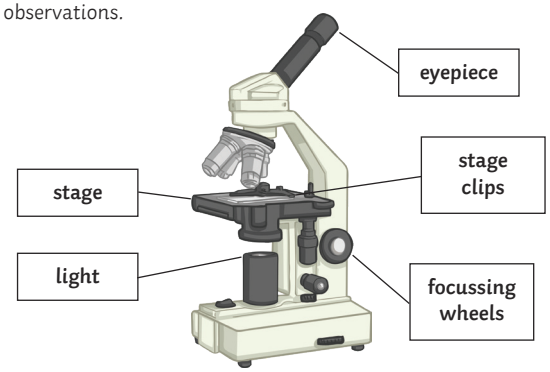
AQA Cell Biology Knowledge Organiser

Required Practical

Microscopy Required Practical

- Includes preparing a slide, using a light microscope, drawing any observations – use a pencil and label important observations.



Osmosis and Potato Practical

- Independent variable – concentration.
- Dependent variable – change in mass.
- Control variable – volume of solution, temperature, time, surface area of the potato.

The potato in the sugar solution will lose water and so will have less mass at the end; the potato in the pure water solution will gain water.

Culturing Microorganisms in the Lab: Use agar jelly which contains nutrients. The bacteria will form colonies on the agar. Use inoculating loops to add the bacteria to the agar jelly. In a school lab the microorganisms are kept at 25°C to prevent the growth of any harmful bacteria.

Investigating the Effect of Antibiotics on Bacterial Growth: Place paper disks that have been soaked with different antibiotics on an agar plate that has bacteria on it. The antibiotics should diffuse on to the agar. The most effective antibiotic at killing the bacteria will have the largest inhibition zone. Be sure to use a control that has sterile water on the disk (to compare to). Leave in an incubator for 48 hours at 25°C.

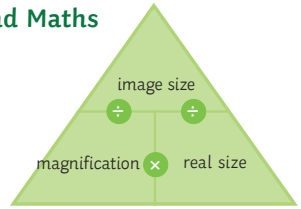
Specialised Cells

When a cell changes to become a specialised cell, it is called differentiation.

Specialised Cell	Function	Adaptation
sperm	To get the male DNA to the female DNA.	Streamlined head, long tail, lots of mitochondria to provide energy.
nerve	To send electrical impulses around the body.	Long to cover more distance. Has branched connections to connect in a network.
muscle	To contract quickly.	Long and contain lots of mitochondria for energy.
root hair	To absorb water from the soil.	A large surface area to absorb more water.
phloem	Transports substances around the plant.	Pores to allow cell sap to flow. Cells are long and joined end-to-end.
xylem	Transports water through the plant.	Hollow in the centre. Tubes are joined end-to-end.

Equations and Maths

Equation



Maths Skills

Conversions:
Micrometres to millimetres: divide by 1000.

Standard Form:
$0.003 = 3 \times 10^{-3}$

$5.6 \times 10^{-5} = 0.0056$

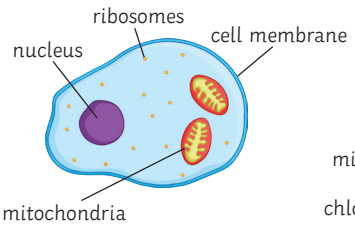
Area (to calculate the area of the inhibition zone around an antibacterial disk): **Area = πr^2**

Use a ruler to measure the diameter and then half it to find the radius.

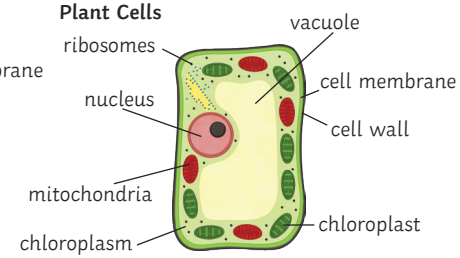
Prokaryotic and Eukaryotic Cells

Eukaryotic cells have membrane-bound organelles, for example, plant cells, animal cells and fungus cells. Prokaryotic cells do not contain a nucleus, for example, a bacterial cell.

Animal Cells



Plant Cells



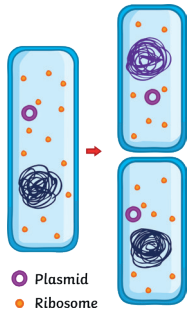
Plant and animal cells have similarities and differences:

	Animal	Plant
nucleus	e	e
cytoplasm	e	e
chloroplast	x	e
cell membrane	e	e
permanent vacuole	x	e
mitochondria	e	e
ribosomes	e	e
cell wall	x	e

Bacterial Cells

Bacterial cells do not have a true nucleus, they just have a single strand of DNA that floats in the cytoplasm. They contain a plasmid.

Prokaryotic cells reproduce by **binary fission** - the cell splits in two.



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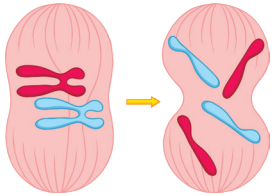
Chromosomes and Mitosis

In the nucleus of a human cell there are 23 pairs of **chromosomes**. Chromosomes contain a double helix of **DNA**. Chromosomes have a large number of genes.

The **cell cycle** makes new cells.

Mitosis: DNA has to be **copied/replicated** before the cell carries out mitosis.

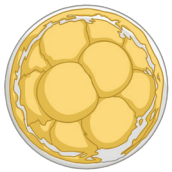


Key Vocabularly

active transport
alveoli
chromosome
diffusion
eukaryotic
gas exchange
mitosis
multicellular
osmosis
prokaryotic
undifferentiated
replicated
specialised
villi

Stem Cells

Embryonic stem cells are **undifferentiated** cells, they have the potential to turn into any kind of cell.



Adult stem cells are found in the bone marrow, they can only turn into some types of cells e.g. blood cells.

Uses of stem cells:

- Replacing faulty blood cells;
- making insulin producing cells;
- making nerve cells.

Some people are against stem cell research.

For Stem Cell Research	Against Stem Cell Research
Curing patients with stem cells - more important than the rights of embryos.	Embryos are human life.
They are just using unwanted embryos from fertility clinics, which would normally be destroyed.	Scientists should find other sources of stem cells.

Stem Cells in Plants

In plants, stem cells are found in the **meristem**. These stem cells are able to produce clones of the plant. They can be used to grow crops with specific features for a farmer, e.g. **disease resistant.**

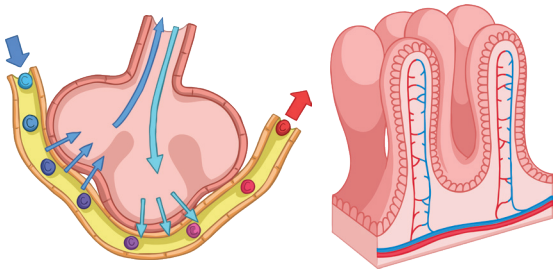
Exchange – Humans

Multicellular organisms have a large surface area to volume ratio so that all the substances can be exchanged.

Gas exchange: Lungs

The alveoli are where gas exchange takes place.

They have a large surface area, moist lining, thin walls and a good blood supply.

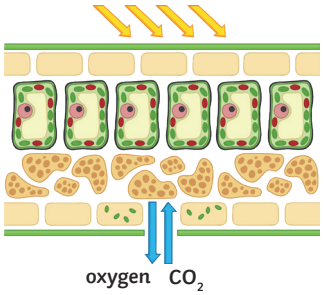


Villi: Small Intestine

Millions of villi line the small intestine increasing the surface area to absorb more digested food.

They are a single layer of cells with a good blood supply.

Exchange in Plants



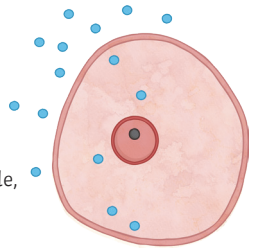
The surface of the leaf is flattened to increase the surface area for more gas exchange by diffusion.

Oxygen and water vapour diffuse out of the stomata. Guard cells open and close the stomata, controlling water loss.

Key Processes

Diffusion is the spreading out of particles from an area of higher concentration to an area of lower concentration.

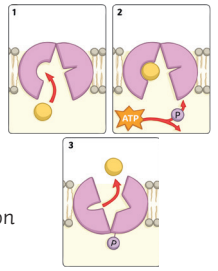
Cell membranes are semi-permeable, only small molecules can get through.



Cell Diffusion

Osmosis is the movement of water molecules across a partially permeable membrane from a region of higher concentration to a region of lower concentration.

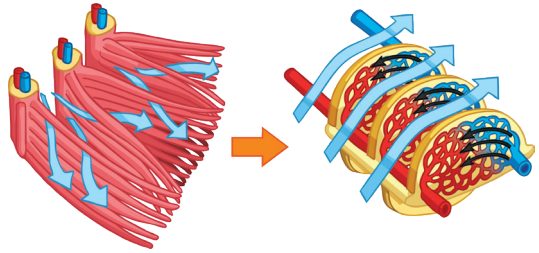
Active transport is the movement of substances against the concentration gradient. This process requires energy from respiration.



Active Transport in Cells

Exchange in Fish

Fish have a large surface area for gas exchange. These are called **gills.** Water enters the fish through the mouth and goes out through the gills. The oxygen is transported from the water to the blood by **diffusion**. Carbon dioxide diffuses from the blood to the water. Each gill has **gill filaments** which give the gills a large surface area. **Lamellae** cover each gill filament to further increase the surface area for more gas exchange. They have a **thin surface layer** and **capillaries** for good blood supply which helps with diffusion.



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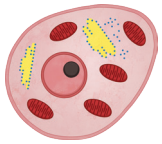
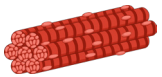
Principles of Organisation



cell

Cells are the basic building blocks of all living things.

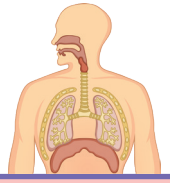


tissue

A group of cells with a similar structure and function is called a tissue.

organ

An organ is a combination of tissues carrying out a specific function.



organ system

Organs work together within an organ system.

organism

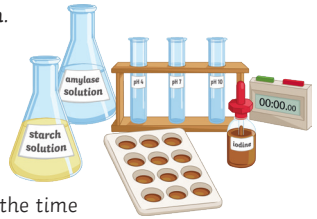
Organ systems work together to form whole living organisms.

Food Tests (Required Practical)

What are you testing for?	Which indicator do you use?	What does a positive result look like?
sugar	Benedict's reagent	Once heated, the solution will change from blue-green to yellow-red.
starch	iodine	Blue-black colour indicates starch is present.
protein	biuret	The solution will change from blue to pink-purple.
lipid	sudan III	The lipids will separate and the top layer will turn bright red.

Effect of pH on the Rate of Reaction of Amylase (Required Practical)

Iodine is used to test for the presence of **starch**. If starch is present, the colour will change to blue-black.



The **independent variable** in the investigation is the pH of the buffer solution.

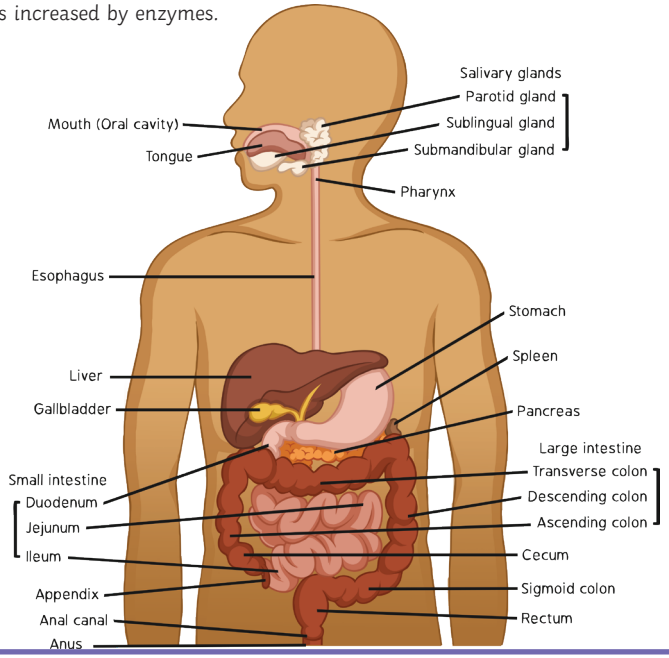
The **dependent variable** in the investigation is the time taken for the reaction to complete (how long it takes for all the starch to be digested by the amylase).

