UR Revision Guide

iGCSE Biology

Photosynthesis

Summary

Green plants and algae use light energy to make their own food. They obtain the raw materials they need to make this food from the air and the soil. The conditions in which plants are grown can be changed to promote growth.

Photosynthesis

- Photo = light
- Synthesis = making of (glucose)
- Photosynthesis = making glucose using light

During photosynthesis:

- light energy is absorbed by a green substance called chlorophyll, which is found in chloroplasts in some plant cells and algae.
- This energy is used by converting carbon dioxide (from the air) and water (from the soil) into sugar (glucose).
- Oxygen is released as a by-product.

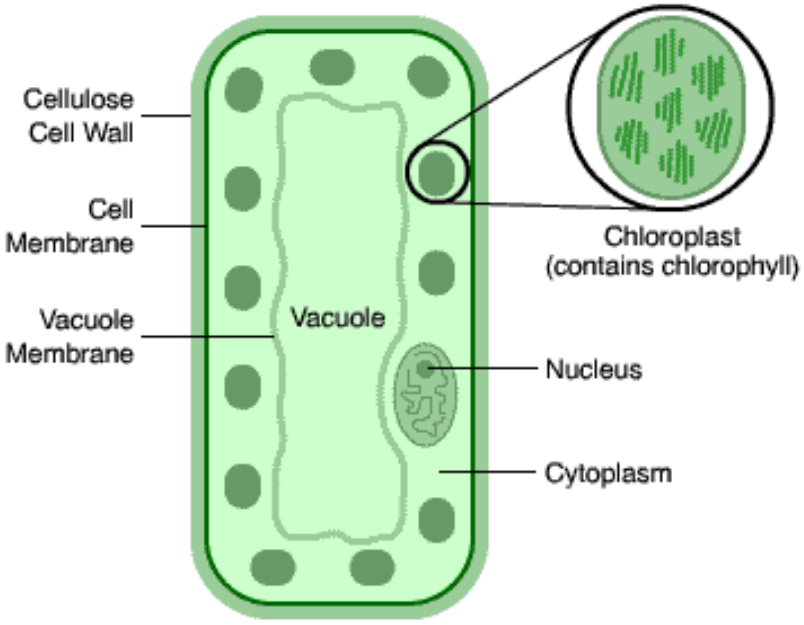
Photosynthesis is summarised by the equation:

$$\text{carbon dioxide} + \text{water} \xrightarrow{\text{light energy}} \text{glucose} + \text{oxygen}$$

Where does photosynthesis happen?

- Leaves are the main site of photosynthesis.
- Photosynthesis mainly in occurs in the mesophyll cells.
- These cells contain lots of chloroplasts.
- Chloroplasts contain chlorophyll.

A palisade mesophyll cell:



Factors that limit the rate of photosynthesis

1) Temperature

A low temperature will limit the rate as the molecules will move less and therefore the reaction happens slower

2) Carbon dioxide

A shortage of CO_2 will limit the rate as fewer molecules will be available for the reaction.

3) Light intensity

A shortage of light means there is less energy to power the reaction.

Limiting factors explained:

- Light, temperature and the availability of carbon dioxide interact and in practice any one of them may be the factor that limits photosynthesis.
- If one of these factors is closest to its minimum value it will limit the rate.
- Increasing this factor will increase the rate.
- The rate will continue to increase until another factor becomes limiting.
- Any further increase in the original factor will now not increase the rate.
- With no limiting factors, increasing a factor above a certain level will not increase the rate. All chlorophyll molecules are being used.

Farming practices

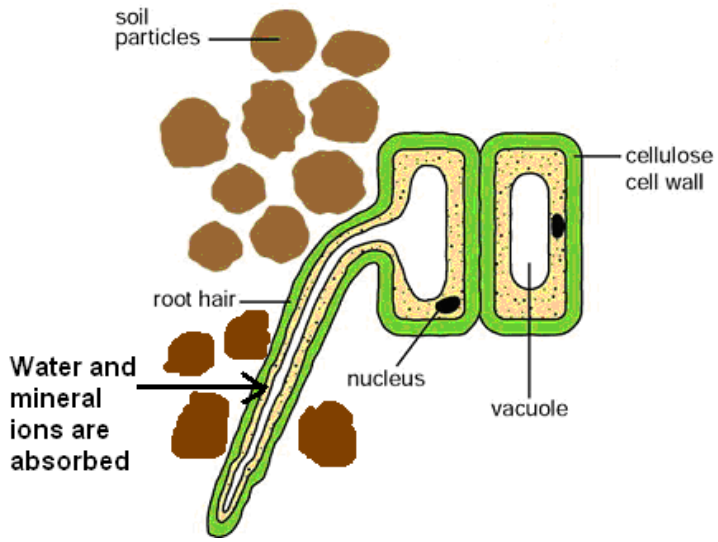
- Farmers artificially manipulate the environment in which they grow plants.
- They grow plants in greenhouses or in polythene tunnels.
- They can control the temperature in greenhouses using heaters and ventilation.
- They can artificially increase the carbon dioxide levels.
- They can control the light using fluorescent lamps.
- By doing all of this, their plants grow faster and certain plants can be grown in this country out of their natural growth season. Eg tomatoes can be grown all year round.
- Therefore, they increase their profits.

How do plants and algae use glucose?

- The glucose produced in photosynthesis may be converted into insoluble starch for storage
- Plant cells use some of the glucose produced during photosynthesis for respiration.
- Some glucose in plants and algae is used:
  - to produce fat or oil for storage
  - to produce cellulose, which strengthens the cell wall
  - to produce proteins:
    - To produce proteins, plants also use nitrate ions that are absorbed from the soil.

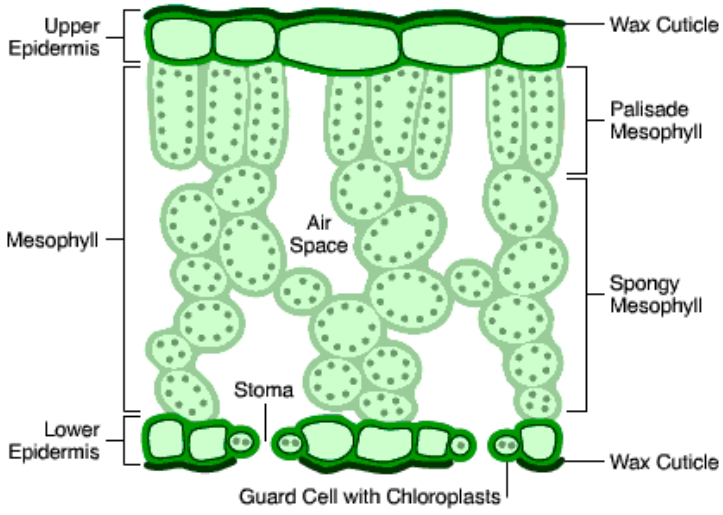
Absorption of water by roots

- The surface area of the roots is increased by root hairs.
- Most of the water and mineral ions are absorbed by root hair cells.
- Water is absorbed by osmosis.
- Most of the mineral ions are absorbed by active transport.



