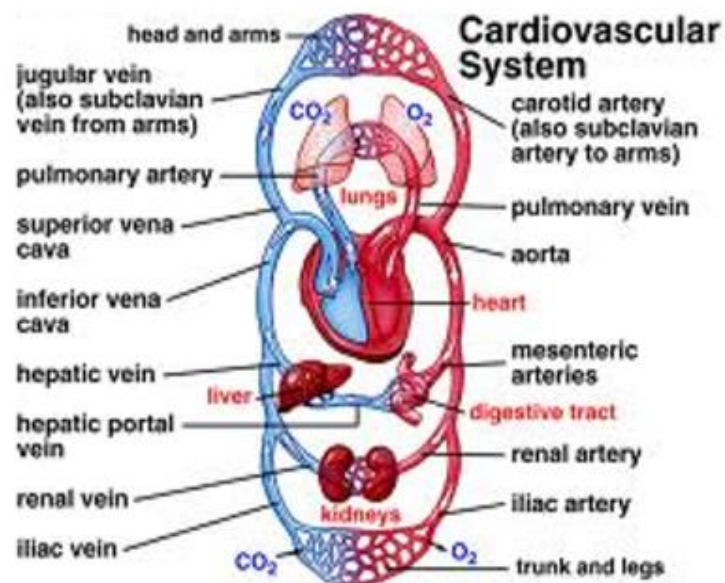
Blood flows away from the heart in arteries, to the capillaries and back to the heart in the veins

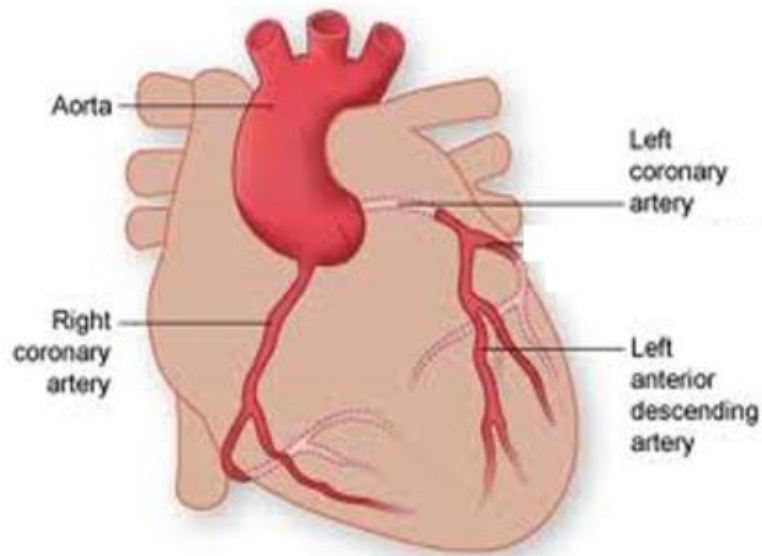
There is a decrease in blood pressure as the blood travels away from the heart

