6.2 THE BLOOD SYSTEM

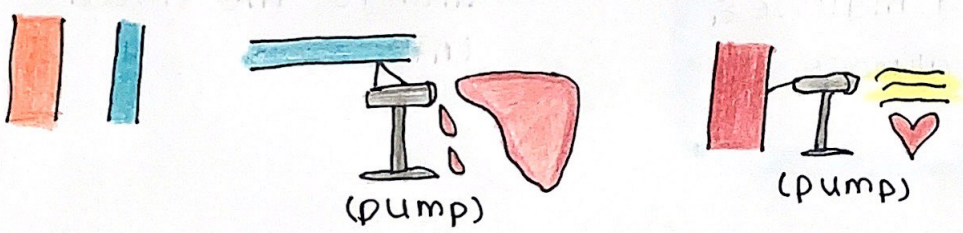
CIRCULATION

Prior findings:

→ arteries and veins were separate blood networks.

→ veins were thought to pump natural blood which was produced by the liver.

→ arteries were thought to pump heat produced by the heart via the lungs which cooled like bellows.

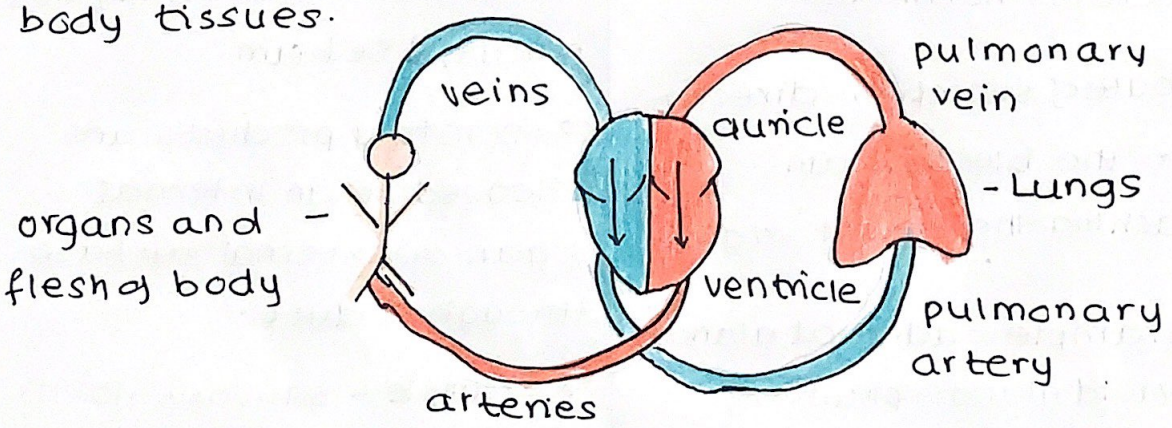


William Harvey's findings:

→ arteries and veins are part of a single connected blood network.

→ arteries pumped blood from heart to lungs & body tissues

→ veins returned blood to the heart from lungs & body tissues.



Pulmonary and systematic circulation

Heart - 4 chambers → 2 atria and 2 ventricles

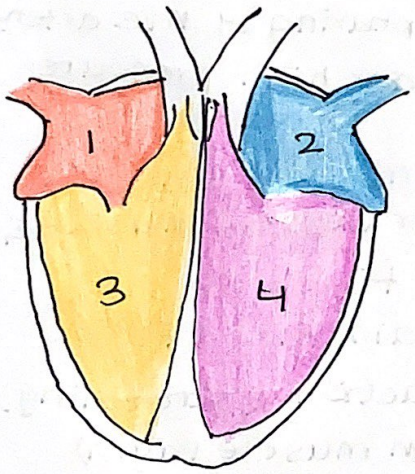
Atria - act as reservoirs

→ blood returns to the heart and is called via veins

→ passed on to the ventricles

Ventricles - act as pumps

→ expell the blood from the heart at high pressure via arteries.