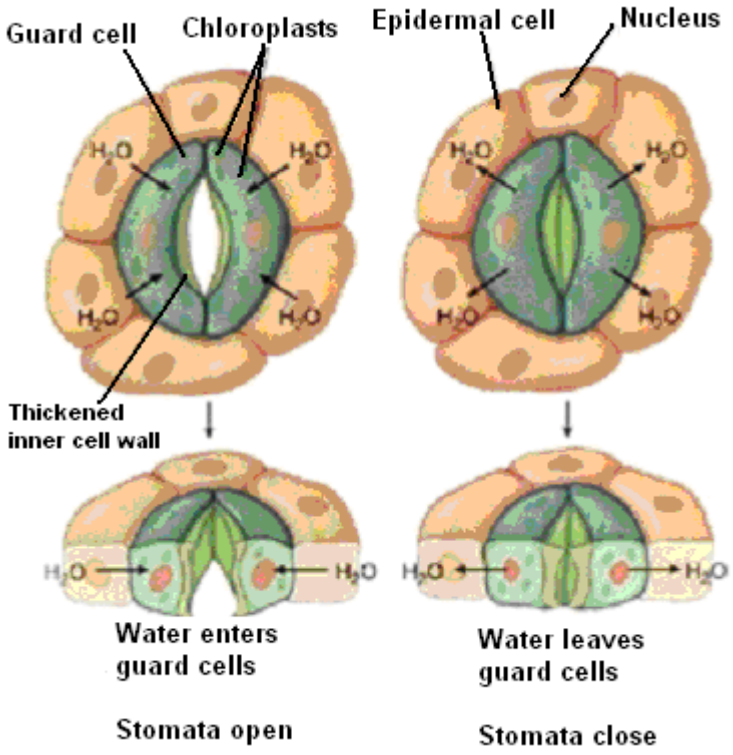
Gas Exchange in the leaf

- The surface area of leaves is increased by the flattened shape and internal air spaces.



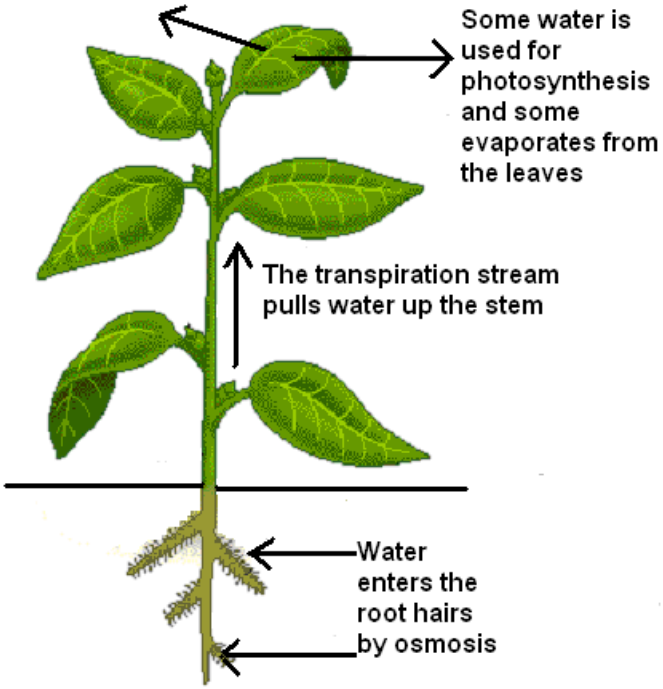
- Most photosynthesis takes place in the palisade cells.
- Carbon dioxide needs to reach the palisade cells.
- Plants have stomata to obtain carbon dioxide from the atmosphere.
- This carbon dioxide is used in photosynthesis.

- The size of stomata is controlled by guard cells, which surround them.
- Stomata open during daylight hours, to enable carbon dioxide to diffuse in.



Transpiration

- The process by which plants lose water vapour from the surface of their leaves.
- It evaporates into the air spaces in the leaf, and then diffuses out through the stomata.



- Transpiration is more rapid in hot, dry and windy conditions:

    - Heat causes the water to evaporate quicker.
    - Dry conditions increases the water vapour concentration gradient.
    - Wind moves the water vapour away from the leaf, maintaining the concentration gradient.
- Most of the water lost by transpiration leaves through the stomata.
- Stomata close when it is dark, when carbon dioxide is not required.
- This reduces the amount of water lost by the plant at a time when it is not needed for photosynthesis.
- If plants lose water faster than it is replaced by the roots, the stomata can close to prevent wilting.

Respiration

Summary

Respiration in cells can take place aerobically or anaerobically. The energy released is used in a variety of ways. The human body needs to react to the increased demand for energy during exercise.

Respiration

- Definition: The process of transferring energy from food molecules in every living cell.
- Aerobic respiration - uses oxygen
- Anaerobic respiration - uses no oxygen
- All chemical reactions inside cells are controlled by enzymes.

Aerobic respiration

- Glucose reacts with oxygen, producing carbon dioxide and water as waste products.
- This takes place continuously in animals and plants.

Word equation:

Glucose + Oxygen $\longrightarrow$ Carbon dioxide + Water + Energy

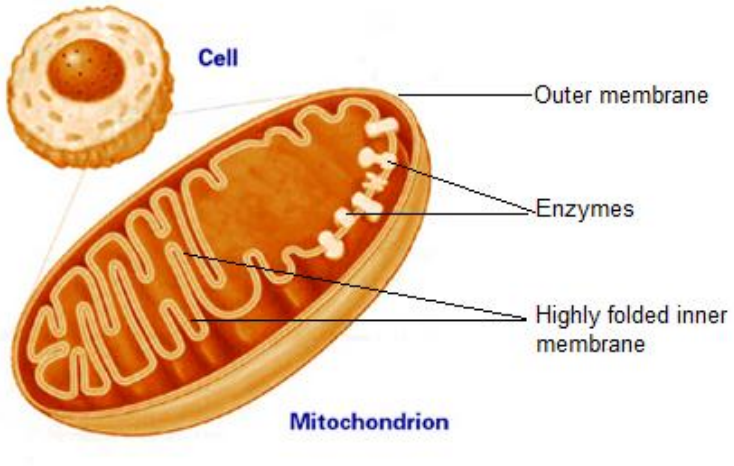
Chemical equation (do not need to learn!):

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

- Respiration actually involves a series of many small reactions.
- Each reaction is controlled by an enzyme.