Method:

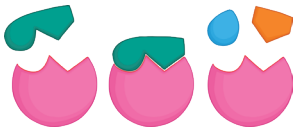
1. Use the marker pen to label a test tube with the first value of pH buffer solution (pH 4) and stand it in the test tube rack.
2. Into each well of the spotting tiles, place a drop of iodine.
3. Using a measuring cylinder, measure 2cm^3 of amylase and pour into the test tube.
4. Using a syringe, measure 1cm^3 of the buffer solution and pour into the test tube.
5. Leave this to stand for five minutes and then use the thermometer to measure the temperature. Make a note of the temperature.
6. Add 2cm^3 of starch solution into the test tube, using a different measuring cylinder to measure, and begin a timer (leave the timer to run continuously).
7. After 10 seconds, use a pipette to extract some of the amylase/starch solution, and place one drop into the first well of the spotting tile. Squirt the remaining solution back into the test tube.
8. Continue to place one drop into the next well of the spotting tile, every 10 seconds, until the iodine remains orange.
9. Record the time taken for the starch to be completely digested by the amylase by counting the wells that were tested positive for starch (indicated by the blue/black colour change of the iodine). Each well represents 10 seconds of time.
10. Repeat steps 1 to 8 for pH values 7 and 10.

The Digestive System

The purpose of the digestive system is to break down large molecules into smaller, soluble molecules, which are then absorbed into the bloodstream. The rate of these reactions is increased by enzymes.



Enzymes



An enzyme is a biological **catalyst**; enzymes speed up chemical reactions without being changed or used up.
This happens because the enzyme lowers the **activation energy** required for the reaction to occur. Enzymes are made up of chains of amino acids folded into a globular shape.

Enzymes have an **active site** which the **substrate** (reactants) fits into. Enzymes are very specific and will only catalyse one specific reaction. If the reactants are not the complimentary shape, the enzyme will not work for that reaction.
Enzymes also work optimally at specific conditions of pH and temperature. In extremes of pH or temperature, the enzyme will **denature**. This means that the bonds holding together the 3D shape of the active site will break and the active shape will deform. The substrate will not be able to fit into the active site anymore and the enzyme cannot function.

Enzyme	Reactant	Product
amylase	starch	sugars (glucose)
protease	protein	amino acids
lipase	lipid	glycerol and fatty acids

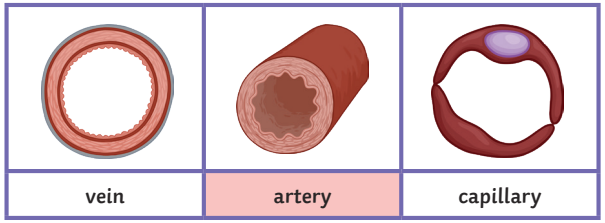
The products of digestion are used to build new carbohydrates and proteins and some of the glucose is used for respiration.

Bile is produced in the **liver** and stored in the gall bladder. It is an **alkaline** substance which **neutralises** the hydrochloric acid in the stomach. It also works to **emulsify** fats into small droplets. The fat droplets have a higher **surface area** and so the rate of their digestion by lipase is increased.

The Heart and Blood Vessels

The **heart** is a large muscular organ which **pumps blood** carrying oxygen or waste products around the body. The **lungs** are the site of **gas exchange** where oxygen from the air is exchanged for waste carbon dioxide in the blood. Oxygen is used in the **respiration** reaction to release energy for the cells and carbon dioxide is made as a waste product during the reaction.

glucose + oxygen ⟶ carbon dioxide + water + [energy]



vein	artery	capillary

The three types of blood vessels, shown above, are each adapted to carry out their specific function.

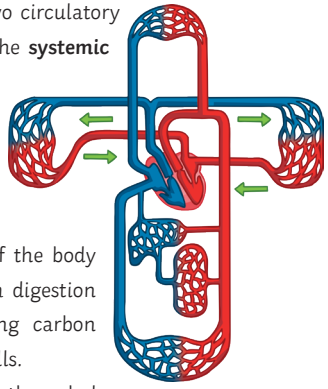
Capillaries are narrow vessels which form networks to closely supply cells and organs between the veins and arteries. The walls of the capillaries are only **one cell thick**, which provides a short **diffusion pathway** to increase the rate at which substances are transferred.

The table below compares the structure and function of arteries and veins:

	Artery	Vein
direction of blood flow	away from the heart	towards the heart
oxygenated or deoxygenated blood?	oxygenated (except the pulmonary artery)	deoxygenated (except the pulmonary vein)
pressure	high	low (negative)
wall structure	thick, elastic, muscular, connective tissue for strength	thin, less muscular, less connective tissue
lumen (channel inside the vessel)	narrow	wide (with valves)

The Heart as a Double Pump

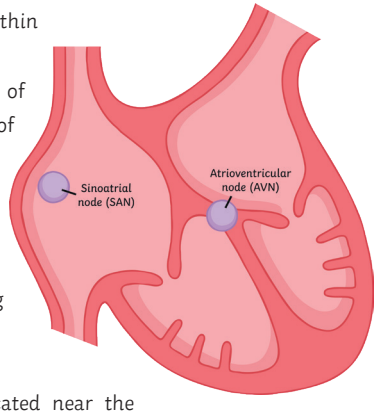
The heart works as a **double pump** for two circulatory systems; the **pulmonary** circulation and the **systemic** circulation.



The pulmonary circulation serves the lungs and bring deoxygenated blood to exchange waste carbon dioxide gas for oxygen at the **alveoli**.
The systemic circulation serves the rest of the body and transports oxygen and nutrients from digestion to the cells of the body, whilst carrying carbon dioxide and other waste away from the cells.
The systemic circulation flows through the whole body. This means the blood is flowing at a much higher pressure than in the pulmonary circuit.

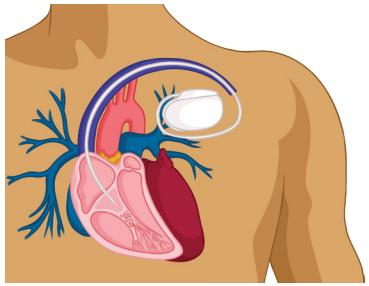
The Heart as Pacemaker

The rate of the heart beating is very carefully, and automatically, controlled within the heart itself.
Located in the muscular walls of the heart are small groups of cells which act as pacemakers. They produce electrical impulses which stimulate the surrounding muscle to contract, squeezing the chambers of the heart and pumping the blood.



The **sino-atrial node (SAN)** is located near the right atrium and it stimulates the atria to contract.
The **atrio-ventricular node (AVN)** is located in between the ventricles and stimulates them to contract.

Artificial pacemakers can be surgically implanted into a person if their heart nodes are not functioning correctly.



Coronary Heart Disease

Coronary heart disease is a condition resulting from **blockages** in the **coronary arteries**. These are the main arteries which supply blood to the heart itself and they can become blocked by build-up of **fatty deposits**.

In the UK and around the world, coronary heart disease is a major cause of many **deaths**.

The main symptoms can include **chest pain**, **heart attack** or **heart failure**. Yet, not all people suffer the same symptoms, if any at all.
Lifestyle factors can increase the risk of a person developing coronary heart disease.

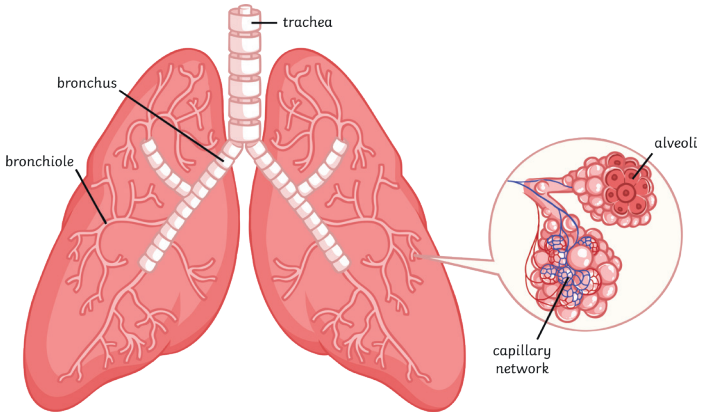
Diet – a high-fat diet (containing lots of saturated fat) can lead to higher cholesterol levels and this cholesterol forms the fatty deposits which damage and block the arteries.

Smoking – chemicals in cigarette smoke, including nicotine and carbon monoxide, increase the risk of heart disease. Carbon monoxide reduces the amount of oxygen which can be transported by the red blood cells and nicotine causes an increased heart rate. The lack of oxygen to the heart and increased pressure can lead to heart attacks.

Stress – prolonged exposure to stress or stressful situations (such as high pressure jobs) can lead to high blood pressure and an increased risk of heart disease.

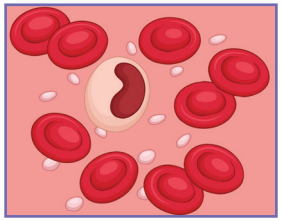
Drugs – illegal drugs (e.g. ecstasy and cannabis) can lead to increased heart rate and blood pressure, increasing the risk of heart disease.

Alcohol – regularly exceeding unit guidelines for alcohol can lead to increased blood pressure and risk of heart disease.



Blood

Blood is composed of red blood cells (erythrocytes), white blood cells and platelets, all suspended within a plasma (a tissue).



The **plasma** transports the different blood cells around the body as well as carbon dioxide, nutrients, urea and hormones. It also distributes the heat throughout the body.

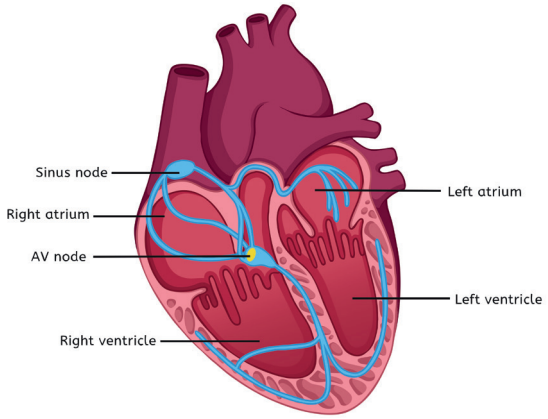
Red blood cells transport oxygen attached to the haem group in their structure. It has a biconcave shape to increase surface area and does not contain a nucleus so it can bind with more oxygen molecules.

White blood cells form part of the immune system and ingest pathogens and produce antibodies. **Platelets** are important blood clotting factors.

at the lungs

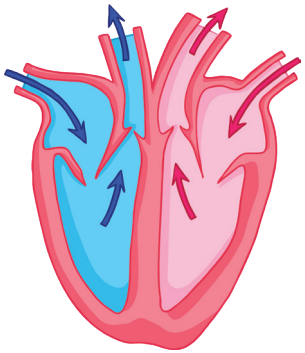
haemoglobin + oxygen $\rightleftharpoons$ oxyhaemoglobin

at the cells



The **right atrium** receives deoxygenated blood via the **vena cava**. It is then pumped down through the valves into the right ventricle. From here, it is forced up through the **pulmonary artery** towards the **lungs** where it exchanges carbon dioxide for oxygen. The oxygenated blood then enters the **left atrium** via the **pulmonary vein** and down into the left ventricle. The muscular wall of the **left ventricle** is much thicker so it can pump the blood more forcefully out of the heart and around the entire body, via the **aorta**.

The blood only flows in **one direction**. This is because there are **valves** in the heart which close under pressure and prevent the backward flow of blood.



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Rate Calculations for Blood Flow

The number of beats the heart performs each minute is called the **pulse** (or heart rate).

It is easily measured by counting the number of beats in a given time, e.g. 15s, and finding the total beats **per minute**.

Typically, a lower resting pulse rate indicates a greater level of physical **fitness**. During exercise, and for some time after, the pulse rate increases while the heart is working to provide more **oxygen** to the muscles.

Cardiac output is a measure of the volume of blood pumped by the heart each **minute**. **Stroke volume** is a measure of the volume of blood pumped from the heart each **contraction** (heart beat).

Cardiac output (cm^3/min) = heart rate (bpm) × stroke volume (cm^3/beat)

Cancer

Cancer is the result of **uncontrolled** cell growth and division. The uncontrolled growth of cells is called a **tumour**.

Benign Tumour	Malignant Tumour
• Usually grows slowly. • Usually grows within a membrane and can be easily removed. • Does not normally grow back. • Does not spread around the body. • Can cause damage to organs and be life-threatening.	• cancerous • Usually grows rapidly. • Can spread around the body, via the bloodstream. • Cells can break away and cause secondary tumours to grow in other areas of the body (metastasis).