2 sets of atria and ventricles because - 2 distinct locations for blood transport.

- 1 - Right atrium
- 2 - Left atrium
- 3 - Right ventricle
- 4 - left ventricle

systematic circulation:

The left side of the heart pumps oxygenated blood around the body.

pulmonary circulation:

The right side of the heart pumps deoxygenated blood to the lungs for oxygenation.

∴ 2 separate circulation for lungs and the body.

Double circulation: blood travels twice through the heart in one complete cycle of the body.

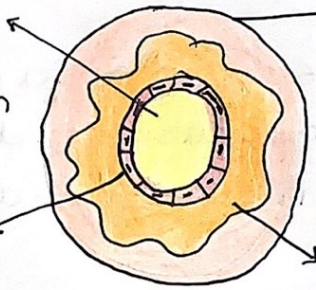
ARTERIES

Function: to convey blood at high pressure from the heart to the tissues of the body.

Ventricles - thick strong muscles in the wall pump blood into the arteries at high pressure.

Structure of arteries

Narrow central lumen
to maintain a high blood pressure.



Tunica externa
outer layer of collagen
to prevent the rupturing of the artery under high pressure.

Tunica intima
a smooth endothelium forming the lining of the artery.

Tunica media
inner layer of muscle & elastic fibres to maintain blood flow.
(contraction & stretching)
(smooth muscle layer)

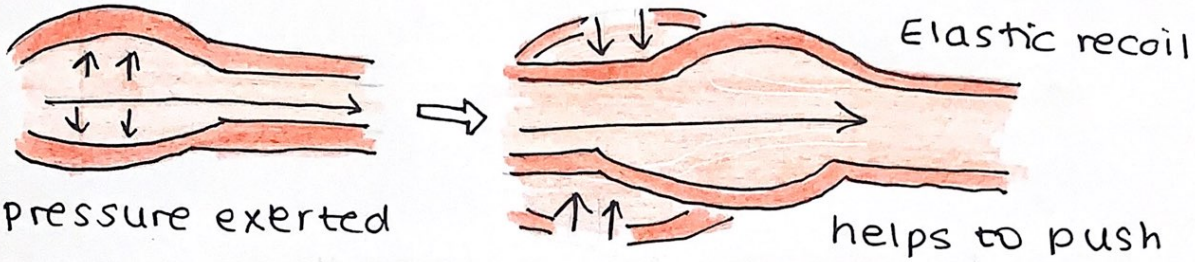
BLOOD FLOW

Pulses: blood flows through the arteries in repeated surges called pulses.

Muscle fibres
→ help forming a rigid arterial wall
→ capable of withstanding high blood pressure without rupturing.
→ contract to narrow the lumen → increases pressure between pumps to maintain blood pressure.

Elastic fibres:

→allow the arterial wall to stretch and expand upon the flow of a pulse through the lumen.



pressure exerted on the wall is returned to the blood when the aretery returns to its normal size. This is called elastic recoil.

