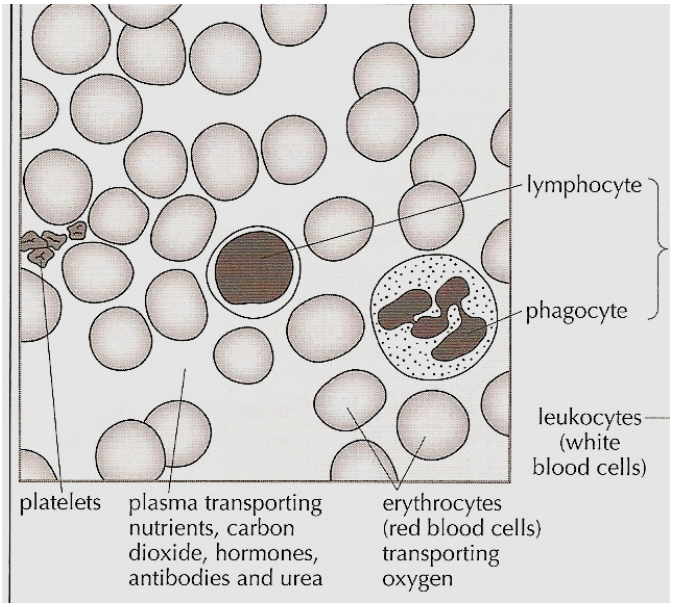
6.2 THE TRANSPORT SYSTEM

Blood composition

- Plasma
- Erythrocytes
- Leucocytes (phagocytes & lymphocytes)
- Platelets

What is transported by the blood?

- Nutrients
- Oxygen
- Carbon dioxide
- Hormones
- Antibodies
- Urea (main excretory product)
- Heat



The structure of the heart

- There are four chambers in the heart, two upper thin-walled atria and two lower thick-walled ventricles.

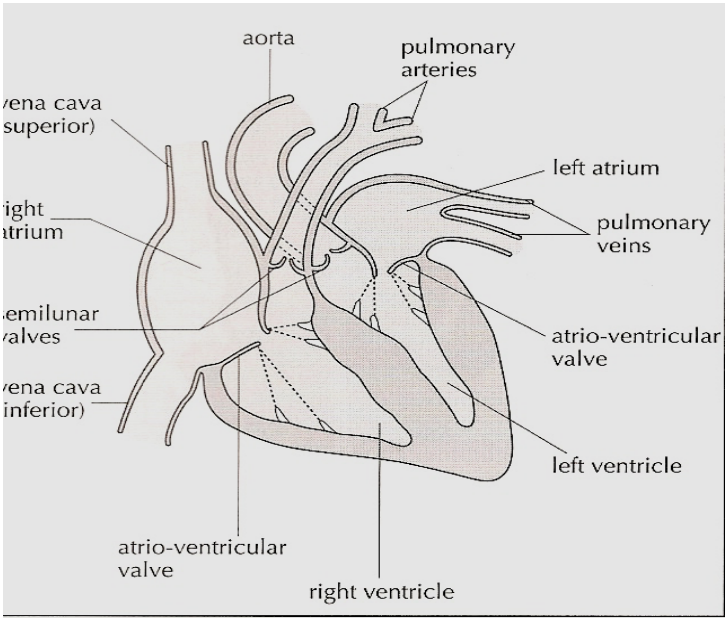
- The right side of the heart is completely separated from the left

- The atria function to collect blood temporarily until it can pass to the ventricles

- The right atrium receives deoxygenated blood from the general circulation of the body, whilst the left atrium receives oxygenated blood from the lungs

- The muscular wall of the left ventricle is at least <u>three times thicker</u> than that of the right ventricle, because it pumps oxygenated blood through the much larger systemic circulation of the body

- The left atrium is separated from the left ventricle by a bicuspid valve, whilst a tricuspid valve separates the right atrium from the right ventricle (or else atrio -ventricular valves).



