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Plant transport system

- Transport system is made up of xylem.
- The second transport system is the phloem.
- Phloem transports sucrose and amino acids.

Xylem - Structure

- A long drainpipe, made of many hollow, dead cells, joined end to end.
- The end walls of the xylem cells have disappeared, so a long, open tube is formed.
- Xylem vessels have no cytoplasm or nuclei.
- Walls are made of lignin majorly.
- Lignin is very strong, so xylem vessels help to keep plants upright.

Phloem - Structure

- Phloem tubes are made of many cells joined end to end.
- Their end walls have not completely broken down.
- The cells are called sieve tube elements.
- Sieve tube elements contain cytoplasm but no nucleus.
- They do not have lignin in their cell walls.
- The cells in phloem are alive, because they have companion cells which contain the nucleus.

This transport system is called a mass flow.

Xylem - Functions

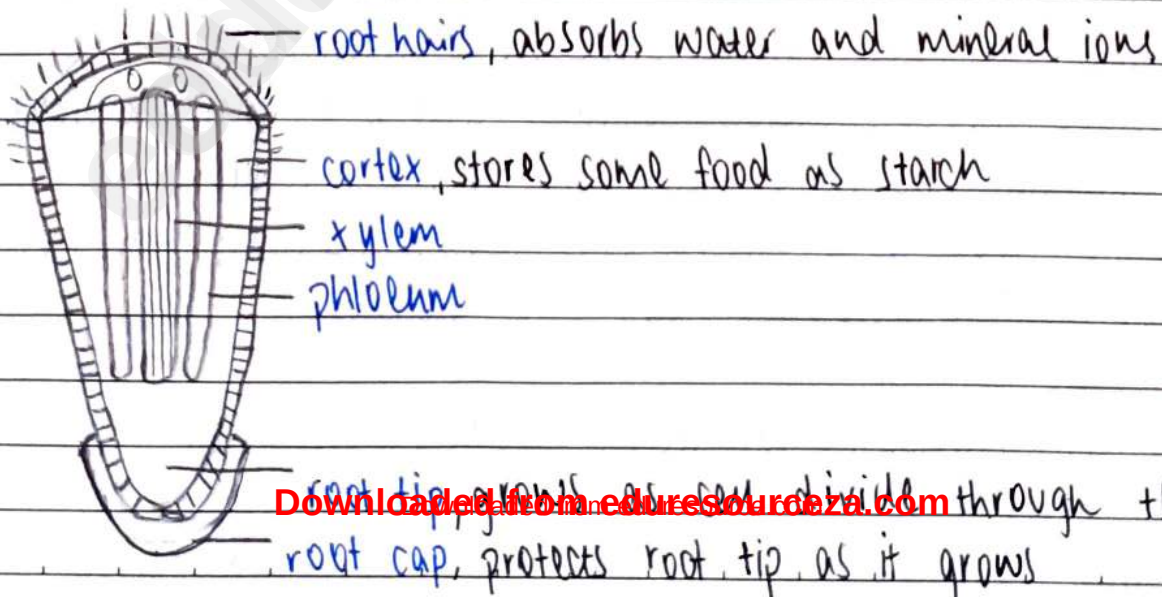
- Transport water and mineral ions.
- Root absorbs water and mineral ions from the soil.
- Water and mineral ions enter xylem in the root and travel upwards in the stem to the leaves, flowers and fruits.
- Transport is one direction — roots via stem to leaves.

Phloem - Functions

- Transports sucrose, amino acids and hormones throughout the plant.
- Sucrose is a soluble, complex sugar, which is especially made for transporting energy. It is made in leaves with the sugars from photosynthesis and from starch in storage organs, such as swollen roots and stems.
- Transport is in two directions — downwards from leaves to roots and upwards from leaves to flowers, fruits or buds.