Plant Tissues, Organs and Systems

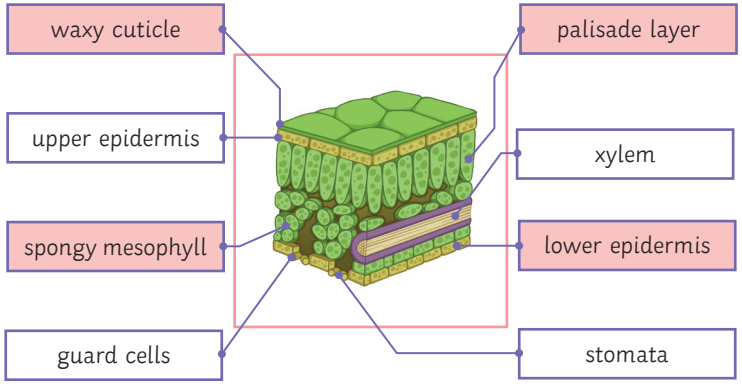
Leaves are plant organs and their main function is to absorb sunlight energy for use in **photosynthesis**. Within the cells are small organelles called **chloroplasts** which contain a green pigment called **chlorophyll**. This is the part of the plant which absorbs the sunlight and where photosynthesis occurs.

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

Leaves are adapted to carry out their function. Leaves are typically flat and thin with a large **surface area**. This means they have a maximum area to absorb the sunlight and carbon dioxide. The **thin** shape reduces the distance for **diffusion** of water and gases.

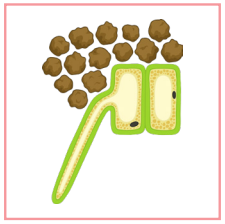
Leaves contain vessels called xylem and phloem. The **xylem** transport water and dissolved minerals toward the leaves. The **phloem** transport glucose and other products from photosynthesis around the plant.

The large **air spaces** between the cells of the spongy mesophyll layer allow for the diffusion of gases. **Carbon dioxide** enters the leaves and **oxygen** exits the leaves.



The **guard cells** are specially adapted cells located on the underside of the leaf. They are positioned in pairs, surrounding the **stomata** (a small opening in the epidermis layer). The guard cells change shape to open and close the stomata, controlling the rate of **gas exchange** in the leaf.

Root Hair Cells

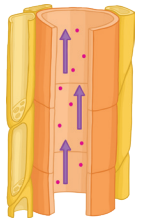


Plants absorb water by **osmosis** through the root hair cells of the roots. Dissolved in the water are important minerals for the plant's growth and development, which are absorbed by **active transport**.

The **root hair cells** are adapted to their function with the following features:

- Finger-like projection in the membrane increases the **surface area** available for water and minerals to be absorbed across.
- The narrow shape of the projection can squeeze into small spaces between soil particles, bringing it closer and reducing the distance of the **diffusion pathway**.
- The cell has many **mitochondria**, which release energy required for the active transport of some substances.

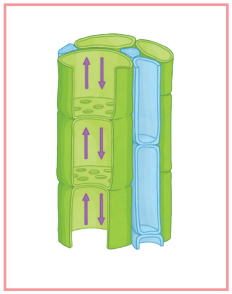
Xylem and Phloem



Xylem vessels transport **water** through the plant, from roots to leaves. They are made up of **dead**, lignified cells, which are joined end to end with no walls between them, forming a long central tube down the middle. The movement of the water, and dissolved minerals, along the xylem is in a **transpiration** stream.

Xylem vessels also provide **support** and **strength** to the plant structure. They are found in the middle of roots so they aren't crushed within the soil. They are found in the middle of the stem to provide strength and prevent bending. In the leaves, they are found in **vascular bundles** alongside the phloem and can be seen as the veins which network across the leaf.

Phloem vessels transport **food** such as dissolved sugars and glucose from photosynthesis. The food is transported around the plant to where growth is occurring (root and shoot tips), as well as to the organs which store the food. The transport occurs in **all directions** throughout the plant. The cells making up the phloem tube are **living**, with small holes in the walls where the cells are joined.



Transpiration and Translocation

Transpiration is the loss of water, by **evaporation** and **diffusion**, from the leaves of the plant. Water is a cohesive molecule and as it evaporates, there is less water in the leaf, so water from further back moves up to take its place. This, in turn, draws more water with it. This is the **transpiration stream**.

Transpiration occurs naturally as there is a tendency for water to diffuse from the leaves (where the concentration is relatively high) to the air around the plants (where the concentration is relatively low), via the **stomata**.

Environmental factors can change the rate at which transpiration occurs:

- Increased **light intensity** will increase the rate of transpiration because light stimulates the stomata to open. The leaf will also be warmed by the sunlight.
- Increased **temperature** will cause the water to evaporate more quickly and so increase the rate of transpiration.
- Increased **humidity** (moisture in the air) will reduce the rate of transpiration. Whereas if the air becomes drier, the rate increases. A greater concentration gradient will increase the rate of diffusion.
- If the **wind speed** increases, then the rate of transpiration also increases. This is because as the water surrounding the leaves is moved away more quickly, the concentration gradient is increased.
- If the **water content** in the soil is decreased, then the rate of absorption in the roots decreases. This causes the stomata to become flaccid and close, reducing transpiration. If the loss of turgor affects the whole plant, then it will wilt.

Disease Interactions

Having one type of illness can often make a person more susceptible to another type of illness:

- immune disorders → increased risk of infectious disease
- viral infection of cells → increased risk of cancer
- immune reactions → can trigger allergies
- very poor physical health → increased risk of depression or other mental illness

Health and Disease

Health is the state of being free from **illness** or **disease**. It refers to **physical** and **mental** wellbeing.

Disease and lifestyle factors, such as diet, stress, smoking, alcohol consumption and the use of illegal drugs, can all impact the health of a person.

Some conditions are associated with certain lifestyle choices:

- Liver conditions are associated with poor **diet** and prolonged excessive **alcohol** consumption.
- Lung cancer is associated with **smoking**.
- Memory loss, poor physical health and hygiene are associated with the use of illegal or recreational **drugs**.
- Obesity and diabetes are associated with poor diet.
- Anxiety and depression are associated with **stress** and prolonged excessive alcohol consumption.

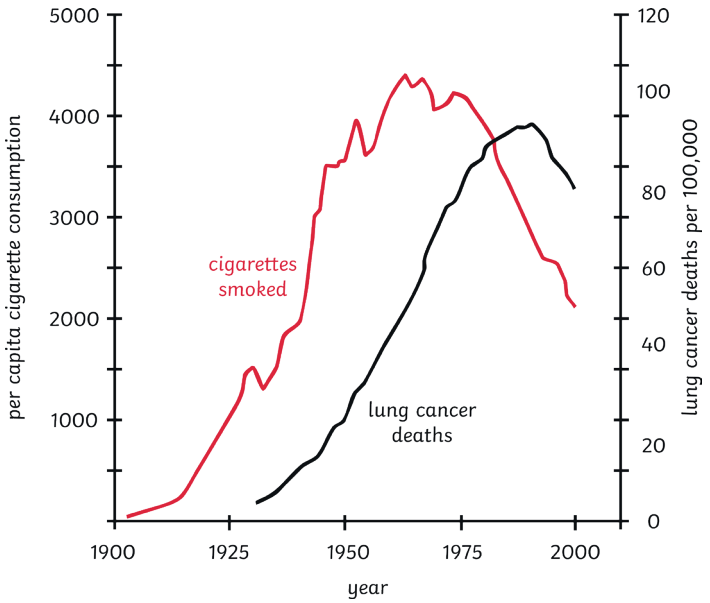
There can often be correlations between some factors and types of illness or specific diseases.

For example, in the graph shown to the right, there is a positive correlation between the number of cigarettes smoked and the number of lung cancer deaths.

However, there are other factors which can contribute to the development of lung cancer e.g. working with asbestos, genetic predisposition.

This means that although the evidence in the graph gives a strong indication that smoking is a cause of lung cancer, it cannot be stated that **'smoking will cause lung cancer'**. Not every person who smokes will develop lung cancer and not every person who develops lung cancer will be a smoker.

Therefore, it can be stated that **smoking increases the risk of lung cancer**.



Heart Disease (Treatments)

There are a range of medical treatments for heart disease.

Treatment	Description	Advantages	Disadvantages
statins	**Drugs** used to lower cholesterol levels in the blood, by reducing the amount produced in the liver.	• Can be used to prevent heart disease developing. • Improved quality of life.	• Long-term treatment. • Possible negative side-effects.
stents	**Mechanical device** which is used to stretch narrow or blocked arteries, restoring blood flow.	• Used for patients where drugs are less effective. • Offers long-term benefits. • Made from metal alloys so will not be rejected by the patients body. • Improved quality of life.	• Requires surgery under general anaesthetic, which carries risk of infection.
heart transplant	The entire organ is replaced with one from an organ **donor** (a person who has died and previously expressed a wish for their organs to be used in this way).	• Can treat complete heart failure in a person. • extended life • Improved quality of life. • Artificial plastic hearts can be used temporarily until a donor is found.	• Requires major surgery under general anaesthetic, which carries risks. • Lack of donors available. • Risk of infection or transplant rejection. • Long recovery times.

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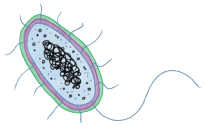
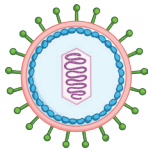
Communicable Disease

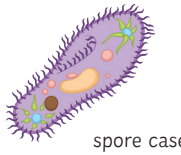
Pathogens are **microorganisms** that enter the body and cause communicable disease (infectious). Plants and animals can be infected by them.



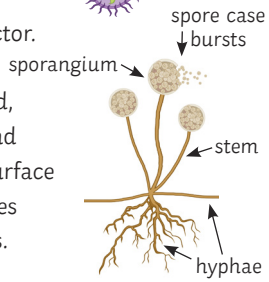
Bacteria are small cells that can reproduce very quickly in the body. They produce **toxins** that make you feel ill, damaging your cells and tissues.



Viruses are much smaller than bacteria; they can also reproduce quickly in the body. Viruses live inside your cells where they replicate. They then burst out of the cell, releasing new viruses.



Protists are eukaryotes (multicellular). Some are parasites which live on or inside other organisms, often carried by a vector.



Fungi are sometimes single celled, others have hyphae that grow and penetrate human skin and the surface of plants. They can produce spores which can spread to other plants.

How Pathogens Are Spread

Pathogens can be spread in many ways, for example:

Water – by drinking dirty water, e.g. cholera.

Air – carried by air and breathed in, e.g. influenza.

Direct contact – touching contaminated surfaces including the skin, e.g. athlete's foot.

Viral Diseases

Measles is spread by droplets of liquid from sneezes and coughs etc. Symptoms include a red rash on the skin and a fever. Measles can be serious or even fatal and it can lead to pneumonia. Most people are vaccinated against measles when they are very young.

HIV is spread by sexual contact or exchanging body fluids. HIV can be controlled be antiviral drugs; this stops the viruses replicating. The virus attacks the cells in the immune system. If the immune system is badly damaged, the body cannot cope with other infections. This is the late stage and is called Aids.

Tobacco mosaic virus affects plants. Parts of the leaves become discoloured. This means plants cannot carry out photosynthesis; this will affect the plants growth.

Fungal and Protist Diseases

Fungal

Rose black spot shows as black spots on the leaves of the plant. This means less photosynthesis occurs. As a result, the plant does not grow as well. It is spread by the wind or the water. They can be treated by using fungicides and taking the leaves off the infected plant.

Protists

Malaria is caused by a protist; mosquitoes are the vectors. They become infected when they feed on an infected animal. The protist is inserted into the blood vessel. Malaria can cause fever and it can also be fatal.

Bacterial Diseases

Salmonella bacteria causes food poisoning. Symptoms include fever, stomach cramps, vomiting and diarrhoea. The symptoms are caused by the toxins produced by the bacteria. Food contaminated with salmonella can give you food poisoning. Most poultry in the UK will have had a vaccination against salmonella.

Gonorrhoea is a sexually transmitted bacterial disease, passed on by sexual contact. Symptoms include pain when urinating and thick yellow/green discharge from the vagina or penis. To prevent the spread, people should be treated with antibiotics and use a condom.

How to prevent the spread:

Being hygienic –

washing hands thoroughly.

Destroying vectors –

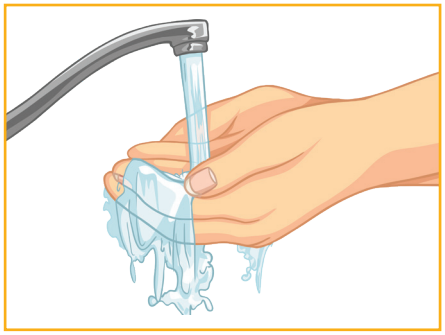
killing vectors by using insecticides or destroying their habitat.