Arterial branches of the aorta supply oxygenated blood to all parts of the body

Deoxygenated blood leaves the organs in veins

Veins unite to form the vena cava which returns the blood to the heart

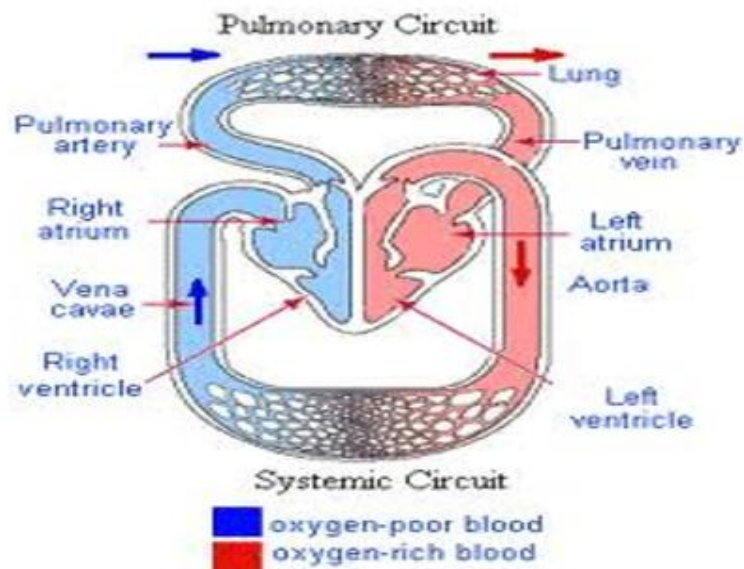




Pulmonary System

This is the route by which blood is circulated from the heart to the lungs and back to the heart again

The pulmonary system is exceptional in that the pulmonary artery carries deoxygenated blood and the pulmonary vein carries oxygenated blood



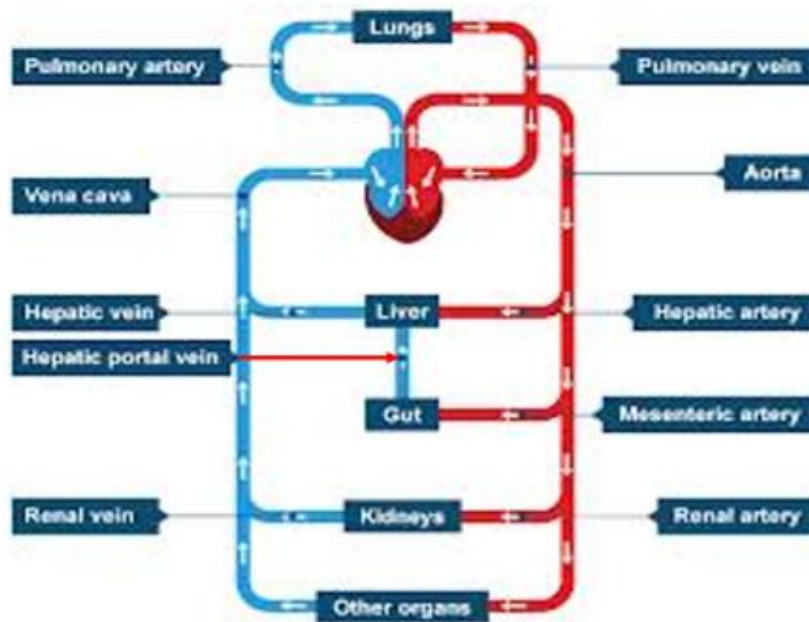
Hepatic Portal Vein

There is another exception in the circulatory system - the hepatic portal vein

Veins normally carry blood from an organ back to the heart

The hepatic portal vein carries blood from the capillary bed of the intestine to the capillary bed of the liver