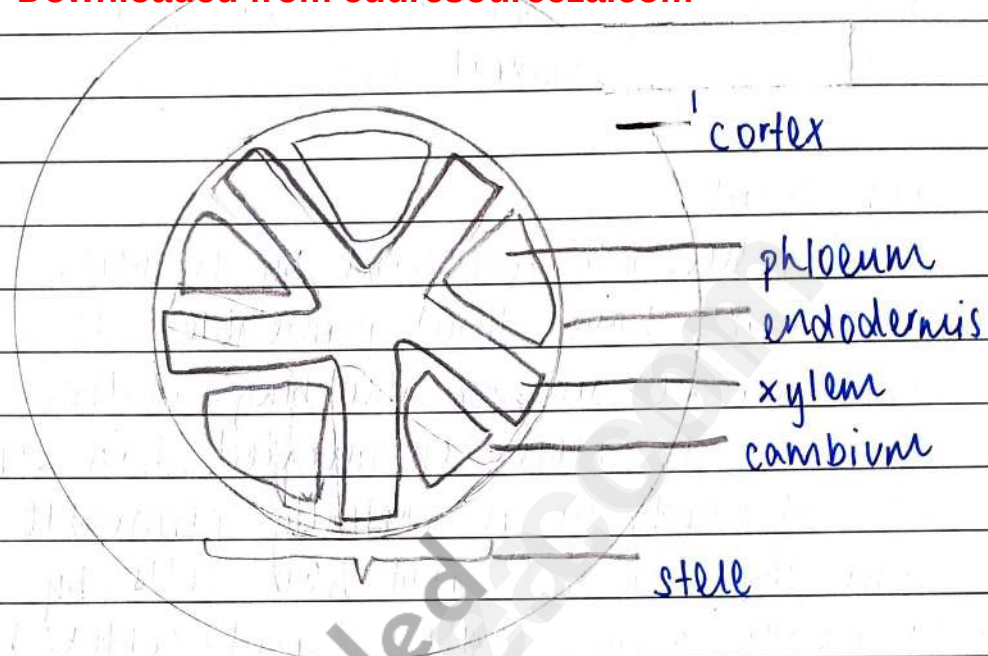
Hormones control cell division for growth.

Transverse section of a root



Transverse section of a root

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Endodermis

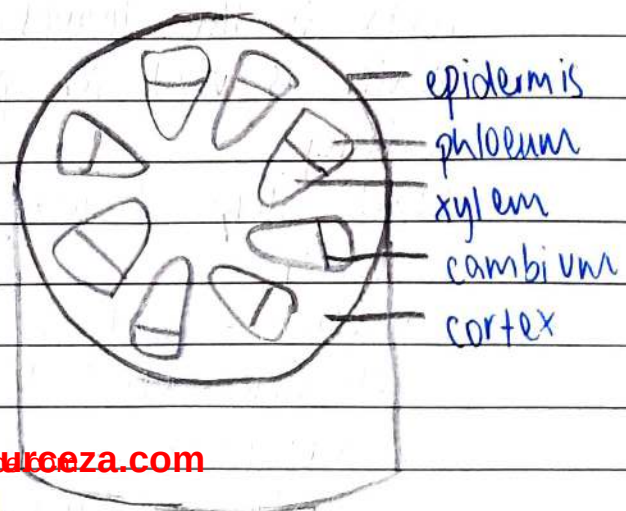
- The central and inner most layer of cortex.
- Regulates water and other substances that get into a plant.

Cambium

- Found in between xylem and phloem.
- Tissue layer that make new xylem and phloem as the plant grows.

Transverse section of a stem

- A vascular bundle is a group of xylem vessels and phloem tubes.
- They help support the plant.
- xylem and phloem are in the centre so that the fluid moves equally in all directions.



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Water Uptake

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- Roots are to anchor the plant into the soil and to take up water and mineral ions.

Root hairs

- Water passes into root hairs by osmosis.
- Root hairs have thin, permeable cell walls, which provide a large surface area for absorbing water.
- Cell Sap is more concentrated than soil water.
- The cell membrane is partially permeable so water diffuses from the soil into root hair cells by osmosis.
- It passes across cells of root cortex by osmosis before passing into the xylem and then up the stem into leaves.
- Mineral ions are absorbed by active transport.

Water is pulled by the evaporation of water at leaves.