Mitochondria

- Most of the reactions in respiration happen in the mitochondria.
- The inner surface of the mitochondria is highly folded to increase the surface area for enzymes.



Energy use

The energy that is released during respiration is used:

- To build up larger molecules using smaller ones.
- In animals, to enable muscles to contract.
- In mammals and birds, to maintain a steady body temperature in colder surroundings.
- In plants, to build up sugars, nitrates and other nutrients into amino acids which are then built up into proteins.

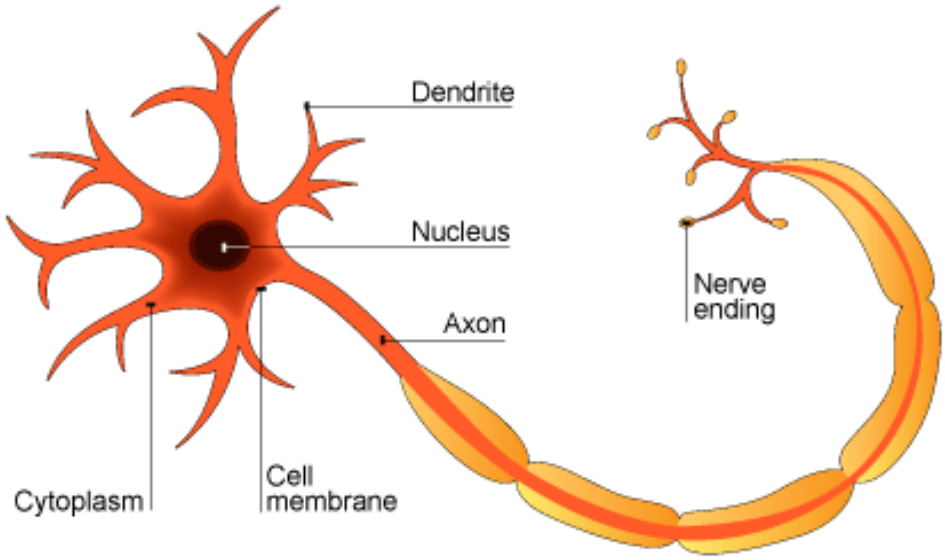
Nerves and Hormones

Summary

The nervous system and hormones enable us to respond to external changes. They also help us to control conditions inside our bodies. Hormones are used in some forms of contraception and in fertility treatments. Plants also produce hormones and respond to external stimuli.

The nervous system

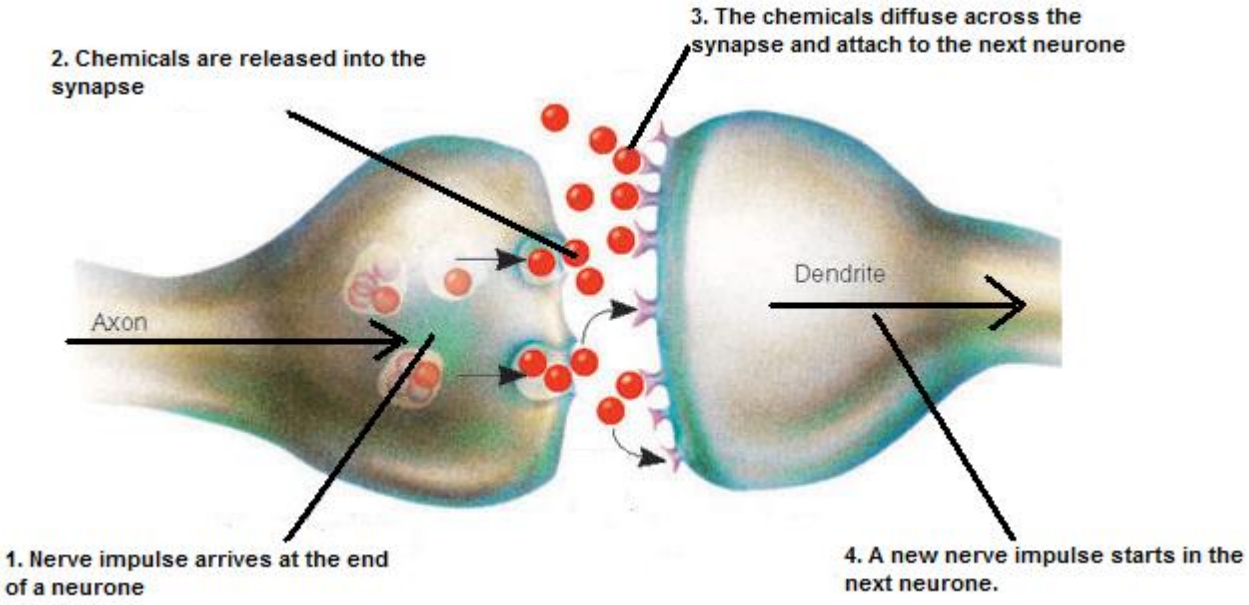
- The nervous system enables humans to react to their surroundings and coordinate their behaviour.
- Central nervous system = brain plus spinal cord.
- Stimuli = changes in the environment.
- Receptors = cells that detect stimuli
- Nerve impulse = electrical message that passes along a neurone.
- Neurones = nerve cells.



- Neurones are highly specialised cells:
    - Very long so nerve impulses can travel quickly to different parts of the body.
    - Branched ends to form connections with many other neurones.
    - Insulating sheath to maintain the nerve impulse.
- Nerve = a bundle of neurones connected to brain or spinal cord.
- Sensory neurone = nerve cell that transmits nerve impulse from a receptor to the central nervous system.
- Relay neurone = neurone in the central nervous system.
- Motor neurone = nerve cell that transmits nerve impulse from the central nervous system to an effector.
- Effector = a structure that the nervous system causes to respond – a muscle or gland.