As a result, the liver has three blood vessels associated with it



Arteries and Veins

The central cavity of a blood vessel is called the lumen

The lumen is lined with a thin layer of cells called the endothelium

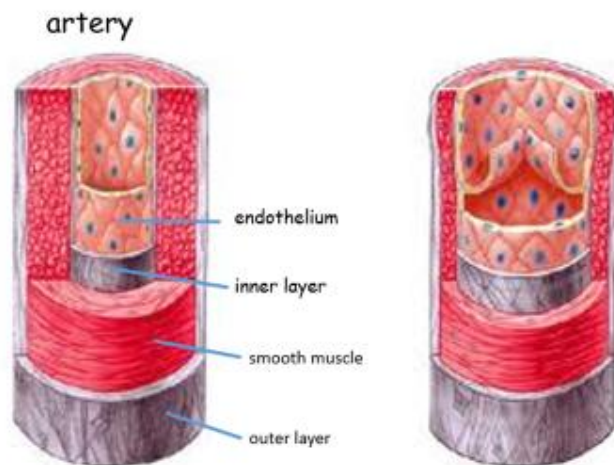
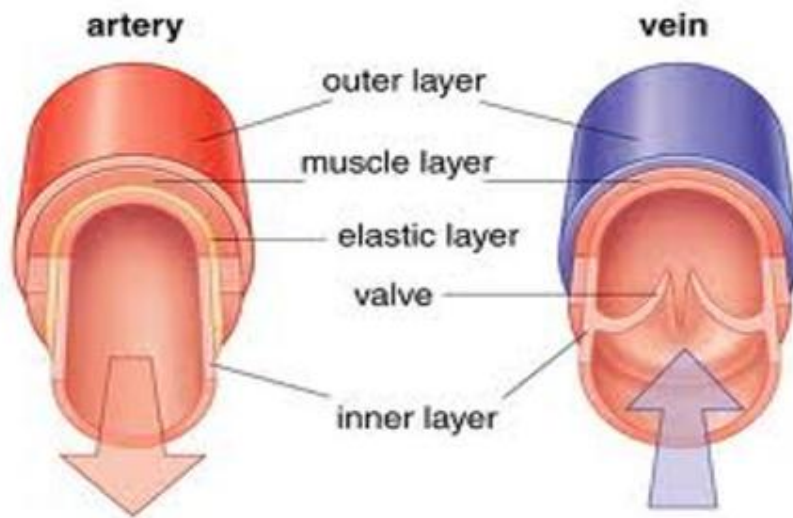
The composition of the vessel wall surrounding the endothelium is different in arteries, veins and capillaries

Arteries carry blood away from the heart

Arteries have a thick middle layer of smooth muscle

They have an inner and outer layer of elastic fibres

Elastic fibres enable the artery wall to pulsate, stretch and recoil, thereby accommodating the surge of blood after each contraction of the heart



Smooth muscle can contract or become relaxed

This contraction or relaxation brings about vasodilation or vasoconstriction to control blood flow

During strenuous exercise the arterioles leading to the muscles undergo vasodilation - the circular muscle in the arteriole wall is relaxed and the lumen is wide

This allows an increased blood flow to the skeletal muscles

At the same time, the arterioles leading to the small intestine undergo vasoconstriction

The circular muscles are contracted and the lumen is narrow

As a result, this reduces the blood flow to the gut

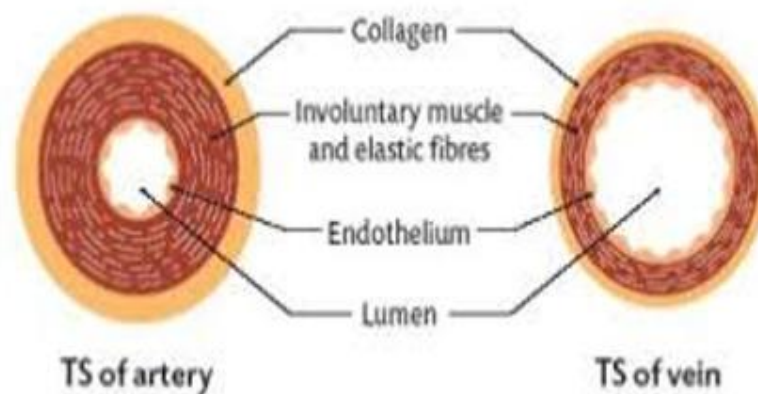
Veins carry blood back to the heart

The muscular layer and layers of elastic fibres in the vein wall are thinner than those in an artery because blood flows along a vein at low pressure