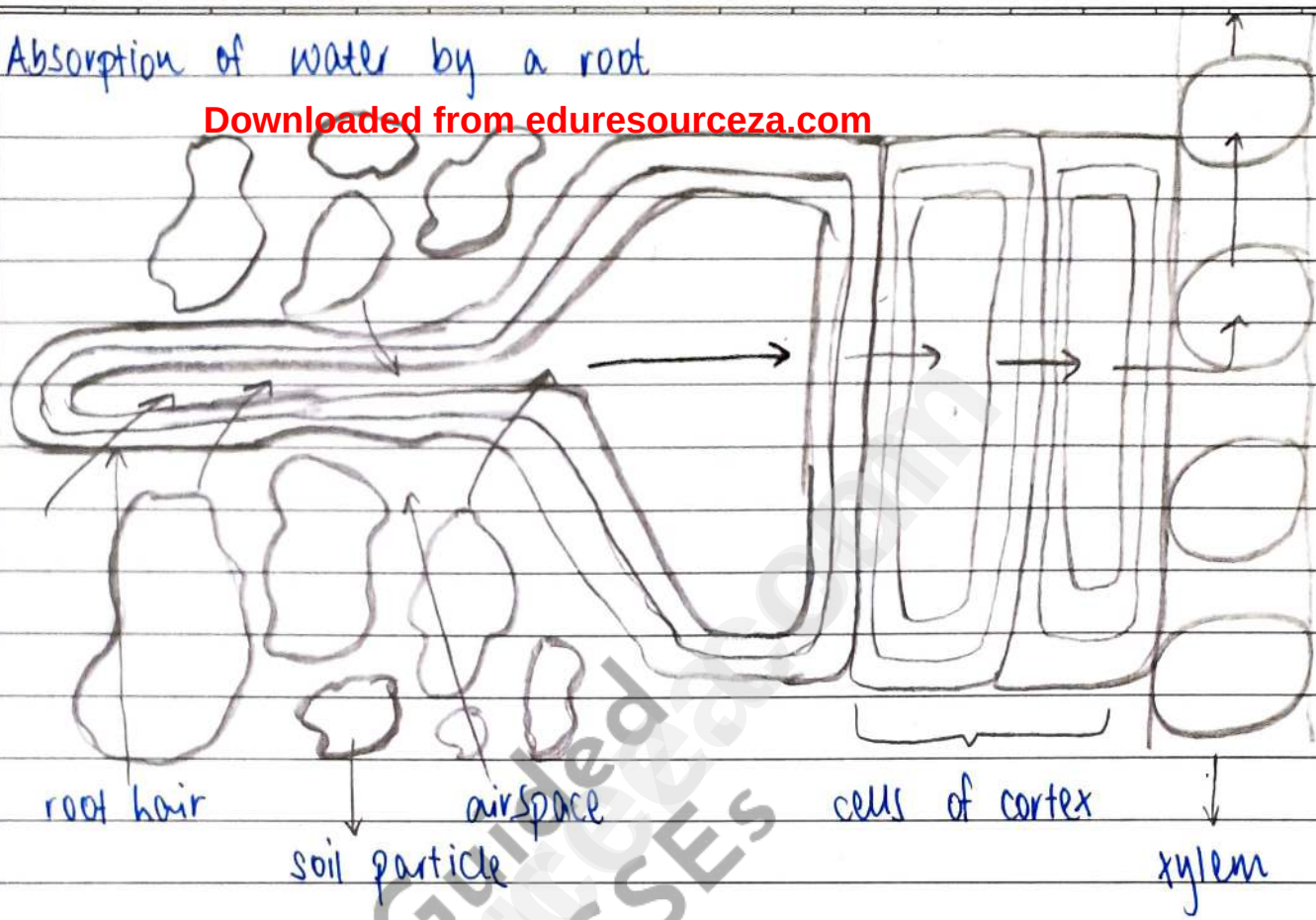
Transpiration

- The evaporation of water from surfaces of mesophyll cells in the leaves and loss of water vapour to the atmosphere.
- Water vapour can diffuse out when stomata are open.
- Water is pulled up the xylem vessels in the stem from the roots to the leaves by transpiration pull.
- Water is used for photosynthesis and to stop plant from wilting.
- Mass flow of water up xylem depends on two properties of water:
 - cohesion - tend to attract each other; stick to each other.
 - adhesion - tend to stick to the inside of the xylem vessels.
- The movement of water up the xylem is known as the transpiration stream.

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Absorption of water by a root

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TRANSPIRATION Air has least water potential - loss of water
Soil has highest water potential

- There is usually more water vapour in the intercellular/air spaces than there is in the air outside.
- Water vapour diffuses through the stomata into the air.
- The water lost is replaced by water pulled up through the xylem.

Transpiration is the evaporation of water at the surfaces of the mesophyll cells followed by the diffusion of water vapour through stomata to the atmosphere.

Wilting

- More transpiration takes place during the day than night as stomata are open (during the day) so that carbon dioxide can diffuse in.
- Stomata at night close to reduce the volume of water loss by transpiration.
- They may also close in hot and dry conditions.
- If the plant still does not get enough water, it will wilt.
- The cells will no longer be turgid, but be flaccid.
- The stem no longer stays upright.
- Leaves move downwards so are out of direct sun or light rays. They do not get as hot.
- When the temperature decreases, the plant can absorb more water than is lost by transpiration, and the leaves will recover.

Factors affecting transpiration

Light intensity [Downloaded from eduresourceza.com](https://www.eduresourceza.com)

- Light causes stomata to open.
- As light increases, stomata open wider, rate of transpiration increases.