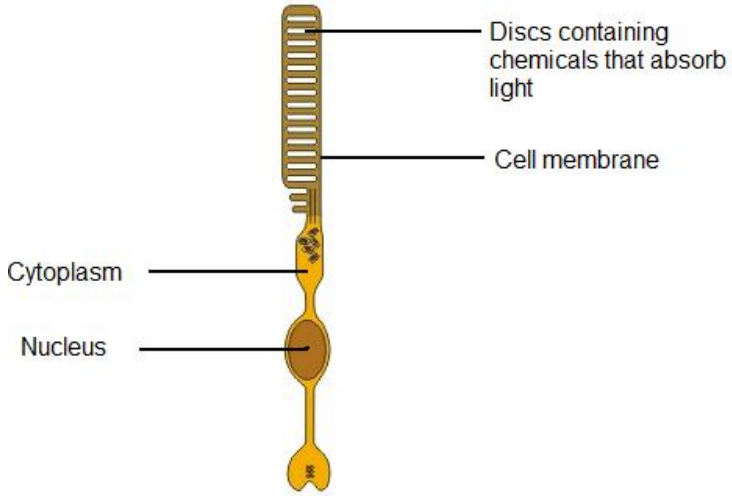
Synapses

- Synapses = junctions between nerve cells.
- When a nerve impulse arrives at the end of a neurone, chemicals are released.
- These diffuse across the synapse, and cause a new nerve impulse in the next neurone.



Receptors

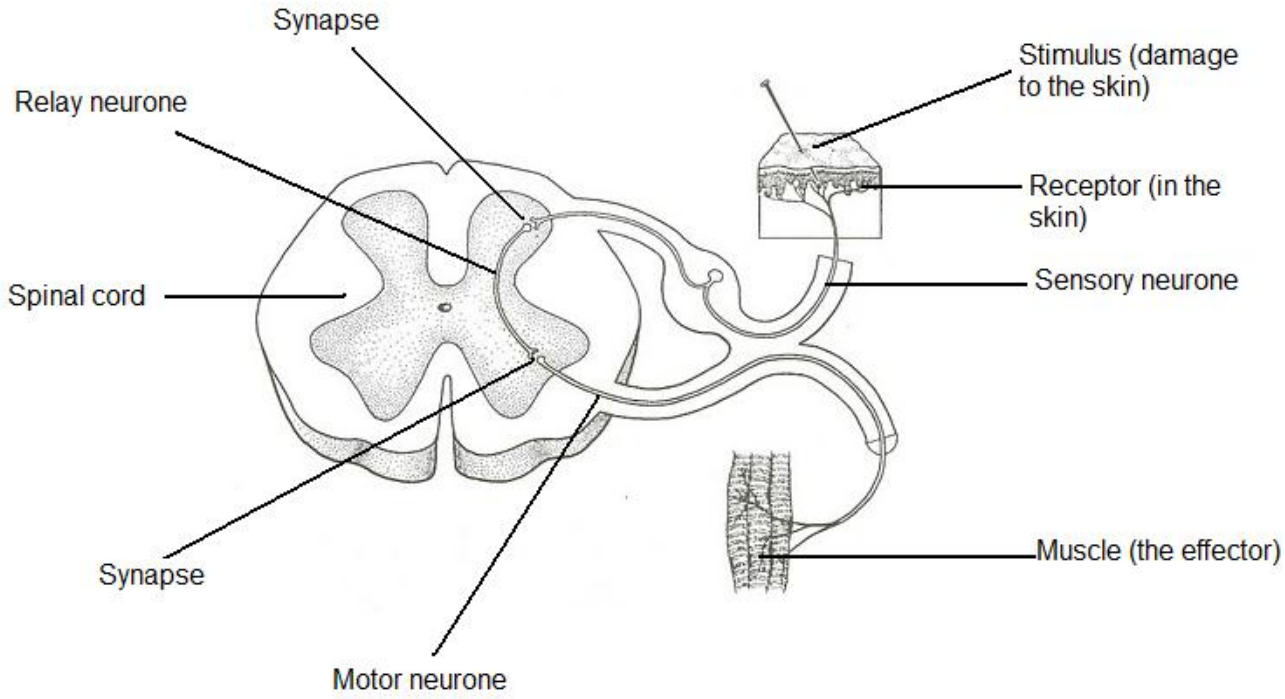
- Receptors and the stimuli they detect include:
  - receptors in the eyes that are sensitive to light
  - receptors in the ears that are sensitive to sound
  - receptors in the ears that are sensitive to changes in position and enable us to keep our balance
  - receptors on the tongue and in the nose that are sensitive to chemicals and enable us to taste and to smell
  - receptors in the skin that are sensitive to touch, pressure, pain and to temperature changes.
- **Light receptor cells**, like most animal cells, have a nucleus, cytoplasm and cell membrane.



- Information from receptors passes along neurones in nerves to the spinal cord and the brain.
- The brain coordinates the response.

Reflex actions

- Reflex actions are automatic and rapid.
- They are simple responses to stimuli that often protect the body from harm.
- They often involve sensory, relay and motor neurones.
- The pathway starting with a stimulus and resulting in a response does not require conscious control by the brain.
- In a simple reflex action:
    - Impulses from a receptor pass long a sensory neurone to the central nervous system
    - There is a synapse between a sensory neurone and a relay neurone in the central nervous system
    - A chemical is released at the synapse between the sensory neurone and a relay neurone.
    - This causes an impulse to be sent along the relay neurone
    - A chemical is then released at the synapse between a relay neurone and motor neurone in the central nervous system
    - This causes impulses to be sent along a motor neurone to the effector
    - This is either a muscle or a gland
    - A muscle responds by contracting
    - A gland responds by releasing (secreting) chemical substances eg salivary gland releases saliva.