Isolation –

isolating an infected person will prevent the spread.

Vaccination –

people cannot develop the infection and then pass it on.



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Plant Diseases and Defences

Plants need ions from the soil. If there isn't enough, then the plants suffer deficiency symptoms.

Ion	Symptoms
nitrates	stunted growth
magnesium	yellow leaves

Plant Diseases – common signs include stunted growth, spots on the leaves, patches of decay, abnormal growth, malformed stems or leaves and discolouration.

Plants have physical, chemical and mechanical defences to stop pathogens.

Physical – waxy cuticle, cell walls, layer of dead cells.

Mechanical – thorns, hairs, leaves that droop or curl and some plants can mimic other organisms.

Fighting Diseases

Defence System

1. The skin acts as a barrier to pathogens.
2. Hairs and mucus in your nose trap particles.
3. The trachea and bronchi secrete mucus to trap pathogens. They also have cilia which move backwards and forwards to transport the mucus towards the throat. This traps any pathogens and the mucus is usually swallowed.
4. The stomach contains hydrochloric acid to kill any pathogens that enter the body via the mouth.

The Immune System

This kills any pathogens that enter the body.

White blood cells:

- **Phagocytosis** is when white blood cells engulf pathogens and then digest them.
- They produce **antitoxins** to neutralise the **toxins**.
- They also produce **antibodies**. Pathogens have **antigens** on their surface. Antibodies produced by the white blood cells lock on to the antigen on the outside of the pathogen. White blood cells can then destroy the pathogens.

Antibodies are specific to one antigen and will only work on that pathogen.

Vaccinations

Vaccinations have been developed to protect us from future infections. A vaccination involves an injection of a **dead** or **weakened** version of the pathogen. They carry antigens which cause your body to produce antibodies which will attack the pathogen. If you are infected again, the white blood cells can produce antibodies quickly.

Pros	Cons
Helps to control communicable diseases that used to be very common.	They don't always work.
Epidemics can be prevented.	Some people can have a bad reaction to a vaccine – however, that is very rare.

Fighting Disease – Drugs

Painkillers relive the pain and symptoms, but do not tackle the cause.

Antibiotics kill the bacteria causing the problem, but do not work on viruses. Viruses are very difficult to kill because they live inside the body cells.

Developing Drugs

There are three main stages in drug testing:

Pre-clinical testing:

1. Drugs are tested on human cells and tissues.
2. Testing carried out on living animals.

Clinical testing:

3. Tested on healthy human volunteers in clinical trials. Starts with a very low dose, then tested on people with the illness to find the optimum dose.

Placebo is a substance that is like the drug but does not do anything.

Placebo effect is when the patient thinks the treatment will work even though their treatment isn't doing anything.

Blind trial is when the patient does not know whether they are getting the drug or the placebo.

Double-blind trial is when both the doctor and the patient do not know whether they are getting the drug.

Drugs from Plants

Chemicals produced by plants to defend themselves can be used to treat human diseases or help with symptoms.

Drug	Plant/Microorganism
aspirin	willow
digitalis	foxglove
penicillin	mould - penicillium

New drugs are now made by chemists, who work for the pharmaceutical industry, in laboratories.

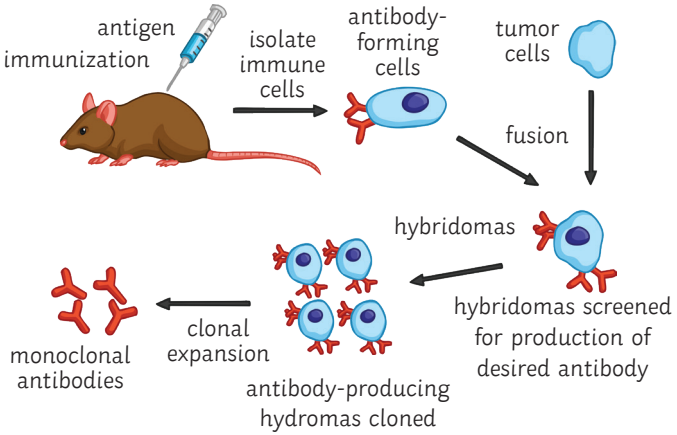
Key Vocabulary

antibodies
antigens
antitoxins
bacteria
blind trial
double-blind
fungus
microorganism
phagocytosis
placebo
protist
toxins
vaccination
vector
virus

Monoclonal Antibodies

Monoclonal antibodies are identical antibodies. Antibodies are produced by B lymphocytes.

It is possible to fuse a B lymphocyte from a mouse with a tumour cell to create a cell called a hybridoma - these can be cloned. They will all produce the same antibodies; the antibodies can be collected and purified.



There are many uses of monoclonal antibodies. For example:

Pregnancy testing: HCG hormone is found in the urine of women when pregnant. Pregnancy testing sticks detect this hormone. The HGC binds to the antibodies on the stick and changes the colour if you are pregnant. If the woman is not pregnant, there is no HCG. This means there is nothing to stick to the blue beads on the test strip, so it does not go blue.

Treating diseases: anti-cancer drugs can be attached to monoclonal antibodies. They can target specific cells (cancer cells) by binding to the cancer marker. This kills the cancer cells, but not the normal body cells.

Research to find specific substances: used to bind to hormones and chemicals in the blood to measure levels. Also used in blood tests for pathogens and locating molecules on a cell or in tissue.

Problems: they have more side-effects than originally thought. For example: fever, vomiting, low blood pressure. They are not used by doctors as much as was first thought.

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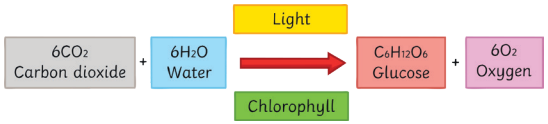
Photosynthesis

Photosynthesis is a chemical reaction which takes place in plants. It converts **carbon dioxide** and **water** into **glucose** and **oxygen**. It uses **light** energy to power the chemical reaction, which is absorbed by the green pigment **chlorophyll**. This means that photosynthesis is an example of an **endothermic** reaction. The whole reaction takes place inside the **chloroplasts** which are small organelles found in plant cells.

Plants acquire the carbon dioxide via diffusion through the **stomata** of their leaves. The water is absorbed from the soil through the **roots** and transported to the cells carrying out photosynthesis, via the **xylem**.



The glucose made in photosynthesis is used for respiration, stored as starch, fat or oils, used to produce cellulose or used to produce amino acids for protein synthesis.

The Rate of Photosynthesis and Limiting Factors

A **limiting factor** is something which stops the photosynthesis reaction from occurring at a faster rate. **Temperature**, **light intensity** and **carbon dioxide** level are all limiting factors.

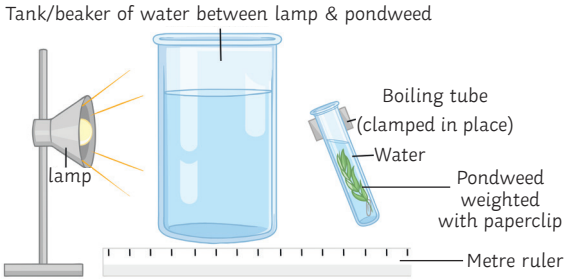
Increasing the temperature of the surroundings will increase the rate of reaction, but only up to around 45°C. At around this temperature, the enzymes which catalyse the reaction become denatured.

Increasing the light intensity will increase the rate of reaction because there is more energy to carry out more reactions.

Increasing the carbon dioxide concentration will also increase the rate of reaction because there are more reactants available.

The Effect of Light Intensity on the Rate of Photosynthesis (RPI)

The amount of light a plant receives affects the rate of photosynthesis. If a plant receives lots of light, lots of photosynthesis will occur. If there is very little or no light, photosynthesis will stop.



Method

1. Measure 20cm^3 of sodium hydrogen carbonate solution and pour into a boiling tube.
2. Collect a 10cm piece of pondweed and gently attach a paper clip to one end.
3. Clamp the boiling tube, ensuring you will be able to shine light onto the pondweed.
4. Place a metre rule next to the clamp stand.
5. Place the lamp 10cm away from the pondweed.
6. Wait two minutes, until the pondweed has started to produce bubbles.
7. Using the stopwatch, count the number of bubbles produced in a minute.
8. Repeat stages 5 to 7, moving the lamp 10cm further away from the pondweed each time until you have five different distances.
9. Now repeat the experiment twice more to ensure you have three readings for each distance.

The **independent** variable was the light intensity.

The **dependent** variable was the amount of bubbles produced. Counting the bubbles is a common method, but you could use a gas syringe instead to more accurately measure the volume of oxygen produced.

The **control** variables were same amount of time and same amount of pondweed. A bench lamp is used to control the light intensity and the water in the test tube containing the pondweed is monitored with a thermometer to monitor and control the temperature.

Interaction of Limiting Factors (HT only)

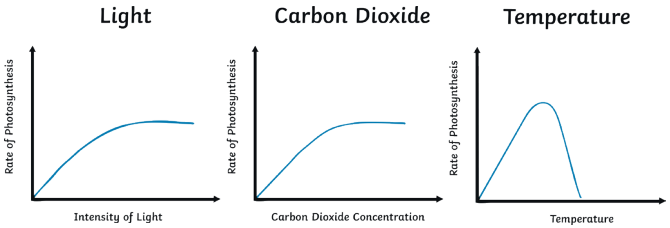
The limiting factor for the reaction will depend on the environmental conditions.

For example:

At night, light intensity is the limiting factor.

In winter, temperature is the limiting factor.

In other conditions, carbon dioxide is usually the limiting factor.



From the graph, you can see that increasing one of the factors will also increase the rate of reaction, but only for so long before it plateaus. This is because another factor will have then become the limiting factor. E.g. you could increase the supply of carbon dioxide, but if there is not enough chlorophyll to absorb the sunlight, then the sunlight will become the limiting factor instead.

Greenhouse Economics (HT only)

To grow plants in the most suitable conditions, a greenhouse can be used.

A greenhouse traps the sun's radiation as heat inside the greenhouse, so that temperature is not a limiting factor for the rate of photosynthesis.

Artificial lighting can be installed in the greenhouse to provide constant light energy and prevent light intensity being a limiting factor.

A paraffin heater can be used in the greenhouse to not only maintain a suitable temperature, but the by-product of the combustion off the paraffin is carbon dioxide.

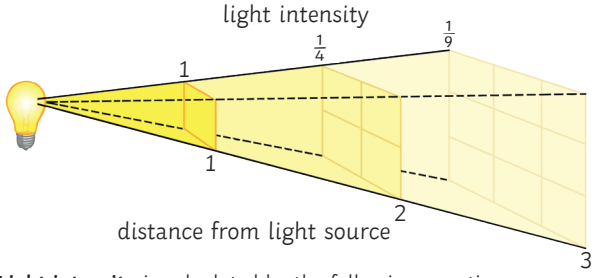
Enclosing the crops in a greenhouse and regulating all the conditions in this way can be expensive; however, it is often outweighed because the harvest of the crop is much healthier, faster-grown crops. Furthermore, the enclosed conditions mean that disease and pests can be easily controlled and prevented.

AQA Bioenergetics Knowledge Organiser

Inverse Square Law and Light Intensity

The **inverse square law** is used to describe the light intensity at different distances from the source.

The inverse square law states that: **the intensity of light is inversely proportional to the square distance from the source.**



Light intensity is calculated by the following equation:

$$\text{light intensity} \propto \frac{1}{\text{distance}^2}$$

- The symbol, ∝, means 'is proportional to'.
- Distance is measured in metres, m.

In other words, if an object is moved twice as far away from the light source, the light intensity received is reduced to just one quarter.

Worked example:

If the light source is 10cm from a plant, calculate the light intensity reaching the plant.

1 ÷ (distance^2)
1 ÷ (0.10 × 0.10)
1 ÷ 0.01
= **100 arbitrary units**

If the light source is moved 25cm from the plant, calculate the light intensity reaching the plant.
1 ÷ (distance^2)
1 ÷ (0.25 × 0.25)
1 ÷ 0.0625
= **16 arbitrary units**

Respiration

Respiration is the chemical reaction which occurs inside the **mitochondria** of all living cells to release energy for living functions and processes, e.g. movement, warmth and building larger molecules for growth and repair. The reaction is **exothermic**, meaning that energy is released to the surroundings.