Humidity -

- There is no concentration gradient for water vapour as it is somewhat the same as inside a leaf and the atmosphere.
- In dry conditions when humidity is low, the rate of transpiration is high. The concentration is very steep so water diffuses out of the leaves through the stomata.

Temperature -

- As temperature increases, water molecules on the cell surfaces have more kinetic energy and enter the air inside the leaf as water vapour.

Measuring transpiration

- It is not easy to measure rate of transpiration.
- A potometer can be used to measure rate of water uptake.
- The volume of water lost is slightly less than volume of water uptake by roots. This is because some of the water is used up in photosynthesis and in keeping the cells turgid.
- Potometer is set up and filled by submerging it in water. An air-bubble is allowed to form in the capillary tube.
- The distance moved by the bubble is a measure of the rate of water uptake.

T RANSLOCATION

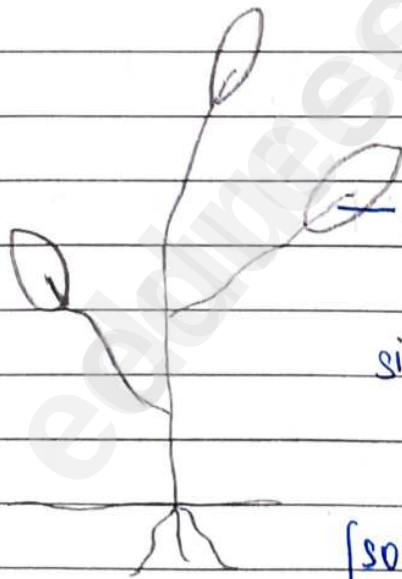
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- Food is made in the leaves by photosynthesis.
- Soluble products are sucrose, amino acids and fatty acids.
- These are carried in the phloem to all parts of the plant.

Translocation is the movement of sucrose and amino acids from the leaves to regions of respiration, growth and storage.

Sucrose is :

- broken down by enzymes to give simple sugar that are used in respiration
- changed to starch for storage in root cortex and in seeds.
- used to make cellulose for cell walls at root tip and shoot tip.
- stored in some fruits to make them sweet and attract animals.

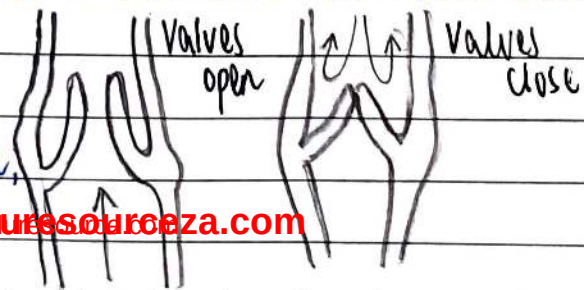


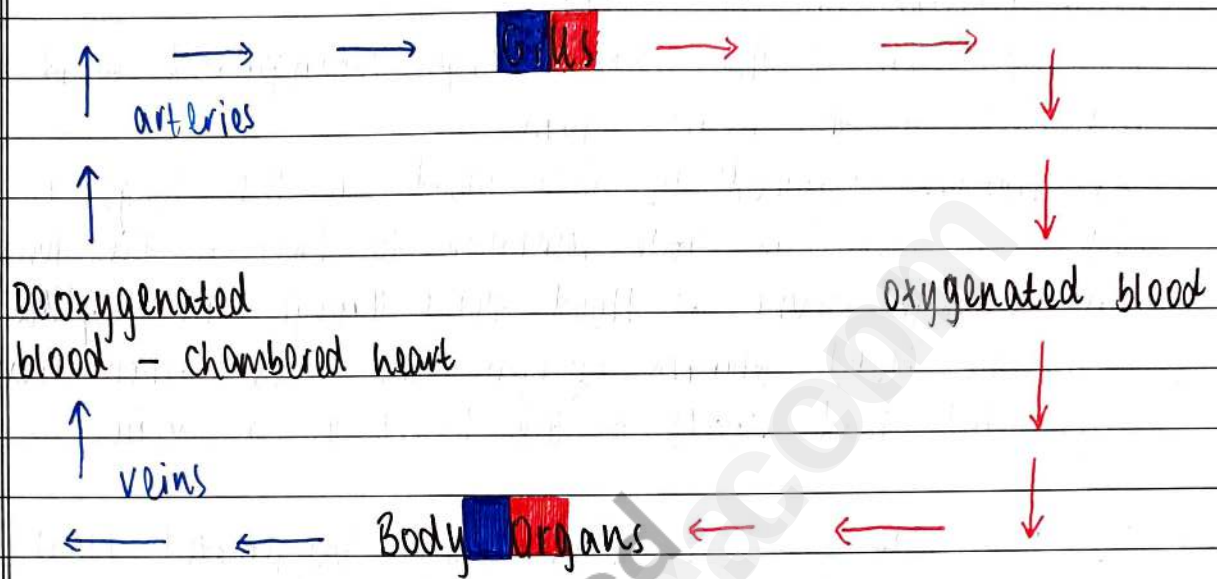
Phloem has bi-directional movement; whereas xylem has uni-directional movement.