The action of the heart

- Collecting blood
- Pumping blood
- Opening and closing valves

- The atria are the collecting chambers. They collect blood from the veins.
- The ventricles are the pumping chambers. They pump blood out into the arteries at high pressure.
- The valves ensure that blood always flows in the correct direction.

Every heartbeat consists of a sequence of actions:

1) The walls of the atria contract pushing blood from the atria into the ventricles through the atrio-ventricular valves, which are open. The semi-lunar valves are closed, so the ventricles fill with blood.

2) The walls of the ventricles contract and the blood pressure rises rapidly inside them. This rise causes the atrio-ventricular valves to close, preventing back-flow to the atria. Then, it causes the semi-lunar valves to open, allowing blood to be pumped out into the arteries (pulmonary artery, aorta). At the same time the atria start to refill as they collect blood from the veins (pulmonary vein, vena cava).

3) The ventricles stop contracting and as pressure falls inside them, the semi-lunar valves close, preventing back flow from the arteries to the ventricles. When the ventricular pressure drops below the atrial pressure, the atrioventricular valves open. Blood entering the atrium from the veins flows on to start filling the ventricles.

The next heartbeat begins when the walls of the atria contract again.

The control of the heart beat

The heart beats on its own accord (**myogenic**) and speeds up or slows down through involuntary control.

One region (**The sinoatrial node/ SA**) is responsible for initiating each heart contraction: **the pacemaker**, which is located in the wall of the right atrium.

Nerves (nervous system) and hormones (endocrine system) can transmit messages to the pacemaker.

- One nerve carries messages from the brain (the medulla) to the pacemaker to tell the pacemaker to speed up the beating of the heart

- Another nerve carries messages from the brain to the pacemaker to tell the pacemaker to slow down the beating of the heart

- A hormone like adrenaline (epinephrine), carried to the pacemaker by the bloodstream tells the pacemaker to speed up the beating of the heart.

Coronary Artery Disease

It is caused by fatty plaque building up in the inner linning of coronary arteries that become narrower (occluded).

→ As the condition worsens, blood flow to the heart is restricted, causing chest pain.

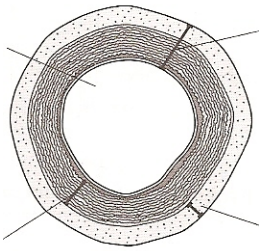
Factors that can cause coronary heart disease are:

- High blood cholesterol levels
- Smoking
- High blood sugar levels (diabetes)
- Genetic factors
- High blood pressure

If the deposit of plaque continues, blood clots will form resulting in **coronary thrombosis** (blocking of arteries).
That means, that oxygen is not received by the cardiac muscle and so stops beating in a coordinated way → Heart attack (**fibrillation**)

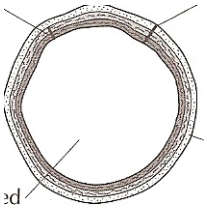
Blood vessels

a) Arteries



- Transport blood away from heart
- Pressure of blood is high and pulsatile
- Rapid blood flow
- Low blood volume
- Blood is oxygenated except in pulmonary artery
- Thick outer layer to avoid leaks
- Thick layers of elastic muscle fibres to help pump the blood after each heart beat
- Narrow **lumen** to help maintain high pressures

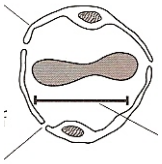
b) Veins



- Transport blood towards the heart
- Blood pressure is low and continuous
- Low blood flow