Respiration can be either **aerobic** (using oxygen) or **anaerobic** (without using oxygen).

glucose + oxygen → carbon dioxide + water + energy

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

In anaerobic respiration, the glucose is not completely oxidised. This means that there is less energy released than in aerobic respiration.

glucose → lactic acid + energy

$$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3 + ATP$$

In plants and yeast, anaerobic respiration makes some different products. The reaction is also called fermentation and is used in bread-making and beer-brewing.

glucose → ethanol + carbon dioxide + energy

$$C_6H_{12}O_6 \rightarrow C_2H_5OH + CO_2 + ATP$$

Effect of Exercise

When a person exercises, their body (specifically their **muscles**) need much more energy. To release more energy, the amount of respiration reactions occurring has to increase.
The **heart** pumps faster and the **breathing** rate and breath volume all increase to supply more **oxygen** to the muscles via the bloodstream.

If the muscles are not receiving enough oxygen to keep up the demand needed by the respiration reactions, then **anaerobic** respiration begins to occur. This incomplete oxidation of the glucose produces **lactic acid**, which can build up in the muscles and results in an **oxygen debt**.

After long periods of exercise, the muscles can become fatigued and stop contracting. You might experience a pain commonly called a **stitch**.

Metabolism

Metabolism is the combination of all the reactions in a cell or in the body.

Energy released during respiration is used during metabolic processes to synthesise new molecules:

- Glucose is converted to starch, glycogen and cellulose.
- Glycerol and three fatty acids are joined to form a lipid molecule.
- Glucose and nitrate ions are joined to form amino acids.
- Amino acids are joined to form proteins.
- Excess proteins are broken down and released as urea during excretion.

Respiration itself is also a processes which is included in metabolism.

Oxygen Debt (HT only)

During vigorous exercise, the body can begin to carry out **anaerobic respiration** and produces **lactic acid**.

Lactic acid is transported via the bloodstream to the **liver**. The liver converts the lactic acid back into **glucose**. However, **oxygen** is needed to carry out this reaction.

The **oxygen debt** is the amount of the oxygen required by the body to convert the built-up lactic acid back into glucose and remove it from the respiring cells.

AQA Homeostasis and Response Knowledge Organiser

Homeostasis

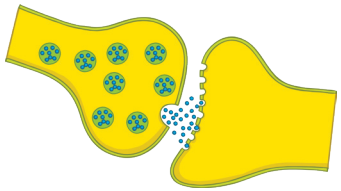
Homeostasis is the regulation of a **constant internal environment**. The conditions are maintained to ensure optimum conditions for metabolism and changes in response to both internal and external fluctuations.

In humans, homeostasis regulates the **blood glucose** (sugar) levels, the body **temperature, CO_2** levels and **water** levels.

The levels are monitored and regulated by automatic control systems which can be either nervous responses (coordinated by the **nervous system**) or chemical responses (coordinated by the **endocrine system**). Information about the environment is called a **stimulus** and is detected by a **receptor**. The information is processed by a **central coordination** system and a response is initiated by an **effector**.

Synapses

A **synapse** is the gap where the ends of two neurons meet.



The information needs to be passed from one neuron to the next, but cannot be passed as an electrical impulse over the synapse (gap). Instead, the message is transmitted by chemical neurotransmitters.

When the electrical impulse arrives at the terminal of the first neuron, it causes a release of neurotransmitter chemicals into the synapse. They travel across the gap and bind to receptor sites on the terminal of the next neuron.

The receptor sites are specific for each type of neurotransmitter. A nerve impulse will only be created in the second neuron when a complimentary chemical binds.

The Nervous Pathway

A stimulus is a change in the environment (internally or externally). In a typical response to stimuli, this information is received by the receptor and sent as an electrical impulse along a sensory neuron towards the central nervous system (CNS). The CNS is comprised of the brain and spinal cord. Here, the impulse is passed through relay neurons and a response to the stimulus is coordinated. This could be consciously or subconsciously. The CNS sends information about the response along a motor neuron as an electrical impulse. The effector receives the impulse and carries out the response.

[stimulus] → receptor → sensory neuron → CNS → motor neuron → effector → [response]

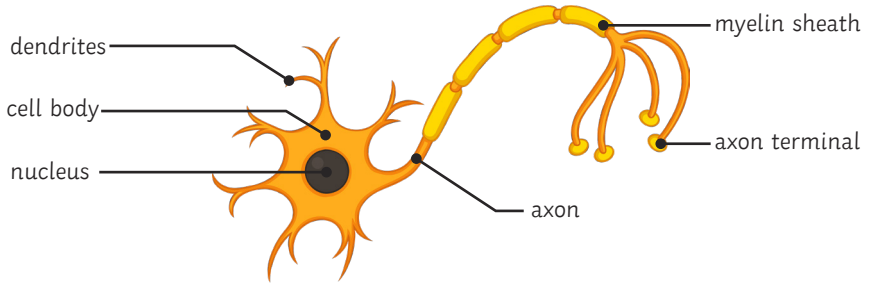
Examples of receptors include rod and cone cells within the eye which respond to light and allow us to see. Or it could be the cells in the skin which respond to pressure or temperature changes allowing us to feel.

An effector could be a muscle or a gland. In response, a muscle might contract to make a movement or a gland releases a chemical into the body.

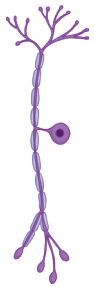
The Human Nervous System

The nervous system allows a fast, short-lived response to a stimulus in the surroundings. The information is received by a receptor, passed along the neurons (nerve cells) as an electrical impulse and results in a response.

You might have to label the parts of a typical neuron:



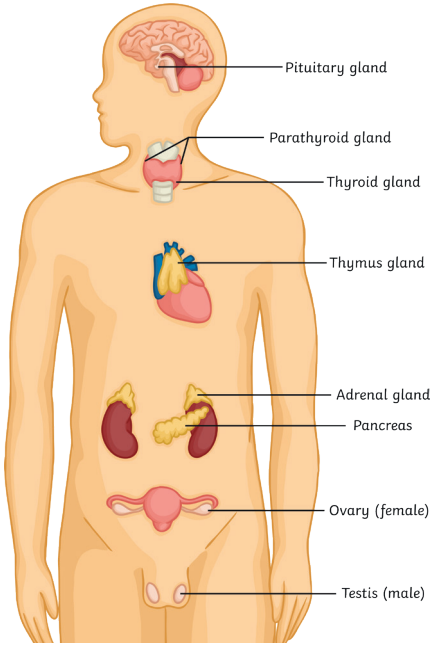
- The axon is the main part of the nerve cell. It is a long, stretched-out fibre of cytoplasm which the electrical impulse will travel along.
- Some axons are surrounded in a layer of fatty cells called the myelin sheath and it helps to insulate the electrical impulse.
- The branched endings, dendrites, connect the neurons together to create a network.

sensory neuron	relay neuron	motor neuron
		

AQA Homeostasis and Response Knowledge Organiser

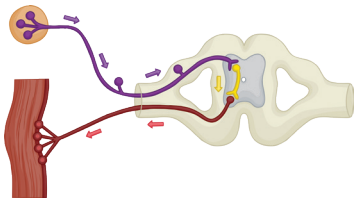
The Endocrine System

You should be able to identify the major glands of the endocrine system, as shown below.



Reflexes

A **reflex** is a fast and automatic response to a particular stimulus which may be harmful to the organism. They are quick because there is no conscious thought or process to deliver the response (they are an **involuntary** action). The pathway which carries the information about a reflex action is called a **reflex arc**.



A **reflex arc** begins with the **stimulus** e.g. a bee sting or a hot object on the skin. The stimulus is detected by the **receptor** cells and an electrical **impulse** is transmitted along the **sensory neuron**. The impulse is passed through **relay neurons** in the spinal cord or the **unconscious** areas of the brain. The response is coordinated **automatically** and sent along the **motor** neuron to the **effector** cells.

Hormones

Hormones are **chemical** messengers transported in the **bloodstream** to an effector where they can activate a response. They are produced and released from glands around the body which all make up the **endocrine system**. Hormones do a similar job to the neurons of the nervous system but there are some differences.

	neurons	hormones
speed	fast	slow
duration	short	long
target area	specific	general

The hormones released travel in the blood plasma to their **target cells** and affect only those certain cells. Hormones act on organs or cells where constant adjustments are made to maintain a stable state.

Some examples you should know:

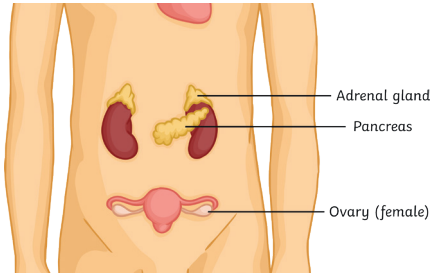
The **pituitary gland** produces a range of hormones including FSH and LH which help to regulate the menstrual cycle. The pituitary gland acts as a **master gland** because many of the hormones it releases control and coordinate the release of other hormones from other glands in the body.

Diabetes

There are two types of diabetes: type 1 and type 2.

Type 1 diabetes is a disorder affecting the pancreas. In type 1 diabetes, the pancreas does not produce enough insulin to control the blood sugar level and so the levels become higher than normal. Type 1 diabetes is usually treated by injections of insulin.

Type 2 diabetes is a disorder of effector cells which no longer respond to the hormones released from the pancreas. Type 2 diabetes can usually be managed through lifestyle choices such as maintaining a carbohydrate-controlled diet and regular exercise.



The risk of developing type 2 diabetes is higher in people who are obese (have a BMI >30).

Hormones in Human Reproduction

Oestrogen is the main reproductive hormone in females. It is produced in the **ovaries**. During puberty, this hormone increases and it stimulates an egg to be released from an ovary each month. This process is called **ovulation** and happens, on average, every 28 days.

Testosterone is the main reproductive hormone in males. It is produced in the **testes**. This hormone stimulates the production of sperm.

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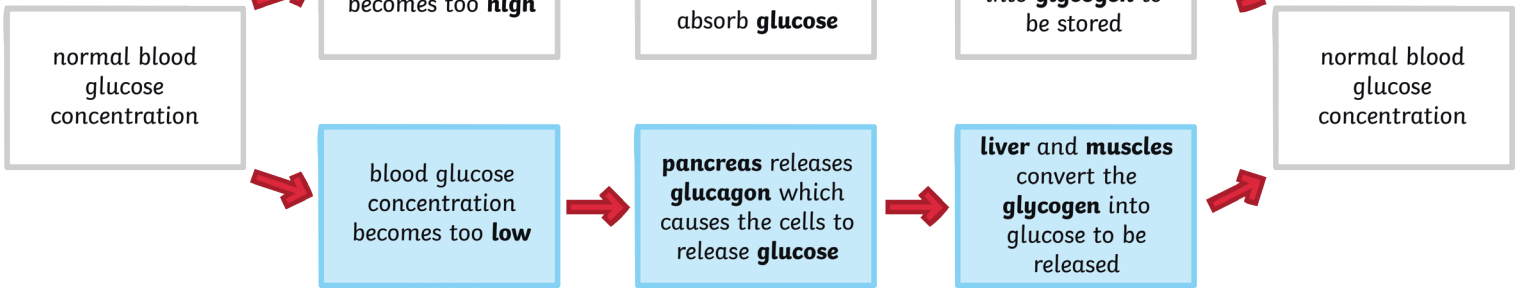
Control of Blood Glucose

The pancreas is the organ and gland which monitors and regulates the blood glucose concentration.

(HT only)

If the blood glucose concentration becomes too low, a negative feedback loop is triggered and the pancreas releases another hormone, **glucagon**, which acts on the liver and muscles to cause the stored **glycogen** to be converted back into **glucose** and released into the bloodstream.

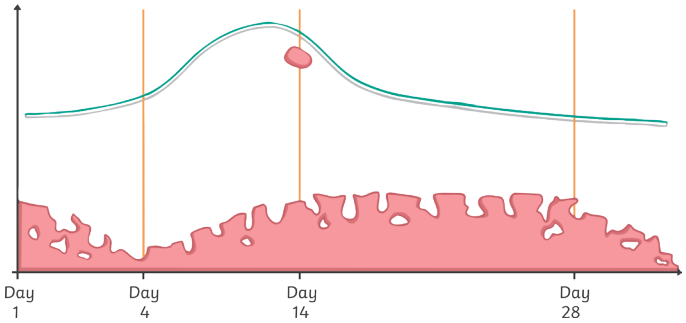


The Menstrual Cycle

The **menstrual cycle** occurs in females, approximately every **28 days**. It is a cyclical process of the building of the lining of the **uterus** and **ovulation**. If the **egg** become fertilised by a sperm, then **pregnancy** follows. If the egg is not fertilised, then the lining of the uterus is shed away and leaves the body as the **menstruation** (or period).