helps to push the blood forward through the arteries & maintains pressure

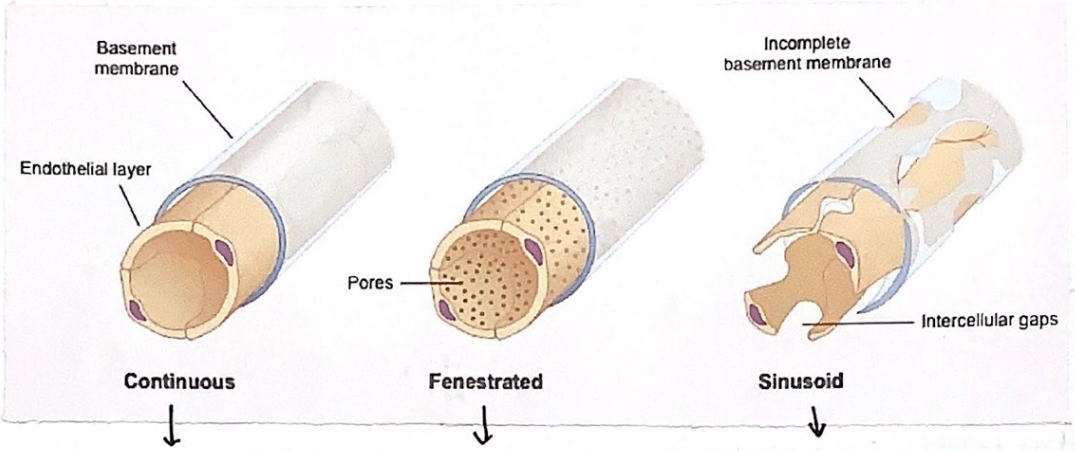
CAPILLARIES

Function: to exchange materials between the cell in tissues and blood travelling at low pressure.

- branching of arteries into capillaries ensures blood is moving slowly and all cells are located near a blood supply.

Structure:

- small diameter - allows passage of only a single red blood cell at a time (optimal exchange).
- wall made of single layer of cells - to minimize the diffusion distance for permeable materials.
- basement membrane - permeable to necessary materials.
- may contain pores - aid in the transport of materials between tissue fluid and blood.

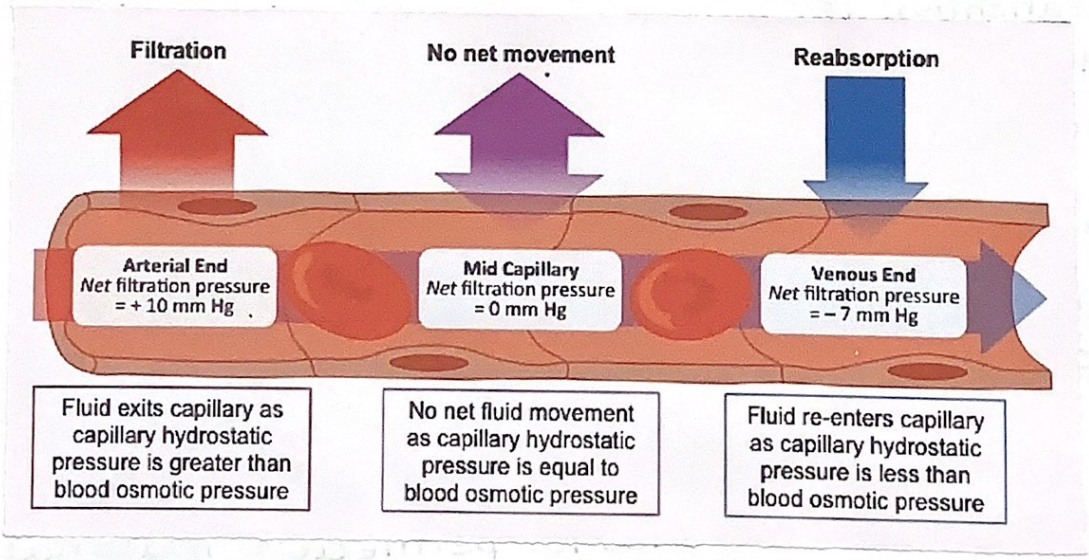


- held together by tight junctions
  ↓
  to limit permeability of large molecules

- in tissues specialised for absorption.
  ↓
  contains pores
  eg. intestine, kidney

- have open spaces between cells.
  ↓
  permeable to large molecules.
  eg. liver

FLOW OF BLOOD



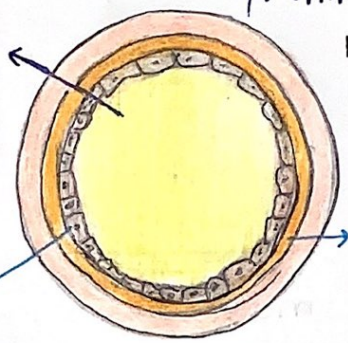
higher hydrostatic pressure forces material from the blood stream into the tissue fluid.

lower hydrostatic pressure allows materials from the tissues to enter the bloodstream.