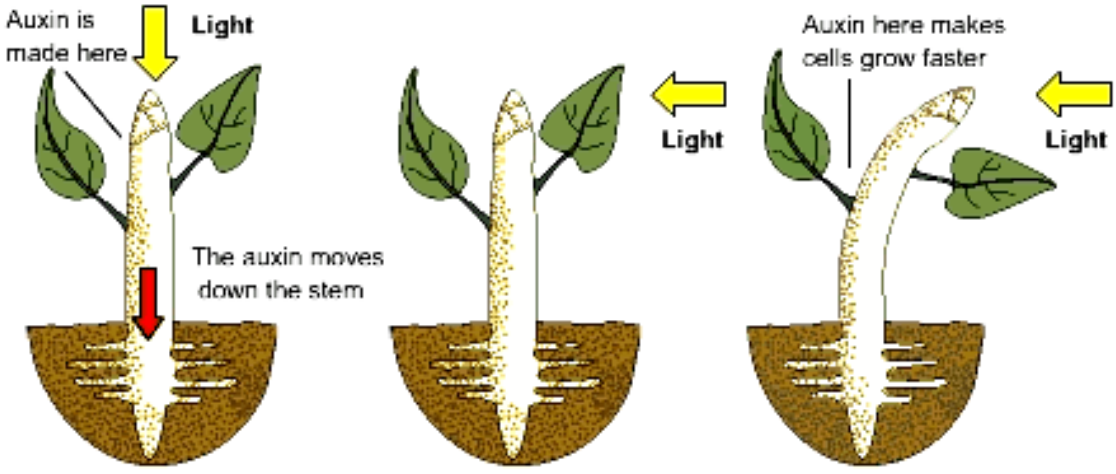


Control in the human body

- Internal conditions that are controlled include:
    - The water content of the body:
        - Water leaves the body:
            - via the lungs when we breathe out
            - via the skin when we sweat to cool us down.
        - Excess water is lost via the kidneys in the urine
    - The ion content of the body:
        - Ions are lost via the skin when we sweat
        - Excess ions are lost via the kidneys in the urine
    - Temperature:
        - To maintain the temperature at which enzymes work best.
        - Enzymes are protein molecules that control reactions inside and outside cells.
        - They are sensitive to changes in temperature and work best at body temperature – 37^{o}C.
    - Blood sugar levels:
        - To provide the cells with a constant supply of energy.
        - We take in sugars as carbohydrate in our food.

Control in plants

- Plants are sensitive to light, moisture and gravity:
- Their shoots grow:
    - towards light
    - against the force of gravity
- Their roots grow:
    - towards moisture
    - in the direction of the force of gravity.
- Plants produce hormones to coordinate and control growth.
- Auxin controls phototropism and gravitropism (also called geotropism).
- The responses of plant roots and shoots to light, gravity and moisture are the result of unequal distribution of hormones, causing unequal growth rates.

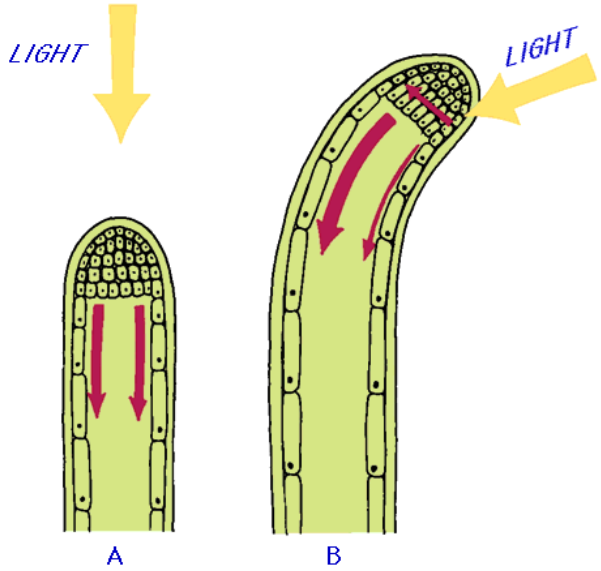


Auxin diffuses down the shoot stimulating growth.

If one side of the shoot is in the light, auxin diffuses away from the light.

The side of the shoot in the shade has more auxin, so grows faster, causing the shoot to bend towards the light.

- The auxin diffuses away from the stimulus.
- It affects the growth of cells in different ways.
- In the shoots:
    - It causes increased cell growth
    - This causes the shoot to curve towards the stimulus.



- In the roots:
    - It inhibits cell growth.
    - This causes the root to curve away from the stimulus.

<u>The use of artificial plant hormones</u>

- Plant growth hormones are used in agriculture and horticulture.
- Agriculture = large scale business involving cultivating of soil, to produce crops, and raise livestock.
- Horticulture = small scale cultivation of fruits, vegetables, flowers, or ornamental plants typically in a garden.
- Chemicals are synthesised that are similar to plant hormones.
- Some people are concerned about these chemicals entering the food chain and causing toxic effects.

Weed killers

- Chemicals that are used that are specific to the weeds eg dandelions.
- They cause the weed to grow very quickly.
- The weed cannot sustain this rate of growth and dies.
- This also kills other wild plant species that are not weeds.

Rooting hormones

- Cuttings are taken from a plant.
- The cutting is dipped into rooting powders.
- The hormone causes cells in the cutting to develop into roots.

Infectious Disease

Summary

Our bodies provide an excellent environment for many microbes which can make us ill once they are inside us. Our bodies need to stop most microbes getting in and deal with any microbes which do get in. Vaccination can be used to prevent infection.

Pathogens

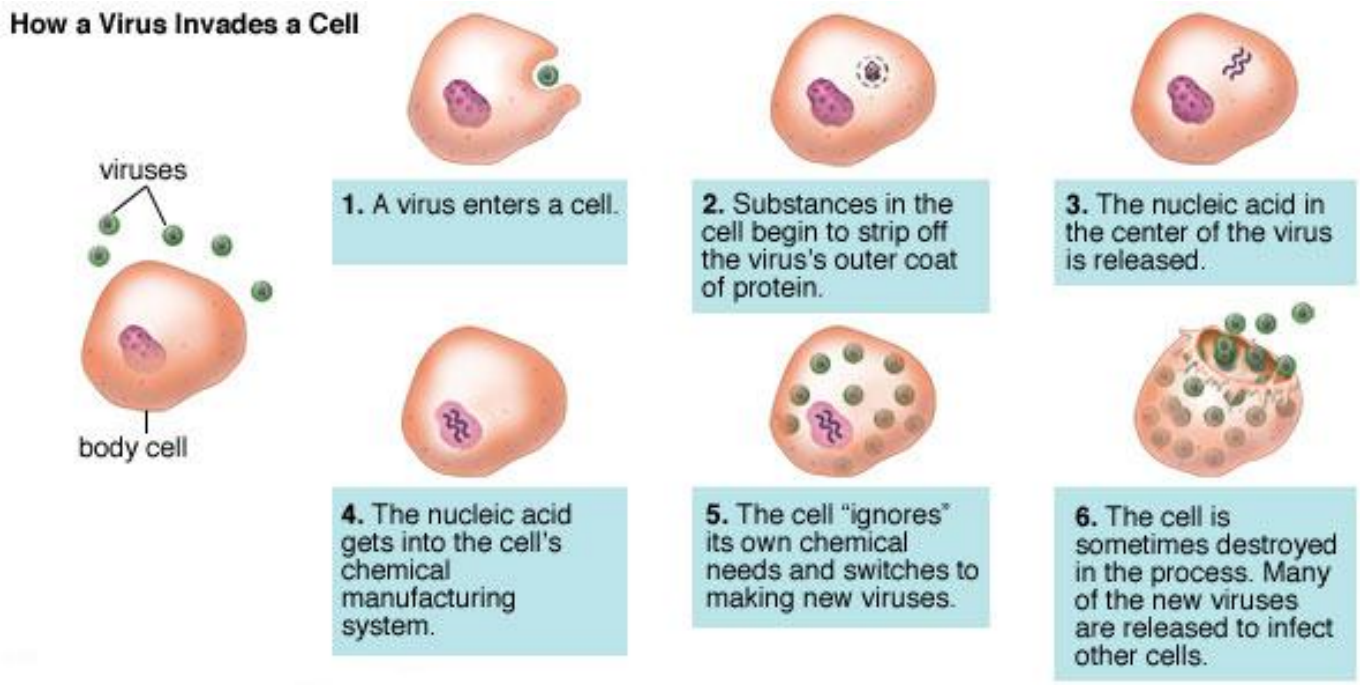
- Microorganisms that cause infectious disease are called pathogens.
- Disease occurs when large numbers of pathogenic micro-organisms enter the body.