The whole cycle is controlled by four main reproductive hormones:

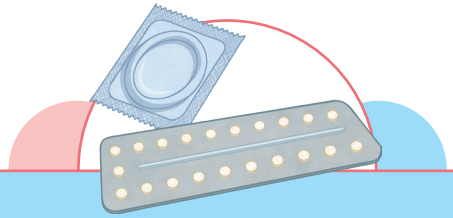
- **follicle stimulating hormone (FSH)**
- **oestrogen**
- **luteinising hormone (LH)**
- **progesterone**



Hormone	Where It Is Produced	Response Caused	Interaction with Other Hormones (HT only)
FSH	pituitary gland	An egg to develop in one of the ovaries.	Stimulates the production of oestrogen.
oestrogen	ovaries	The lining of the uterus builds up and thickens.	Stimulates the production of LH. Inhibits the production of FSH.
LH	pituitary gland	Ovulation (at around day 14 of the cycle).	Indirectly stimulates the production of progesterone.
progesterone	ovaries	The uterus lining to maintain.	Inhibits the production of LH.

Contraception

There are many different types of **contraceptive** (or birth control) methods. They are categorised as **hormonal** methods and **non-hormonal** methods.



Method	Hormonal or Non-Hormonal	How It Works	Pros and Cons
oral contraceptives ('the pill')	hormonal	Pill taken which contains hormones to **inhibit FSH** so that an egg does not mature.	Easily self-administered. Short-term effects. Can easily be reversed. Very reliable. May have mild side-effects associated. Could lead to pregnancy if missed. Does not protect from STIs.
injection, implant or skin patch	hormonal	Contains **progesterone** which is slowly released to inhibit the release of eggs for months or even years.	Administered through routine appointment at GP surgery. Requires little to no aftercare or maintenance. Very reliable. May take some time for effects to be reversed once removed. Does not protect from STIs.
condoms or diaphragm (female condom)	non-hormonal	Creates a **physical barrier** to prevent the sperm from reaching the egg.	Easy to use. Short-term effects. Very reliable. Provides protection from most STIs. Can fail.
intrauterine devices (coil)	hormonal	The device is attached to the lining of the uterus and **releases hormones or prevents the implantation** of an embryo.	Requires little to no aftercare or maintenance. Very reliable. May take some time for effects to be reversed once removed. Does not protect from STIs.
spermicidal agents	non-hormonal	Contains chemicals to **kill** or **immobilise sperm** cells.	Easy to use. Short-term effects. Does not protect from STIs. Less effective when used as the only method.
abstaining from intercourse (around the time of ovulation)	non-hormonal	Avoiding sexual intercourse when there is a likelihood of an egg being present in the oviduct.	inexpensive Not always reliable.
surgery	non-hormonal	A surgical procedure carried out in men or women. In males, the vas deferens tubes are sealed or blocked to prevent the passage of sperm from the testes. In females, the fallopian tubes (oviducts) are sealed or blocked to prevent the passage of the egg from the ovaries.	Risks associated with surgery (such as infection). Difficult to reverse (if at all possible). Can take several months to be reliable.

Infertility (HT Only)

Depending on the reason for the **infertility**, there are different methods of treatment and technologies to help women become pregnant.

The hormones **FSH** and **LH** can be given in a **'fertility drug'** to help stimulate the normal cyclic processes and enable the woman to become **pregnant** naturally.

In Vitro Fertilisation (IVF) is a treatment which involves several stages:

- The woman is given FSH and LH to **stimulate the ovaries** to mature and release several eggs.
- The **eggs** are then collected from the woman and **fertilised** using **sperm** collected from the man. This is done in the lab (in vitro means "outside the living organism").
- The fertilised eggs develop into **embryos**.
- At the early stage of development (blastocyst), one or two embryos are inserted into the woman's **uterus** for **implantation**.
- If successful, the **pregnancy** progresses as normal.

Fertility treatments offer couples the chance to have their own baby. However, the processes are often very stressful and emotional. The success rates are low. The underlying causes of the infertility are not usually being treated. Fertility treatments can carry a higher chance of multiple births (twins, triplets or more), which carries a risk to both the mother and the unborn babies.

Adrenaline and Thyroxine (HT Only)

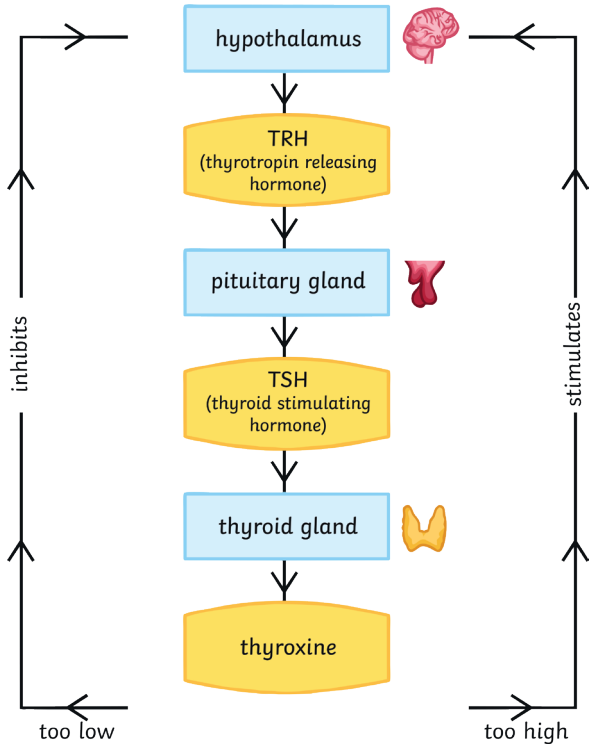
Adrenaline is a hormone produced by the **adrenal glands**. It is released in response to stress or fear. The hormone acts on major organs including the heart and lungs. The effect is to increase the heart rate and breathing rate and cause vasodilation (widening of the blood vessels), in order to supply the brain and muscles with more oxygen and glucose.

This prepares the body for a 'flight or fight' response to the fear or stress.

Thyroxine is a hormone produced by the **thyroid gland**. It stimulates the rate of **metabolism** in the body by controlling how quickly food products and oxygen are reacted, therefore controlling how quickly **energy** is released.

Negative Feedback of Thyroxine

A **negative feedback** system regulates the level of thyroxine in the body.



Required practical activity 7: plan and carry out an investigation into the effect of a factor on human reaction time.

The aim of the investigation is to **investigate out whether reaction times can be reduced with practice.**

Method:

In this experiment you are working with a partner and you are always using the opposite hand to your writing hand.

1. One of the pair sits upright on a chair and places their forearm on the table so that their hand is hanging over the edge of the table.
2. The other partner places a ruler vertically between the person sitting down's thumb and first finger. The thumb and first finger should be as far apart as possible.
3. Ensure the 0cm end of the ruler is pointing downwards.
4. Place the 0cm mark level with the top of the thumb and drop without telling your partner you are going to do it. Do tell them that the aim is for them to catch the ruler as quickly as possible.
5. Reading from the top of the thumb, record how many centimetres it took to catch.
6. Repeat nine more times.
7. Swap roles with your partner.
8. Using the reaction time conversion tables, convert your results from centimetres to reaction times (s).

The **independent variable** is the method for improvement e.g. amount of practice, use of caffeine

The **dependent variable** is the reaction time in seconds (converted from the cm taken to catch the ruler).

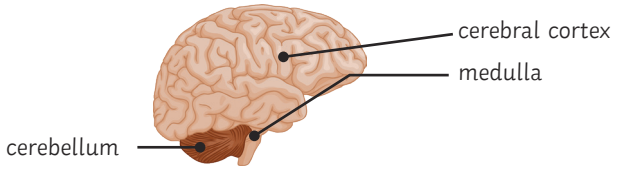
The Brain

The human **brain** is made up of a huge network of billions of **neurons** which control complex **behaviours**, both conscious and subconscious. The brain is made up of different **regions** and each contributes to carrying out different functions in the body.

Cerebral cortex – controls conscious activities and other functions including memory, language, speech and intelligence.

Cerebellum – controls muscle coordination.

Medulla – controls unconscious functions including the heartbeat and breathing.



The Brain (HT only)

The human brain is a fascinating organ which scientists are really interested in studying.

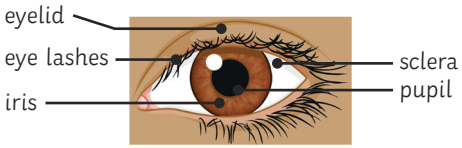
In order to study the functions of the brain, scientists use a range of methods:

- **Studying patients who have suffered brain damage** - by looking at how the behaviour of the patient changes, scientists are able to imply the function of that area of the brain. For example, if a patient suffered a trauma to the frontal lobe of their brain and consequently lost the ability to walk, then we know that part of the brain has a role in coordinating movement.
- **Electrical stimulation of the brain – electrodes** can be inserted into the brain tissue and used to send electric impulses which stimulate that area of the brain. The response can then be observed and links made between the region of the brain and the observed response.
- **MRI scanning – a magnetic resonance imaging scanner** is a large piece of medical equipment which can scan entire areas of the body, such as the brain, to produce detailed images of the structure. By scanning the brain and observing the brain whilst a patient is doing a specific activity (such as listening to music), scientists can see which parts of the brain are active and stimulated during certain activities.

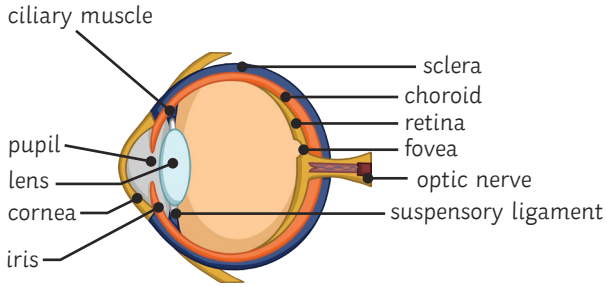
The brain is highly complex and difficult to study but, using the methods described above, scientists have been able to map which regions of the brain are linked to particular functions.

The Eye

The human **eye** is a sense organ which enables us to receive **light rays** and transmit them to our **brain** to produce an **image**. Receptor cells in the eye allow the eye to detect light intensity and colour.

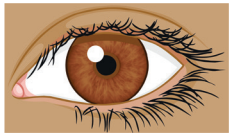


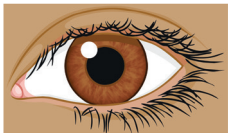
You should be able to identify the different parts of the human eye, including those not visible from the outside. They are labelled below on the cross-sectional view of the human eye.



retina	Incoming light is **focused** onto the retina. This part of the eye contains the light receptor cells, **rods and cones**, for detecting light intensity and colour, respectively.
optic nerve	Contains the **neurons** which transmit the impulses between the eye and the brain so we can process the received information and form an image.
sclera	This tough, opaque outer layer protects the eye.
cornea	The cornea is continuous with the sclera. It is transparent and allows the light enter the eye. Light is **refracted** (bends) as it enters the eye through the cornea to help focus the rays onto the retina.
iris	The iris is made up of circular and radial **muscles** which contract and relax to **dilate** the pupil. This controls the amount of light which is let into the eye.
ciliary muscles	These **muscles** are attached to the **lens** (via the suspensory ligaments) and alter the shape of the lens to **focus** the incoming light.
suspensory ligaments	Attaches the ciliary muscles to the lens of the eye.

The Pupil Reflex





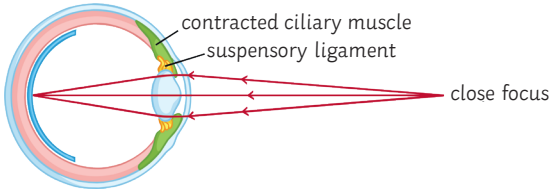
The muscles in the iris contract and relax to change the size of the pupil and to control the amount of light allowed to pass into the eye. This action is controlled by a **reflex action**.

When there is **bright light**, the **pupil contracts** and becomes smaller (left-hand image). This is to **reduce the amount of light** entering the eye and prevent the retina becoming damaged. The **radial muscles** in the iris **relax**, whilst the **circular muscles contract**.

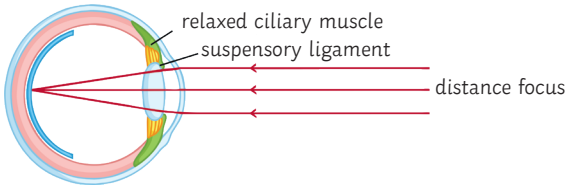
When there is **dim light**, the **pupil dilates** and becomes larger (right-hand image). This is to **increase the amount of light** entering the eye so a clearer image can be produced. The **radial muscles** in the iris **contract**, whilst the **circular muscles relax**.