VEINS

Structure and Function:

wide central lumen to maximise blood flood flow for more effective return.



→ thin outer layer less muscle and elastic fibre as blood pressure is low.

→ thin layer of muscle.

endothelium

→ because of the low pressure, they have valves which:
- prevent back flow of blood
- stop the blood from pooling at the lowest extremities.

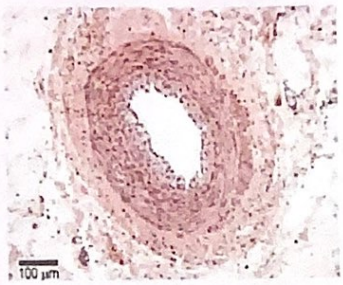
FLOW OF BLOOD

- veins typically pass between skeletal muscle groups, which facilitate blood flow by periodic contractions.

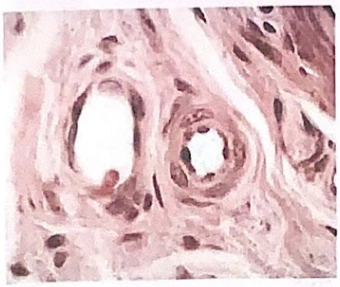
- Skeletal muscles contract → squeeze the vein → blood flows from the site of compression.

- similar effect can be caused by the rhythmic arterial bulge created by a pulse.

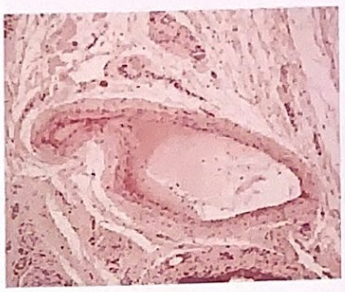
COMPARISON



Artery



Capillary*

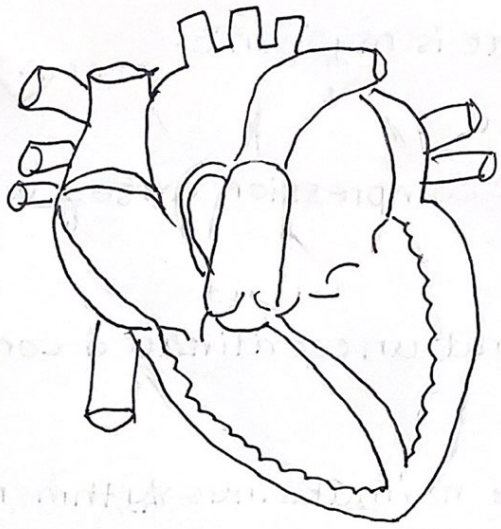


Vein

* The capillary is a significantly smaller structure and thus is shown at a substantially higher magnification than the artery and vein

• send blood from the heart	material exchange	send blood to the heart.
• high pressure	low pressure	low pressure
• narrow lumen	extremely narrow lumen	wide lumen
• thick wall	extremely thin wall	thin wall
• large amount of muscle & elastin fibres	none	small amounts of muscle and elastin fibres.

HEART STRUCTURE



Chambers:

Two atria: smaller chambers - left atrium & right atrium

Two ventricles: larger chambers - left ventricle & left atrium.

Valves:

atrioventricular: between atria & ventricles - tricuspid & biscuspid

semilunar: between ventricles & atteries - aortic & pulmonary

Blood vessels:

Vena cava: feeds into the right atrium
returns deoxygenated blood from the body.

pulmonary artery: connects to the right ventricle and sends deoxygenated blood to the lungs.

pulmonary veins: feeds into the left atrium
returns oxygenated blood from the lungs.

aorta: extends from the left ventricle
sends oxygenated blood around the body.