The lumen of a vein is wider than that of an artery

Valves are present in veins, to prevent the backflow of blood

Following two slides compare an artery and vein

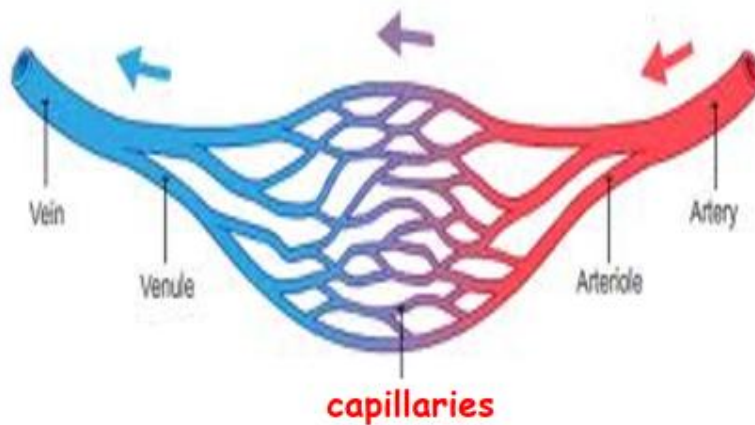
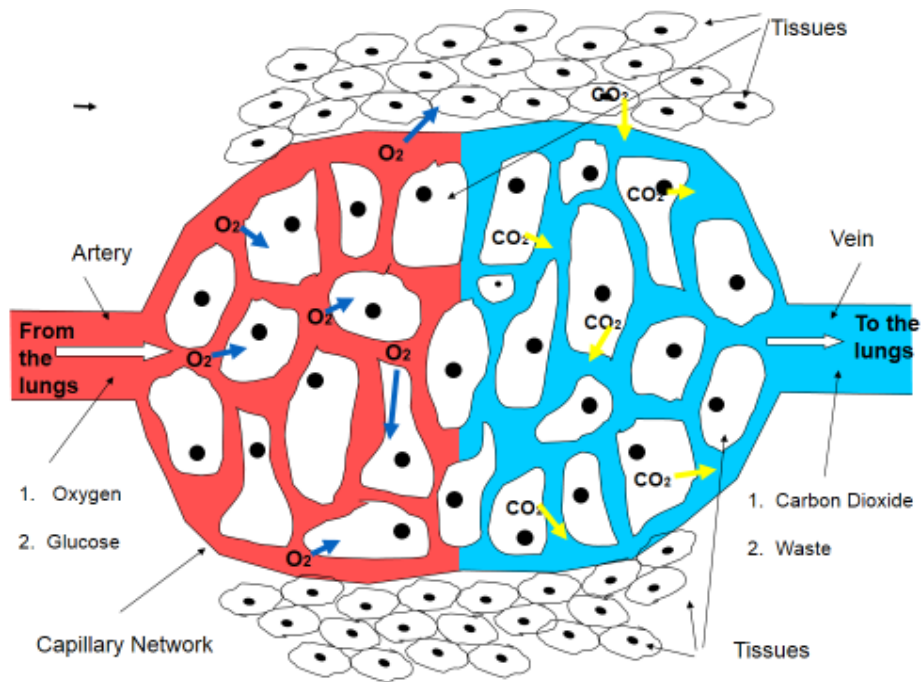


Capillaries and Exchange of Materials

Blood is transported from arterioles to venules by passing through a dense network of blood vessels called capillaries

All exchanges of substances between blood and living tissue takes place through capillary walls

Capillary walls are composed of endothelium and are only one cell thick



Plasma is a watery yellow fluid containing dissolved substances such as glucose, amino acids, blood cells, platelets and plasma proteins

Blood arriving at the arteriole end of a capillary bed is at a higher pressure than blood in the capillaries

As blood is forced into the narrow capillaries, it undergoes pressure filtration and much of the plasma is squeezed out through the thin walls

This liquid is called tissue fluid

The only difference between plasma and tissue fluid is that plasma has proteins
Tissue fluid contains a high concentration of dissolved food, oxygen, useful ions
etc.