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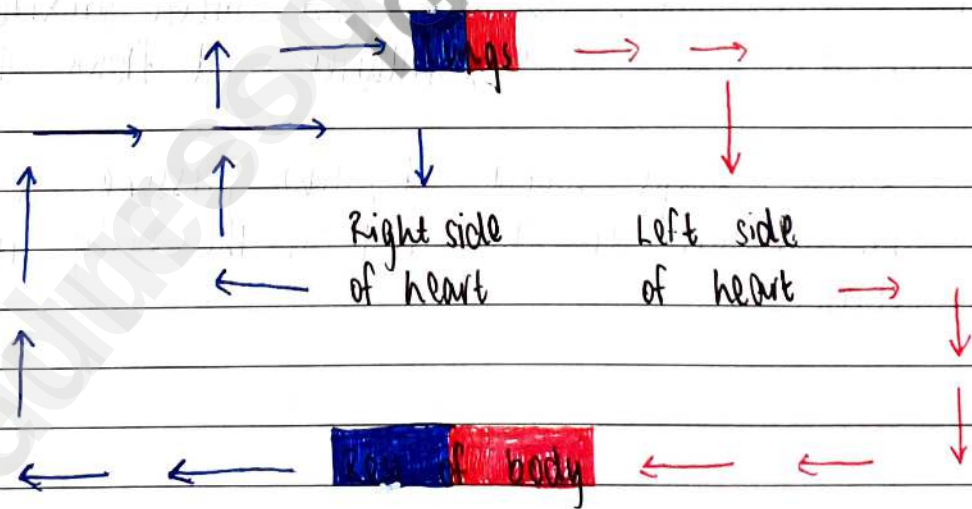
B7

- The heart is a pump which circulates blood through blood vessels.
- Blood flows in arteries away from the heart. - high pressure
- Blood flows in veins back to the heart. - low pressure
- The smallest blood vessels that connect arteries to veins are capillaries.
- Cells are very close to capillaries. Therefore, they receive a good supply of oxygen, and nutrients. They can also have carbon dioxide and waste removed efficiently.
- The circulatory system allows a one-way flow of blood around the body.
- The heart pumps blood, giving pressure, so that it flows inside the arteries. This helps to maintain one-way flow.
- This is good for getting blood to capillaries.
- High-blood pressure damages the delicate capillaries.
- Small muscular blood vessels known as arterioles reduce the pressure before blood enters the capillaries.
- When blood leaves the capillaries, the pressure is even lower.
- In veins, there are semi-lunar valves.
- Semi-lunar valves ensure that blood does not flow backwards, away from the heart.
- The valves open when pressure of blood pushes against them, and close when blood starts to back to fill the pockets.





- Fish have a single circulation in which bloods flows through the heart once in a circuit around the body.



- In a mammal, blood flows twice through the heart in one circuit.
- The septum is a thick wall of muscle that seperates the left side of the heart with the right side.