HEART BEAT

contraction of heart beat is myogenic.

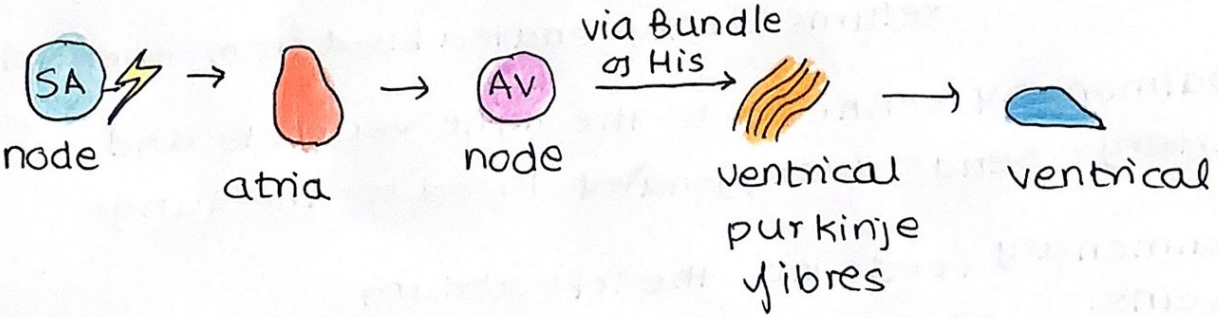
the signal for cardiac compression arises within the heart tissue itself.

fibrillation: irregular and uncoordinated contraction of the heart muscle

defibrillation: when the normal sinus rhythm may be re-established with a controlled electrical current.

Mechanism of Heart beat:

- electrical signals are initiated by a sinoatrial node.
- this stimulates the atria to contract and also relays signals to an atrioventricular node.
- the atrioventricular node sends signals to ventricular purkinje fibres via a Bundle of His within the wall of septum.
- these purkinje fibres cause the ventricular walls to contract.



normal sinus rhythm - 60-100bpm

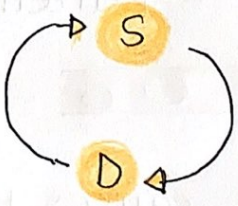
- The pace maker is regulated by the medulla oblongata
- Sympathetic nerves release noardrenaline which increases the heart rate.

- Parasympathetic nerves release acetylcholine which decreases the heart rate.

- It can also be increased by the hormones - adrenaline and epinephrine.
  ↳ causes a more sustained elevation in heart rate that that achieved by the action of the brain stem.

CARDIAC CYCLE

describes the events of a heart beat
→ comprised of systole and diastole.



Systole (contraction)

- Atria contract, atrial pressure exceeds the ventricular pressure.
- This causes the atrioventricular valves to open & the blood flows to the ventricles.
- Ventricles contract, ventrical pressure exceeds the atrial pressure which causes the AV valves to close and make the 1st sound.
- Pressure builds until the ventricular pressure exceeds the atrial pressure.

- This causes the semilunar valves to open and blood flows into the arteries.

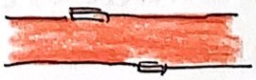
Diastole (relaxation)

- Blood flows into the arteries and the ventricular pressure drops.
- The aortic valve closes to prevent the backflow of blood which initiates the second heart sound.
- when ventricular pressure drops below the atrial pressue, AV valves open and the cycle is repeated.

CORONARY HEART DISEASE (CHD)

- Coronary thrombosis → caused by clots within the coronary arteries.

- The deposits reduce the diameter and increase the blood pressure.
- This causes the walls to get damaged which gets repaired by fibrous tissues.



- The wall loses its elasticity and forms atherosclerotic plaques.
- If these plaques rupture, blood clotting is triggered which forms a thrombus.

- This thrombus can block blood flow resulting in a myocardial infraction.

These events collectively are known as CHD.