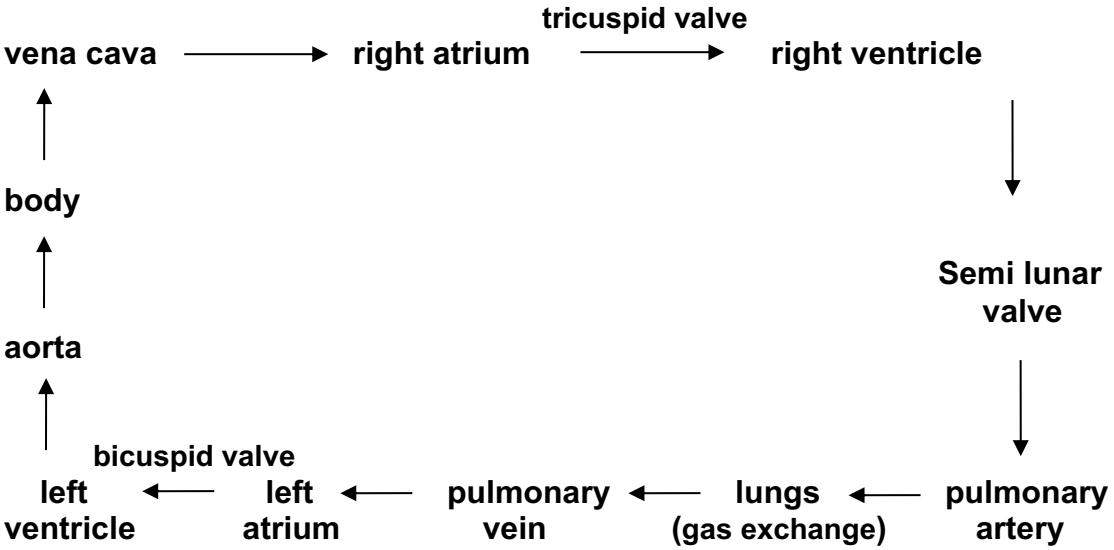
- Increased blood volume
- Blood is deoxygenated except in pulmonary vein
- Thin wall allowing it to be pressed flat by adjacent muscles, helping to move the blood
- Thin outer layer because there is little danger of bursting
- Thin inner layer with few elastic muscle fibres because blood does not flow in pulses
- Wide lumen is needed to accommodate the slow-flowing blood
- Veins have valves to prevent back-flow

c) Capillaries



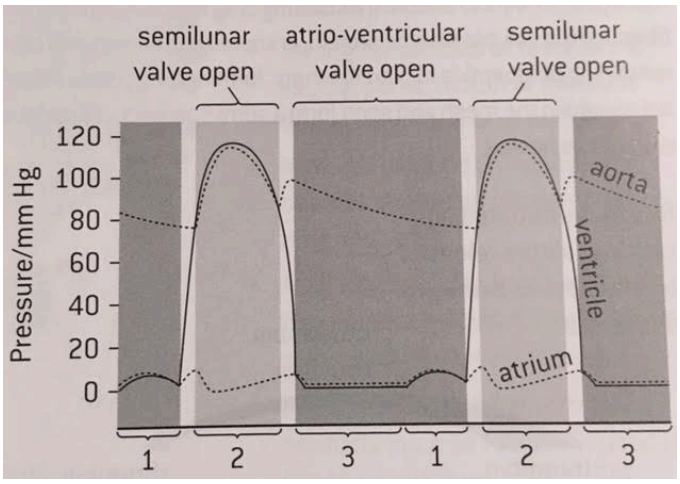
- Link arteries to veins
- Site of exchange of materials between blood and tissues (they receive nutrients from the digestive system)
- There are no elastic muscle fibres
- Mixed oxygenated and deoxygenated blood
- High blood volume and slow blood flow

A diagram of blood flow



Pressures in the Cardiac Cycle

The graph shows pressure changes in the **left atrium**, **left ventricle** and the **aorta** during each heartbeat:



William Harvey (17th Century) and the circulation of blood

According to Galen, an ancient Greek philosopher it was thought that blood was produced by the liver, pumped out by the heart and consumed in the other organs of the body!

Harvey demonstrated that:

(a) blood flow through vessels is unidirectional with valves to prevent backflow

(b) the rate of flow through major vessels is far to high for blood to be consumed in the body after being pumped out by the heart

(c) the heart pumps blood out in the arteries and that it returns in veins

He also suggested (this was proved after his death) the presence of numerous fine vessels (i.e capillaries) that linked arteries to veins in the tissues of the body.

Due to Harvey the circulation is considered to be double:

a) Pulmonary and (b) Systemic