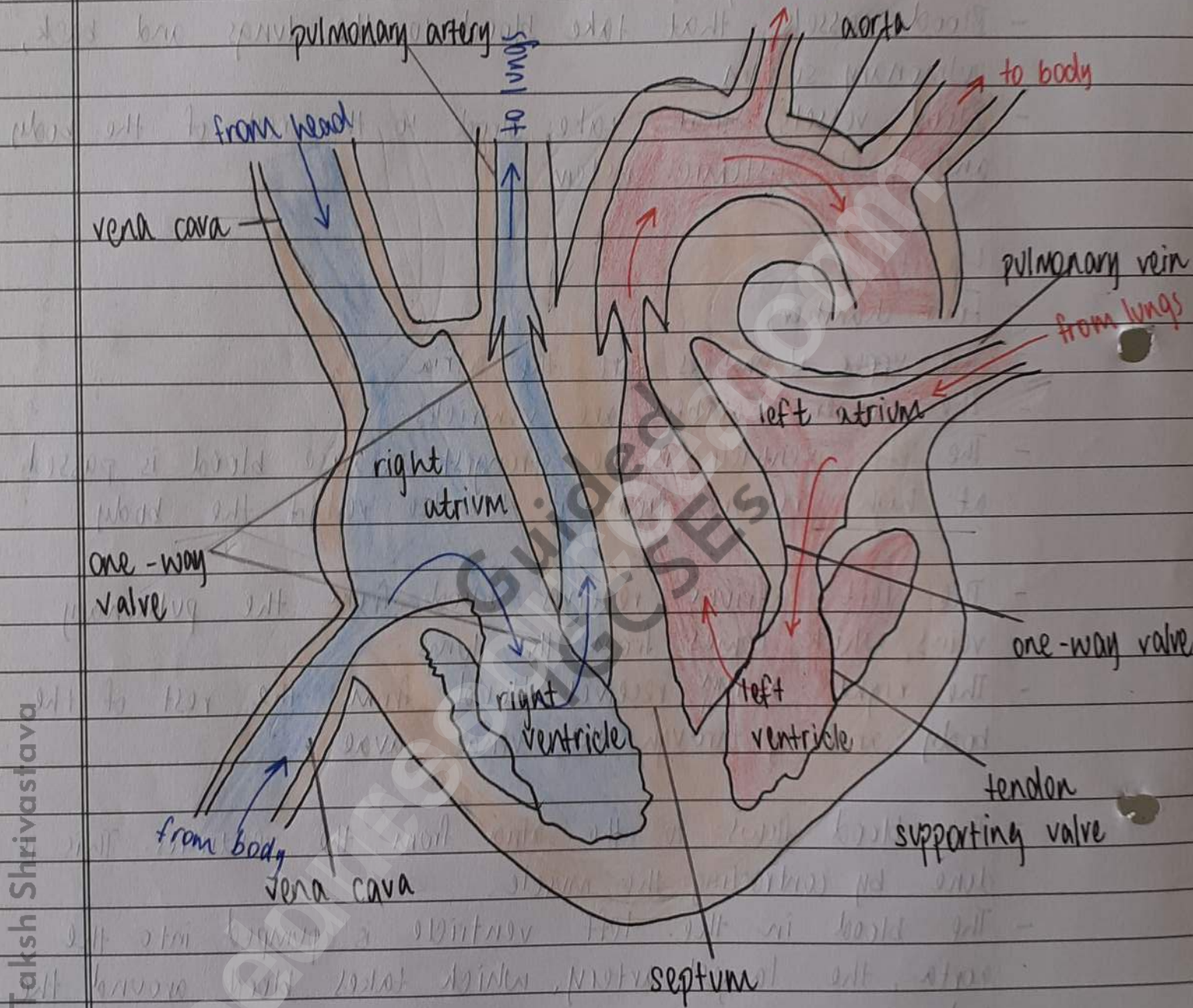
Blood circulation Downloaded from eduresourceza.com

- The right side of the heart pumps deoxygenated blood to the lungs and back to the heart again.
- The pressure required to force blood to the lungs is not very high as there is little resistance to flow in the lungs.
- Gas exchange occurs as blood flows through the capillaries in the lungs. The blood absorbs oxygen and loses carbon dioxide.
- Oxygenated blood returns to the heart in a vein.
- The left side of the heart pumps oxygenated blood to the rest of the body and back to the heart again.
- The pressure of blood leaving the left side is much greater than on the right side as there is more resistance to flow.
- Gas exchange occurs as blood flows through the capillaries in organs. Oxygen leaves the blood and carbon dioxide enters.
- Deoxygenated blood leaves capillaries and flows through veins.
- The heart pumps blood at low pressure to the lungs and at high pressure to the rest of the body in a double circulation.

- Blood vessels that take blood to the lungs and back, pulmonary system.
- Blood vessels that take blood to the rest of the body and back, systemic system.

Heart

- Four chambers
- The upper chambers are the atria.
- The lower chambers are ventricles.
- The left ventricle is the strongest because blood is passed at high pressure from it to the rest of the body.
- The left atrium receives blood from the pulmonary veins, which comes from the lungs.
- The right atrium receives blood from the rest of the body, arriving through the venae cavae.
- The blood flows to the atria from the ventricles. This is done by contracting the muscle.
- The blood in the left ventricle is pumped into the aorta, the largest artery, which takes blood around the body.
- The right ventricle pumps blood into pulmonary artery, which takes it to the lungs.
- Ventricles have thicker and more muscular walls than atria as they pump blood out of the heart to the rest of the body.
- Valves close with each heart beat.