Bacteria

- Not all bacteria are pathogens.
- Pathogenic bacteria reproduce rapidly inside the body and may produce poisons (toxins) which make us feel ill.
- Example: *E.coli* produces toxins that cause fever symptoms when we have food poisoning.

Viruses

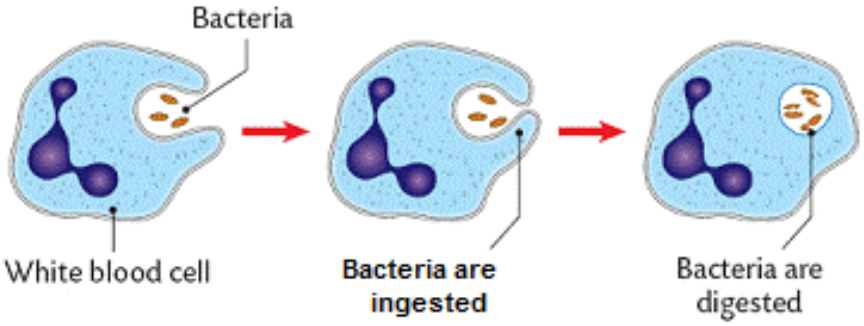
- Viruses are much smaller than bacteria.
- All viruses are pathogens.
- Viruses also produce toxins and they damage the cells in which they reproduce, leading to illness.
- Viruses replicate by invading cells, reproducing inside them and bursting them.
- This causes damage to tissues, leading to illness.



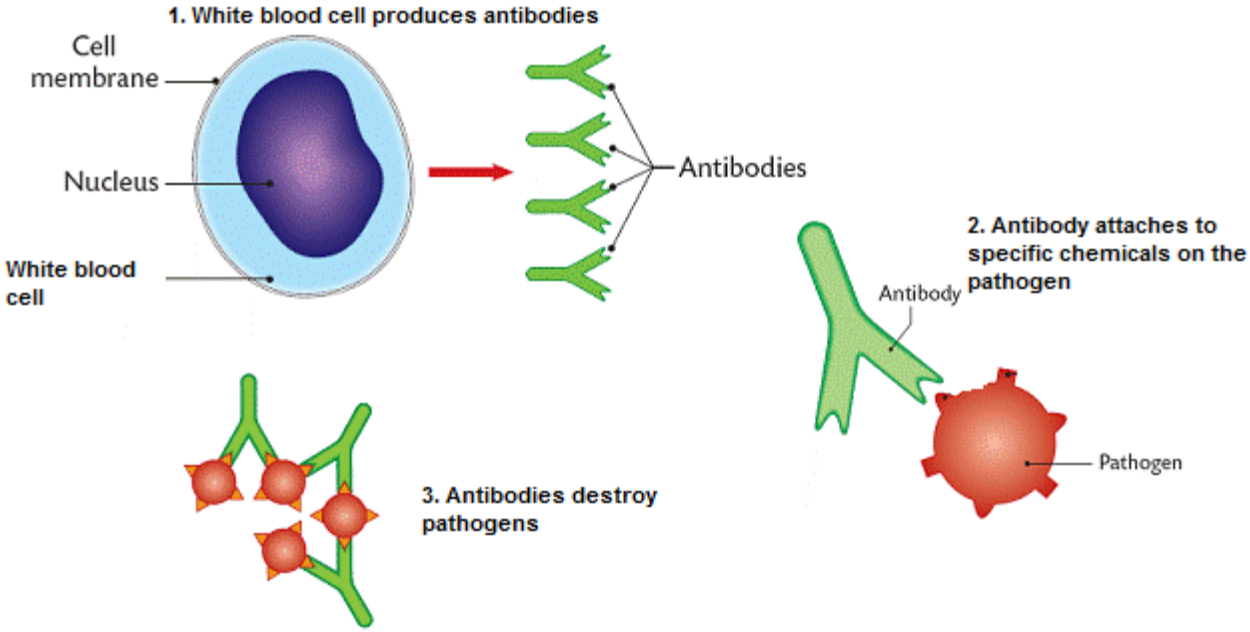
- Examples:
  - HIV damages white blood cells, reducing immunity and leading to AIDS.
  - Influenza virus released toxins which cause aches and fever symptoms.

The immune system

- The body has different ways of protecting itself against pathogens.
- White blood cells defend our internal environment from pathogens
- These form part of our immune system.
- There are various types of white blood cells:
    - Cells that ingest and destroy microorganisms



- Cells that produce antitoxins that destroy toxins released by pathogens
- Cells that produce antibodies that destroy specific pathogens:
    - They produce specific antibodies to kill a particular pathogen.
    - This leads to immunity from that pathogen.
    - The body is able to rapidly produce large numbers of the specific antibodies if it is exposed to the same pathogen in the future.
    - In some cases, dead or inactivated pathogens stimulate antibody production.



    - This also leads to immunity.