Accommodation

The **lens** changes shape, controlled by the **ciliary muscles** and **suspensory ligaments**, in order to focus on near or distant objects. This process is called **accommodation**.



Near objects – to focus on an object near to the eye, the **lens becomes thicker** so that the light rays are **refracted more**. To make the lens fatter, the **suspensory ligaments loosen** and the **ciliary muscle contract**.



Far objects – to focus on an object in the distant, the **lens becomes thinner** so that the light rays are **refracted less**. To make the lens thinner, the **suspensory ligaments contract** and the ciliary **muscles relax**.

Vision Defects

The two most common vision defects are **hyperopia** and **myopia**.

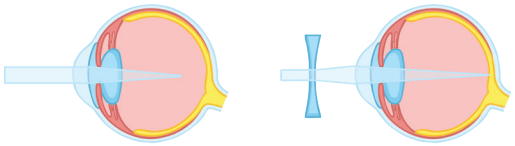
These eye defects are usually corrected through the use of **spectacle lenses** (glasses) or **contact lenses**.

Laser eye surgery or **lens replacement** can be performed to correct vision more permanently. Laser eye surgery changes the shape of the cornea to correct the degree of refraction of light into the eye.

Myopia, or **short sightedness**, is the inability to focus clearly on distant objects.

Myopia is caused when the eye is elongated meaning that refracted light rays cannot reach the retina when they are focused. It could also be caused when the lens is too fat or curved, again meaning that the light is refracted and focuses before reaching the retina. A concave lens is used to correct myopia.

How lenses correct **myopia**:

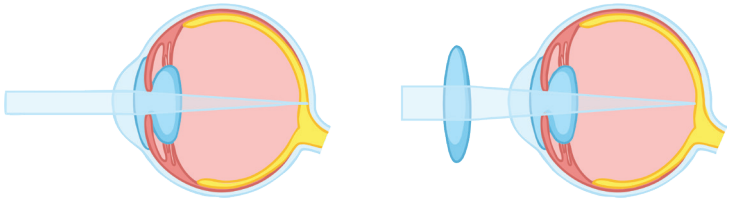


myopia | myopia correction

Hyperopia, or **long sightedness**, is the inability to focus clearly on near objects.

Hyperopia is caused when the eye is too short meaning that refracted light rays focus after the retina. It can also be a result of reduced elasticity in the lens, which is usually linked to ageing. A convex lens is used to correct myopia.

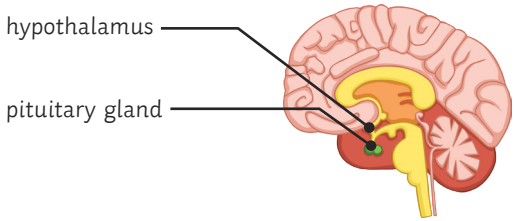
How lenses correct **hyperopia**:



hyperopia | hyperopia correction

Control of Body Temperature

Body temperature is constantly maintained around 37˚C. This is the optimal temperature for **enzymes** which carry out many of the metabolic processes within the body.



Within the **hypothalamus** of the brain is the **thermoregulatory centre** which controls how the temperature is maintained. The thermoregulatory centre contains **receptors** which are responsive to the temperature changes of the **blood**. The **skin** also contains temperature receptors which are responsive to **external temperature stimuli**. They send this information to the brain as **impulses** along the **sensory neurons**.

When our body becomes **too hot**, the following things happen:

- We **sweat** – water released from glands onto the skin's surface is evaporated. This uses heat energy from the body.
- **Vasodilation** occurs – blood vessels near the skin become wider and blood flow increases meaning more heat is transferred away from the body.
- **Skin hairs lie flat** – the hair erector muscles relax and so the hairs lie flat to the skin's surface.

When our body becomes **too cold**, the following things happen:

- We **shiver** – the skeletal muscles contract and relax rapidly to make us shiver. This movement of the muscles generates heat.
- **Vasoconstriction** occurs – blood vessels near the skin become narrower and blood flow decreases meaning less heat is transferred away from the body.
- **Skin hairs stand upright** – the hair erector muscles contract and so the hairs stand erect on the skin's surface. This traps an insulating layer of air across the skin's surface and reduces heat loss.

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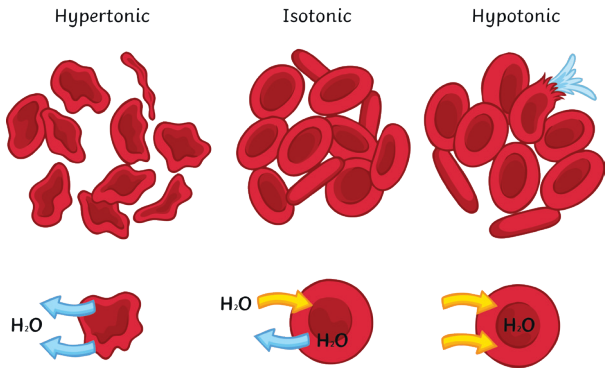
Maintaining Water Balance in the Body

The control of water and mineral salts within the body is called **osmoregulation**.

It is important that the levels are maintained to prevent the cells from **bursting** or **shrivelling** and so that they continue to function efficiently.

If the **concentration** inside the cell is at **equilibrium** to the outside, then the water and salts move in and out of the cell at an equal rate.

If the concentration of salts inside the cell becomes **higher** than the concentration outside the cell, then the solution outside is **more dilute (hypotonic)**. This means that water moves **into** the cell by **osmosis**. This causes the cell to **swell** and it can **burst open**.



If the concentration of salts inside the cell becomes **lower** than the concentration outside the cell, then the solution outside is **more concentrated (hypertonic)**. This means that water moves **out of** the cell by osmosis. This causes the cell to **shrivel** and it cannot function properly.

Water is lost from the body through the **lungs** when **breathing out (exhalation)** and through the skin when we **sweat**. Dissolved in the sweat are **mineral ions** and **urea**. The body does not regulate the amount of water, ions or urea lost through the lungs and skin. Instead, excess water, ions and urea are removed from the body in **urine**, via the **kidneys** which are part of the **urinary system**.

Maintaining Nitrogen Balance in the Body (HT Only)

When our food is digested, **proteins** are broken down by **protease enzymes** into **amino acids**. Not all of these amino acids are needed by the body and the excess need to be removed safely. The body cannot store extra proteins or amino acids.

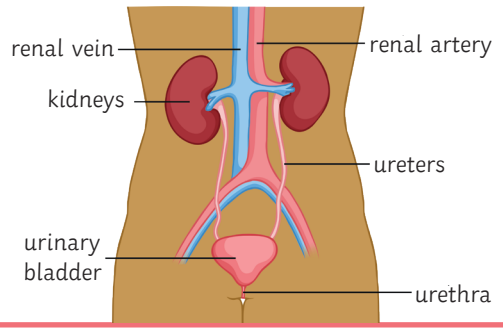
The **liver** forms **ammonia** by the process of **deamination** of excess amino acids. Ammonia is highly **toxic** so the body immediately converts it into **urea** so it can be safely **excreted**. The **liver cells** release urea and water into the **bloodstream** so it can be transported to the **kidneys**. At the kidneys, the blood is **filtered** and the urea is excreted from the body as **urine**.

Filtration and Selective Reabsorption in the Kidneys (HT Only)

Blood is transported to the kidneys through the **renal artery** and filtered at high pressure in the **kidneys**.

Useful materials such as **glucose, salt ions** and **water** are absorbed back into the body in a process known as **selective reabsorption**. Once filtered, the blood returns to the rest of the body via the **renal vein**.

The waste materials from the filtration process, including urea, are dissolved in water to form urine. This is carried along the ureter to the bladder where it is stored temporarily. When the bladder is filled, the urine leaves the body via the urethra.



Kidney Dialysis (HT Only)

Disease or damage to the **kidneys** can affect the ability to remove toxic waste substances from the body. Humans can function with the use of only one kidney, but in case of total **kidney failure**, treatment is needed urgently. This can be done as an **organ transplant** or by using **kidney dialysis**.

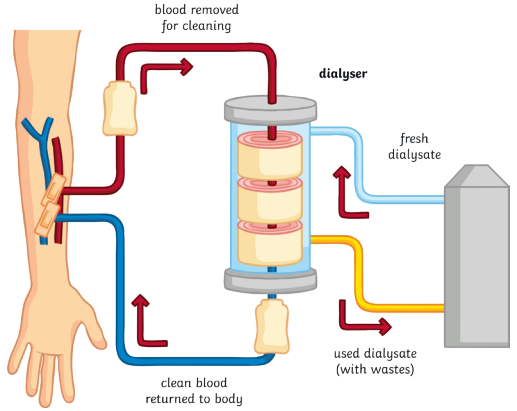
A **dialysis machine** can be used for patients who are waiting for a suitable **donor** to become available for an organ transplant.

Kidney dialysis uses specialised equipment, usually in a hospital setting.

Unfiltered blood is taken from the body via a blood vessel in the arm. It is mixed with **anti-coagulants** to prevent the natural blood clotting and then pumped into the dialysis machine. Inside the machine is a **partially permeable membrane** which separates the patient's unfiltered blood from the **dialysis fluid**.

The blood flows in the opposite direction to the dialysis fluid to ensure a concentration **gradient** is maintained and exchange of substances can occur. The dialysis fluid contains **glucose, ion**s and **no urea**.

This means that the urea moves across the partially permeable membrane, **down the concentration gradient** and into the fluid by **diffusion**. The **glucose** and **ion concentrations** in the dialysis fluid are similar to the concentrations within the blood plasma, so they are only exchanged across the membrane if there is an imbalance and safe levels are maintained.



Kidney Dialysis (HT Only) Continued

The **advantages** and **disadvantages** of **kidney dialysis** are listed in the table.

Advantages	Disadvantages
• Allows a patient with kidney failure to maintain their health. • Reduces the levels of urea in the blood. • Maintains glucose levels. • Restores the natural water and ion levels.	• expensive • Time consuming and restrictive on lifestyle: on average it takes 4 to 6 hours, 2 to 3 times per week, at the hospital. • Only effective whilst the dialysis is being run so patients must monitor their levels carefully between treatments. • Restrictions on diet: must avoid high salt foods and excessive protein consumption. • Only effective for a limited time – many patients die while waiting for an organ transplant.

ADH (HT Only)

The **hypothalamus** in the brain detects any changes in the **blood plasma**, including temperature and **water concentration**. To regulate the water concentration, the hypothalamus stimulates another region of the brain, the **pituitary gland**. The pituitary gland regulates the release of the **anti-diuretic hormone**, or **ADH**. The concentration of water in the blood plasma is controlled by the release of ADH in a **negative feedback loop**.

Organ Transplant (HT Only)

A **kidney transplant** involves replacing the entire **organ** with another taken from a **donor**. It is a much better treatment for kidney failure than dialysis because the patient is usually able to lead a **normal lifestyle** afterwards, without the restrictions imposed by dialysis treatment.

A potential problem of organ donation is the presence of **protein antigens** on the surface of the cells. Every cell in our body has these antigens and they are unique to each individual. The antigens help our body to distinguish between our own cells and invading pathogens or other foreign cells.

As the organ from the donor displays different antigen proteins, the patient's immune system will detect the transplanted organ as foreign and initiate an **immune response** against it. This is called **rejection**.

To help reduce the likelihood of **organ rejection**, there are two **precautions** that can be taken:

1. **Tissue typing** – donors and patients are matched based on how similar their antigens are. This can mean that there is a long wait to find a suitable donor organ and patients have to use dialysis in the meantime.
2. **Immuno-suppressant drugs** – patients take these drugs for the rest of their lives following an organ transplant. The drugs reduce the effect of the immune system and so reduce the response to the transplanted kidney. However, the drugs cannot target the immune response on the kidneys only, and so the patient has a reduced immune response to all other pathogens and this increases the risk of infections.

Unfortunately, even taking both precautions, many patients won't survive more than 10 years before requiring a new transplant or before returning to dialysis treatment.

The **advantages** and **disadvantages** of **organ transplant** are listed in the table.

Advantages	Disadvantages
• Patients can lead a normal and non-restrictive lifestyle. • Cheaper than kidney dialysis overall.	• Patients must take drugs which increases risk of infections. • There is a shortage of organ donors. • Transplanted organs only last 8 to 9 years, on average. • There are risks associated with the operation: excess bleeding, infections, allergic response to anaesthetic.