- Blood vessels, on the outside of the heart, are called coronary arteries. These supply blood to the heart muscles.
- Muscles of the heart are so thick that nutrients and oxygen in the blood cannot fully diffuse to all the muscles.
- The heart needs a constant supply of nutrients and oxygen so that it can keep contracting and relaxing. The coronary arteries supply this.
- If a coronary artery gets blocked - for example, by a blood clot - the cardiac muscles run short of oxygen. This leads to a heart attack.
- Blockage of coronary arteries is called coronary heart disease (CHD).
 - Smoking cigarettes
 - Diet
 - Obesity
 - Stress
 - Genes
 - Gender

Heart beat

- A pulse is caused by the expansion and relaxation of an artery, which is due to the heart pushing blood through it.

Pulse rate = Heart rate

- Exercise Downloaded from eduresourceza.com faster heart beat $\rightarrow$ muscles use oxygen faster.

- Pacemaker: patch of muscle that controls the rate at which the heart beats, and sends electrical signals through the walls of the heart at regular intervals, making the muscles contract.

The pacemaker's rate changes according to the needs of the body.

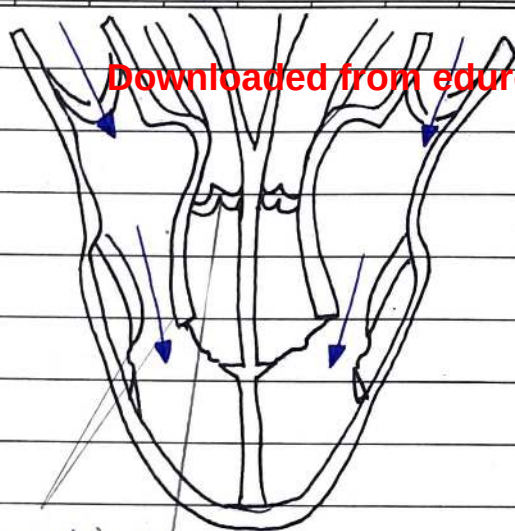
Rate of pacemaker = rate of heart beat

The brain sends impulses along nerves to the pacemaker.

- During exercise, muscles respire more quickly in order to release energy needed for movement. Hence, there is more carbon dioxide dissolved in the blood. This lowers the pH.
- Receptor cells sense the drop in pH and trigger an increase in the frequency of nerve impulse sent to the pacemaker.

Valves in the heart

- Contraction: heart becomes smaller - squeezes blood out
- Relaxation: heart becomes larger - allows blood to flow into chambers
- Atrioventricular valves stop blood flowing from the ventricles back to the atria.



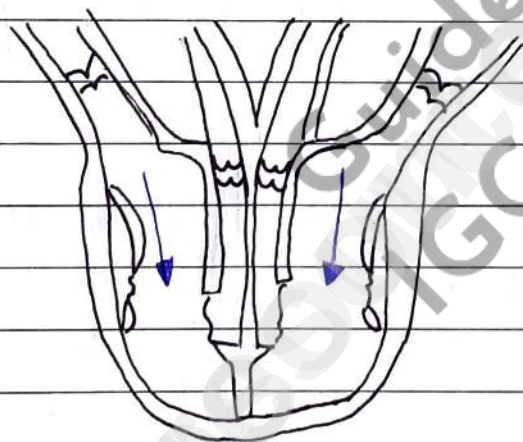
atrioventricular
valves

semi-lunar valves

- The (semi-lunar) valves are shut, preventing blood flowing into the ventricles.

- The muscles of the atria relax, allowing blood to flow into the heart from the veins.

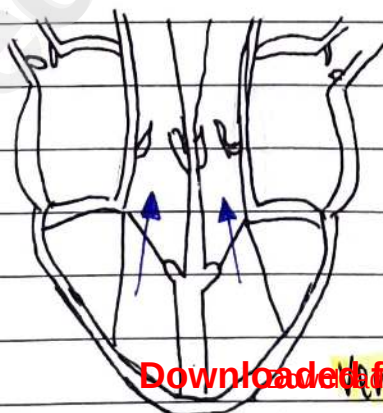
Relaxation: all muscles relaxed. Blood flows into heart.



- The (semi-lunar) valves remain shut.

- The valves in the veins are forced shut by the pressure of the blood.

- The muscles of the atria contract. The muscles of the ventricles remain relaxed. Blood is forced into the ventricles. This is atrial contraction.



- The (semi-lunar valves) are forced open by the pressure.

- The atrioventricular valves are forced shut by the pressure.