Eg Influenza

- A viral disease.
- Most people recover in a week.
- People who are old or very young or already ill can die.
- Different strains of influenza affect other animals.
- These rarely affect humans, because humans need to directly contact an infected animal.
- Humans that are infected may be more likely to die than if they had human influenza.
- Most of these viruses cannot be transmitted from human to human.
- However, there are concerns that the viruses could mutate and become able to be transmitted between humans.
- If it does this, it will start off by causing an epidemic, which may spread to become a pandemic.
- Many people could die, particularly very old people, very young people, and people who are already ill.

Immunisation

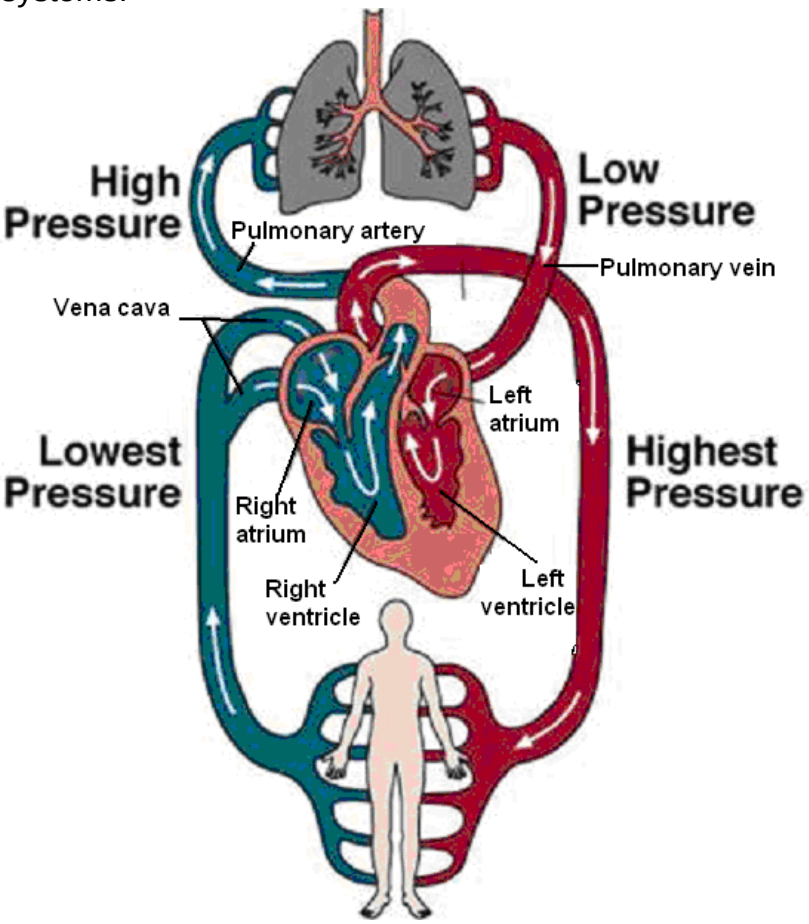
- If a large proportion of the population is immune to a pathogen, the spread of the pathogen is very much reduced.
- Eg small pox was completely eradicated by the 1970s.
- People can be immunised against a disease by introducing small quantities of dead or inactive forms of the pathogen into the body (vaccination).
- Vaccines stimulate the white blood cells to produce antibodies that destroy the pathogens.
- This makes the person immune to future infections by the microorganism.
- The body can respond by rapidly making the correct antibody, in the same way as if the person had previously had the disease.
- An example is the MMR vaccine used to protect children against measles, mumps and rubella.

How are dissolved materials transported around the body?

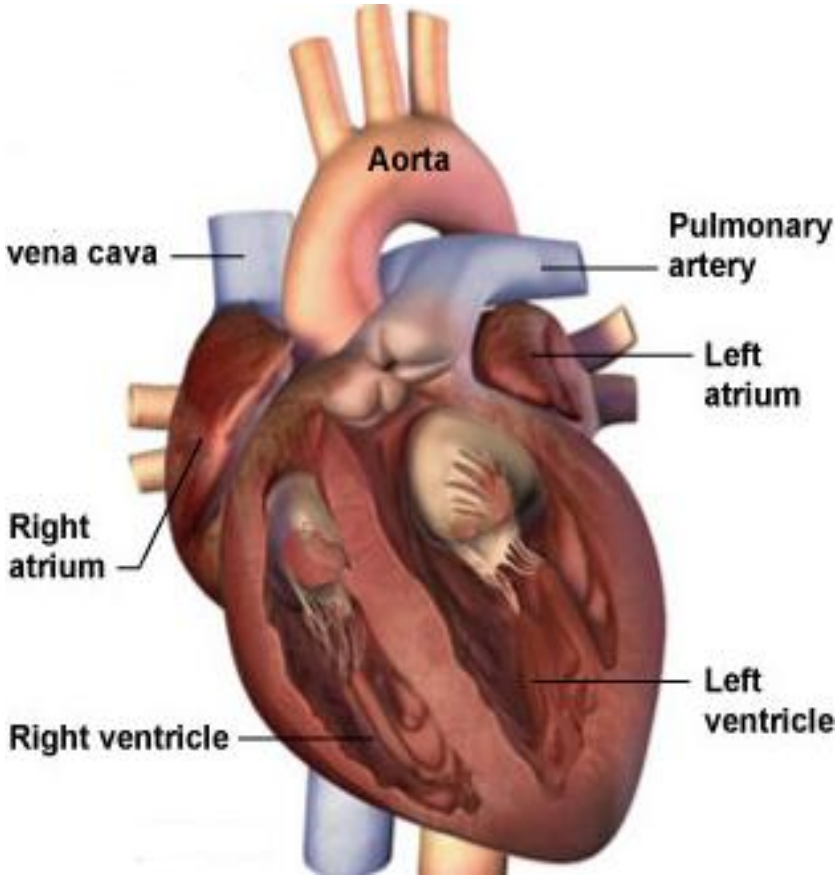
- Substances are transported around the body by the circulation system:
  - The heart
  - The blood vessels
  - The blood
- They are transported from where they are taken into the body to the cells, or from the cells to where they are removed from the body.
- Substances are taken in:
  - In the digestive system
  - In the lungs
- Substances are removed:
  - From the lungs
  - By the kidneys

The Heart

- The heart pumps blood around the body.
- Its walls are mainly made of muscle.
- This muscle contracts to pump blood through the circulation systems.
- It is a double pump, because there are two separate circulation systems:
  - One to the lungs
  - One to all the other organs of the body.
- The blood passes through the heart twice in order to pass round both of these circulation systems.