These diffuse, down a concentration gradient, into the surrounding cells

Carbon dioxide and other metabolic wastes diffuse out of the cells, down a
concentration gradient, into the tissue fluid to be excreted

Tissue fluid and Lymph

Much of the tissue fluid returns to the blood in the capillaries at the venule end
of the capillary bed

This is brought about by osmosis

Tissue fluid lacks plasma proteins so it has a higher water concentration than
the blood plasma

Some of the tissue fluid does not return to the blood in the capillaries

This excess tissue fluid is absorbed by thin-walled lymphatic vessels

When the tissue fluid is in the lymphatic vessel it is called lymph

Tiny lymph vessels unite to form larger vessels

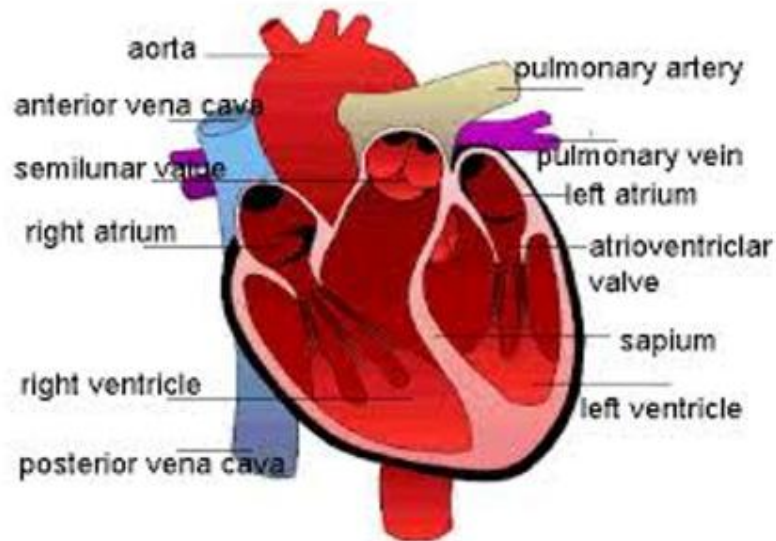
Flow of lymph is brought about by the vessels being compressed when muscles
contract during breathing, movement etc.

Larger lymph vessels have valves to prevent backflow

Lymph vessels return their contents to the blood via two lymphatic ducts

These enter the veins coming from the arms

Structure and Function of the Heart



Continuous circulation of blood is maintained by a muscular pump, the heart

The heart is divided into 4 chambers, two atria and two ventricles

The right atrium receives deoxygenated blood from all parts of the body via the vena cavae

Deoxygenated blood passes into the right ventricle before leaving the heart through the pulmonary artery

The pulmonary artery divides into two branches, each leading to a lung

Oxygenated blood returns to the heart by the pulmonary veins

It flows from the left atrium to the left ventricle before leaving the heart by the aorta

The wall of the left ventricle is more muscular and thicker than that of the right ventricle

The left ventricle is required to pump blood all around the body

The right ventricle only pumps blood to the lungs

Valves between the atria and ventricles are the atrio-ventricular (AV) valves

Valves prevent the backflow of blood

The presence of valves ensures the blood flows in one direction through the heart

Semi-lunar valves are present at the origins of the pulmonary artery and the aorta

These valves open during ventricular contraction allowing flow into the arteries

When arterial pressure exceeds ventricular pressure, they close

Cardiac Function

At each contraction the right ventricle pumps the same volume of blood through the pulmonary artery as the left ventricle pumps through the aorta

Heart rate (pulse)

This is the number of heart beats per minute

Stroke volume

This is the volume expelled by each ventricle on contraction

Cardiac output is the volume of blood pumped out of a ventricle per minute

It is summarised by the following equation -

$$CO = HR \times SV$$

HR is heart rate, SV is stroke volume

Pulse, health indicator

If a person is fit, the quantity of cardiac muscle present in their heart wall is greater and more efficient than that of an unfit person

A very fit person tends to have a lower pulse rate than an unfit person - the fit person's heart is larger and stronger

A fit person's stroke volume is greater

A fit person's heart does not need to contract as often to pump an equal volume of blood round the body