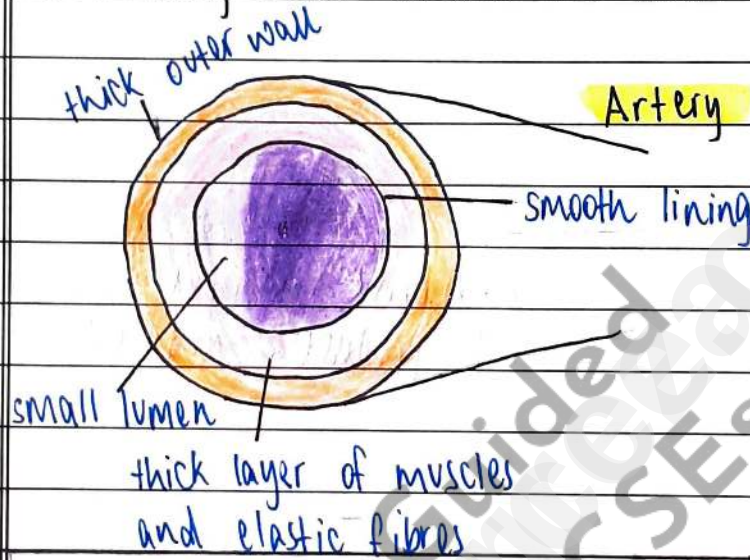
- The muscles of the ventricles contract, forcing blood out.

After ventricular contraction the muscles of the atria relax. Muscles of ventricles contract, forcing blood to the arteries.

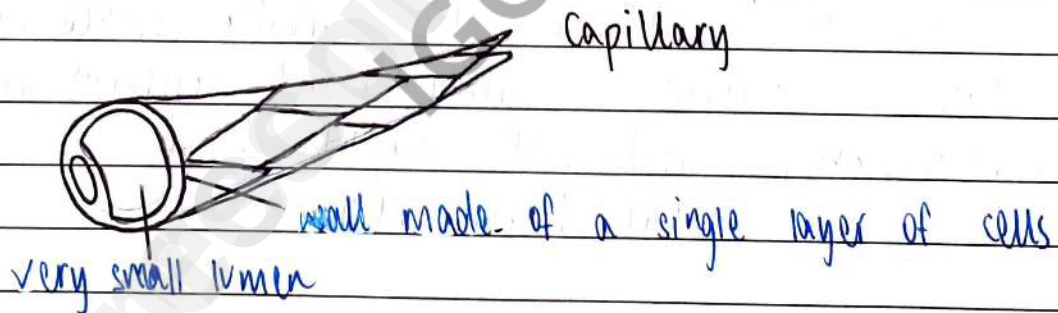
Blood vessels

Arteries, Capillaries, Veins

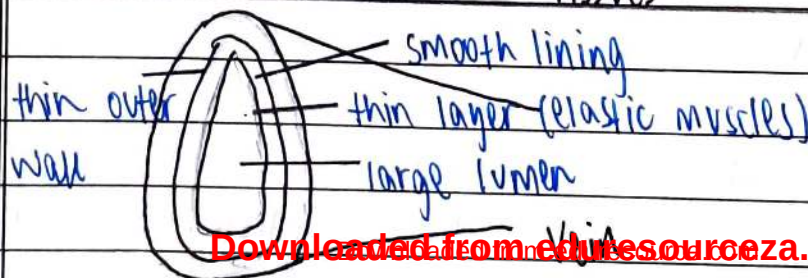
- carry blood away from the heart.
- divide again and again, and form tiny vessels called capillaries.
- capillaries join up and form veins.
- veins carry blood towards the heart.



- strength and elasticity needed to withstand the pulsing of the blood as it is pumped through the heart.
- small lumen decreases pressure



- no need for strong walls as blood pressure has become lost.
- thin walls and narrow lumen bring blood into close contact with blood tissues



- wide lumen offers less resistance
- valves prevent back flow
- pressure is lost, so no thick walls

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Blood

- Liquid part is called plasma.
- Floating in plasma are cells. Most of these are red blood cells (RBCs). A small number are white blood cells (WBCs).
- Small fragments form from special cells in the bone marrow. These are platelets.

Plasma transports :

- glucose
 - amino acids
 - mineral ions
 - hormones
 - carbon dioxide
- medicine suppress,
not produce antibodies

Red blood cells

- biconcave discs with no nucleus - greater surface area
- contain haemoglobin - a protein, which contains iron.
- transport oxygen and small amount of CO_2 .
- can squeeze through tiny capillaries

White blood cells

- variable shapes, have nucleus, squeeze through capillaries
- engulf and destroy pathogens (foreign bodies, which cause diseases)
- make antibodies
- some digest bacteria, in a process called phagocytosis.
- antibody production

Platelets

- small fragments of cells, with no nucleus
- help in blood clotting, preventing pathogens entering the body and preventing too much blood loss.

renal artery → kidneys → renal vein

pulmonary artery → lungs → pulmonary vein

[hepatic artery → liver → hepatic vein] not needed

*oxyhaemoglobin is an unstable structure