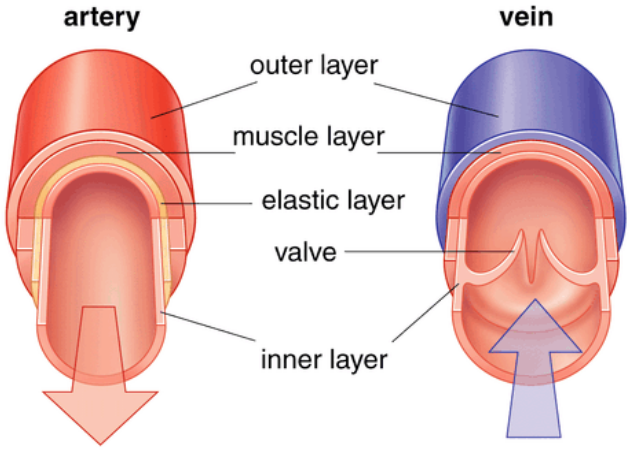


- Blood is pumped to the lungs from the right ventricle through the pulmonary artery.
- The blood returns from the lungs to the left atrium through the pulmonary vein.
- Blood is pumped to the organs of the body from the left ventricle through the aorta.
- Blood returns to the heart from the organs into the right atrium through the vena cava.

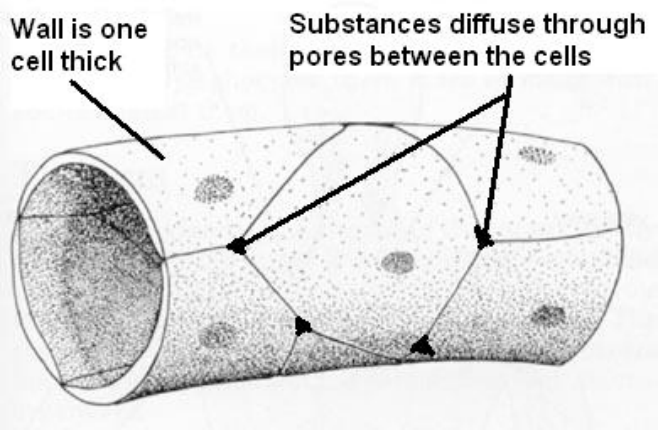


Blood vessels

- Blood flows from the heart to the organs through arteries and returns through veins.



- In the organs, blood flows through capillaries.
- Substances needed by cells in the body tissues pass out of the blood, and substances produced by the cells pass into the blood through the walls of the capillaries.



Arteries	Capillaries	Veins
Carry blood away from the heart to the organs.	Carry blood away from arteries into organs then back into veins.	Carry blood away from the organs back to the heart.
High blood pressure.	Decreasing blood pressure.	Low blood pressure.
Elastic to withstand high blood pressure.	No elastic tissue – walls one cell thick.	Not elastic.
Muscular walls, to create a pulse, to maintain blood pressure.	No muscle – walls one cell thick.	Very little muscle.
Rarely contain valves.	No valves.	Contain valves to control the direction of blood flow.

Blood

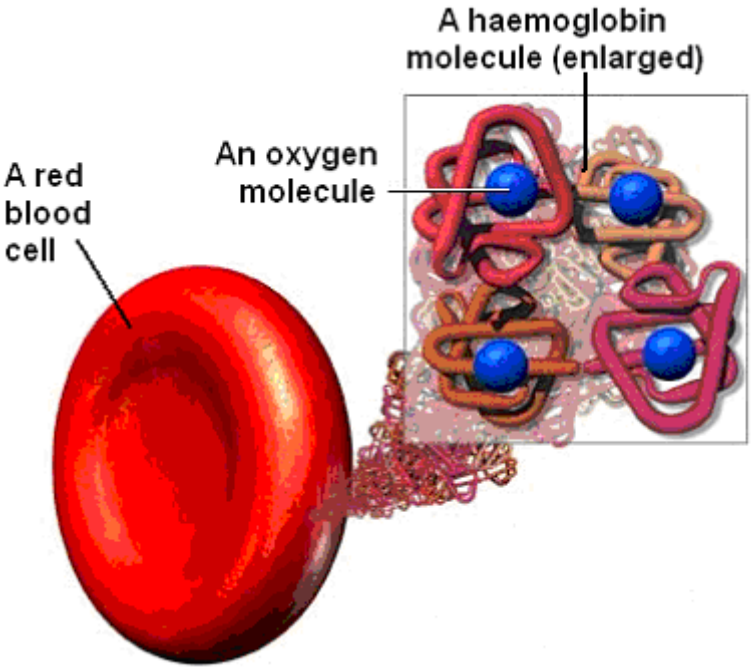
- Blood has two main components:
  - Plasma
  - Cells

Plasma:

- The liquid part of the blood.
- Blood plasma transports:
  - Carbon dioxide from the organs to the lungs
  - Soluble products of digestion from the small intestine to other organs:
    - Glucose
    - Amino acids
  - Urea from the liver to the kidneys.

Blood cells:

- White blood cells – involved in the immune system (covered in Unit 1).
- Platelets – fragments of cells; involved in blood clotting.
- Red blood cells transport oxygen from the lungs to the organs.



- Red blood cells have no nucleus.
- They are packed with a red pigment called haemoglobin.
- In the lungs:
    - Oxygen diffuses into the red blood cells.
    - Haemoglobin combines with oxygen to form oxyhaemoglobin.
- In the other organs:
    - Oxyhaemoglobin splits up into haemoglobin and oxygen.
    - Oxygen diffuses out of the red blood cell.
- They have a biconcave shape.
- This increases their surface area to increase rate of diffusion across the cell membrane.

<u>The role of respiration during exercise</u>

- Muscles contract to move the bones in our bodies.
- Respiration releases energy, which is used to contract the muscles:
- When we exercise, our muscles contract more quickly and with more force.
- This requires more energy.
- This requires more glucose and oxygen.
- Also, more carbon dioxide is created which needs to be removed.
- The human body needs to react to the increased demand for energy during exercise.

Changes during exercise

- During exercise a number of changes take place:
    - The rate and depth of breathing increases.
        - This increases the rate of gaseous exchange.
        - More oxygen is taken into the blood.
        - More carbon dioxide is removed from the blood.
    - The heart rate increases.
        - This increases rate of blood flow to the muscles
- All of these changes increase the blood flow to the muscles and so increase the supply of sugar and oxygen and increase the rate of removal of carbon dioxide.

Glycogen

- Glucose is stored as glycogen is in the muscles.
- During exercise, glycogen is broken down into glucose in the muscles.
- This increases the amount of glucose that can be respired.