Plant Hormones

Phototropism – a plant's response to light.

Auxins are hormones in plants that control plant growth. They are found in the tips, roots and shoots and are sensitive to light. This is called phototropism. If the tip of the plant is removed, then the plant will no longer grow.

(HT Only)

Gravitropism/geotropism – a plant's response to gravity.

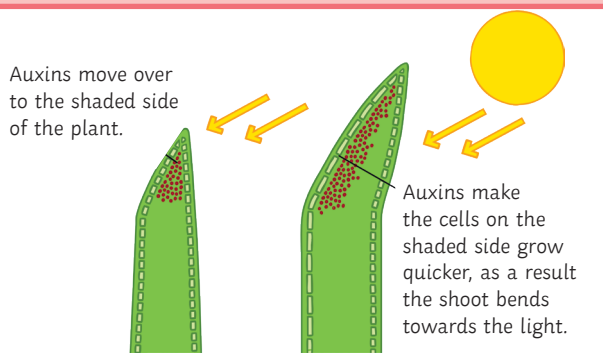
Auxins are also affected by gravity.

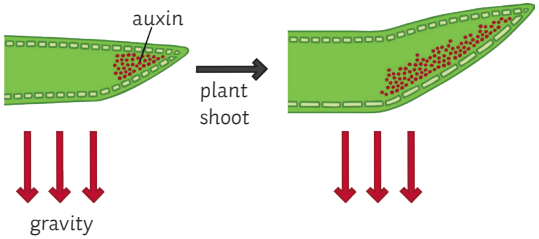
The Shoots

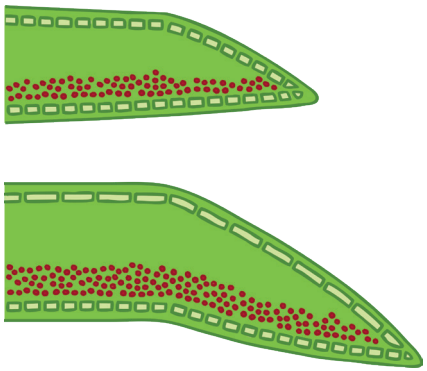
The **shoots** will grow away from gravity. A shoot that grows sideways will end up with more auxin on the lower side of the shoot and the lower side will grow more, causing the shoot to grow upwards.

The Roots

The **roots** will grow towards gravity. If a root grows on its side, more auxins will be on the lower side. In a root, the auxins will stop growth. The cells on the upper surface will grow more, bending the root downwards.







Use of Plant Hormones

Plant Hormone	Uses	Commercial Uses
auxins	Controlling plant growth.	• Killing weeds – some weed killers contain auxins which will only kill larger leaved plants (weeds). They affect how they grow and eventually kill them. • Growing plants from cuttings – by placing the plants in rooting powder (containing auxins), they will produce roots and grow a new plant. • Producing new plants from tissue culture produces clones. Auxins are added to the growth medium to allow the plants to grow.
gibberellin	Starts off seed germination, growth of stems and flowering.	• Gibberellin can be added to seeds to make them germinate at a specific time of year. This ensures that they would all germinate at the same time. • It can be used to grow bigger flowers and also make them flower no matter what the environmental conditions. • Adding gibberellin to some fruit will increase the size.
ethene	A gas produced when a plant ages. It controls cell division and the growth of plants. It is also involved in the ripening of fruit.	• Used to speed up ripening of fruit. Fruit can be picked whilst still unripe, ethene can then be added to ripen this fruit, ready for the supermarket shelf.

Required Practical Activity 7: Plan and carry out an investigation into the effect of a factor on human reaction time.

The aim of the investigation is to **investigate whether reaction times can be reduced with practice.**

Method:

In this experiment, you are working with a partner and you are always using the opposite hand to your writing hand.

1. One of the pair sits upright on a chair and places their forearm on the table so that their hand is hanging over the edge of the table.
2. The other partner places a ruler vertically between the person sitting down's thumb and first finger. The thumb and first finger should be as far apart as possible.
3. Ensure the 0cm end of the ruler is pointing downwards.
4. Place the 0cm mark level with the top of the thumb and drop without telling your partner you are going to do it. Do tell them that the aim is for them to catch the ruler as quickly as possible.
5. Reading from the top of the thumb, record how many centimetres it took to catch.
6. Repeat nine more times.
7. Swap roles with your partner.
8. Using the reaction time conversion tables, convert your results from centimetres to reaction times (s).

The **independent variable** is the method for improvement e.g. amount of practice/use of caffeine.

The **dependant variable** is the reaction time in seconds (converted from the cm taken to catch the ruler).

Required Practical Activity 8: Investigate the effect of light or gravity on the growth of newly germinated seedlings.

The aim of the investigation is to investigate the effect of light intensity on the growth of seeds.

Method: Germination of the Seeds

Before the investigation into the effect of light intensity on seedling growth can commence, it is important that the seeds that are to be measured have been germinated in the same conditions.

1. Place equal amounts of cotton wool into the base of three Petri dishes.
2. Add 10ml of water to the cotton wool.
3. Place 10 seeds on the cotton wool in each of the Petri dishes. Try to give each of the seeds plenty of space because it will make it easier to measure them.
4. Place the seeds in a warm place and allow time for them to germinate.
5. Add equal amounts of water to each of the Petri dishes if the cotton wool is becoming too dry.

Method: Measuring Growth of the Seedlings

1. Once the seeds have germinated, ensure there is an equal number in each Petri dish. This may mean you have to remove some. (Some seeds may not germinate.)
2. Place one Petri dish in each of the following places: a dark cupboard receiving no/very little light; a windowsill that will get as much light as possible; an area with partial light.
3. Every day for five days, measure the height of the seedlings and record the results.
4. To measure the height of the seedlings, you must ensure each seedling is at its full height. You may need to use the forceps to carefully lift the seedling.
5. Calculate the mean height of the seedlings each day.

The **independent variable** is light intensity. This is not a numerical value but based on the location of the seeds in the classroom e.g. windowsill or dark cupboard.

The **dependent variable** is the height of the seedlings growth, measured in centimetres.

AQA Inheritance, Variation and Evolution Knowledge Organiser

Keywords

allele – An alternative form of a gene.

asexual reproduction – The production of offspring from a single parent by mitosis. The offspring are clones of the parent.

chromosome – Structures that contain the DNA of an organism and are found in the nucleus.

cystic fibrosis – A disorder of cell membranes caused by a recessive allele.

DNA - A polymer that is made up of two strands that form a double helix.

dominant – An allele that is always expressed, even if only one copy is present.

fertilisation – The fusion of male and female gametes.

gamete – Sperm cell and egg cell in animals; pollen and egg cell in plants.

gene – A small section of DNA that codes for a specific protein.

genome – The entire genetic material of an organism.

genotype – The combination of alleles.

heterozygous – A genotype that has two different alleles – one dominant and one recessive.

homozygous – A genotype that has two of the same alleles. Either two dominant alleles or two recessive alleles.

meiosis – The two-stage process of cell division that reduces the chromosome number of the daughter cells. It makes gametes for sexual reproduction.

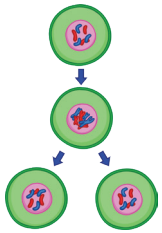
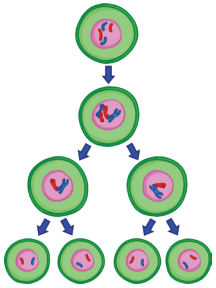
mutation – A change in DNA.

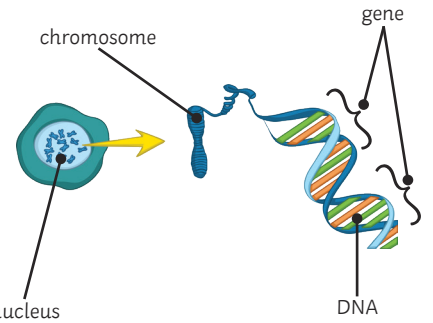
phenotype – The characteristic expressed because of the combination of alleles.

polydactyly – Having extra fingers or toes. Is caused by a dominant allele.

recessive – An allele that is only expressed if two copies of it are present.

sexual reproduction – The production of offspring by combining genetic information from the gametes of two parents. Leads to variation in the offspring.

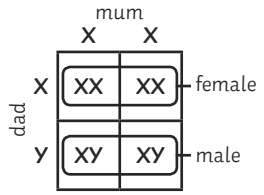
Mitosis	Meiosis
Produces two daughter cells.	Produces four daughter cells.
Daughter cells are genetically identical.	Daughter cells are not genetically identical.
The cell divides once.	The cell divides twice.
The chromosome number of the daughter cells is the same as the parent cells. In humans, this is 46 chromosomes.	The chromosome number is reduced by half. In humans, this is 23 chromosomes.
Used for growth and repair, and asexual reproduction.	Produces gametes for sexual reproduction.
	



Sex Determination

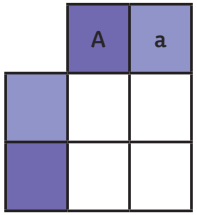
Females carry two X chromosomes.

Males carry one X and one Y chromosome.

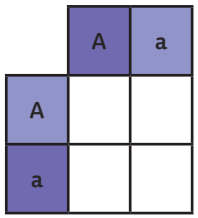


How to Complete a Punnet Square

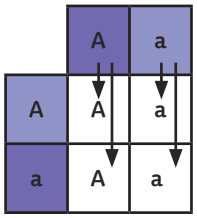
Step 1: Put the two alleles from one parent into the boxes at the top. This parent is a heterozygote. This means they have one dominant and one recessive allele.



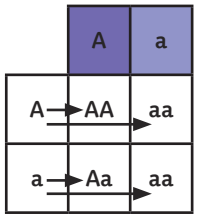
Step 2: Put the two alleles from the second parent into the boxes on the left. This parent is also a heterozygote.



Step 3: Put the alleles from the first parent into the two boxes beneath them.

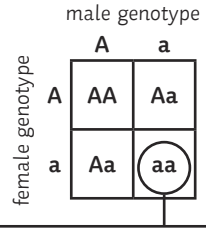


Step 4: Put the alleles from the second parent into the two boxes to the right of them.



Probability

There are four possible combinations of gametes that offspring can inherit.



One of these four has the genotype aa, that's $\frac{1}{4}$, 25% or 0.25.

The recessive phenotype has a ratio of 1:3 because only one combination will show the phenotype, while the other three will not.

AQA Inheritance, Variation and Evolution Knowledge Organiser

Keywords

embryo screening – Genetic tests carried out on an embryo to see whether it carries a faulty allele.

evolution – A change in the inherited characteristics of a population, over time, through a process of natural selection.

evolutionary tree – A method used to show how scientists believe organisms are related.

extinction – The permanent loss of all members of a species.

fossils – The remains of organisms from millions of years ago which are found in rocks.

genetic engineering – The process by which scientists manipulate and change the genotype of an organism.

natural selection – The process by which organisms that are better suited to an environment are more likely to survive and reproduce.

selective breeding – Humans selecting animals or plants, that have a required characteristic, for breeding.

speciation – The process by which two species evolve from a single original species by natural selection. The two populations have become so different that they can no longer interbreed to produce fertile offspring.

variation - Differences in characteristics of individuals in a population.

Variation

Variation maybe be due to differences in:

- the genes that have been inherited (genetic causes);
- the conditions in which they have developed (environmental causes);
- a combination of genes and the environment.

Evolution

All species of living things have evolved from simple life forms by natural selection.

- If a variant/characteristic is advantageous in an environment then the individual will be better able to compete.
- This means they are more likely to survive and reproduce.
- Their offspring will inherit the advantageous allele.

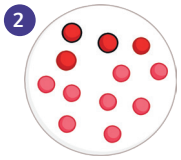
Resistant Bacteria

To reduce the rate at which antibiotic resistant strains appear:

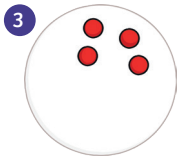
- Antibiotics should only be used when they are really needed, not for treating non-serious or viral infections.
- Patients should complete their courses of antibiotics, even if they start to feel better.
- The agricultural use of antibiotics should be restricted.

1. There is variation in the bacterial population. One bacterium develops a mutation by chance that means it is resistant to an antibiotic.

2. The antibiotic kills some of the bacteria, the resistant bacterium survives and reproduces.



3. The antibiotic kills the rest of the non-resistant bacteria so the person may start to feel a little better. The resistant bacterium has survived the antibiotic and continues to multiply.



Fossils

Fossils could be:

- the actual remains of an organism that has not decayed;
- mineralised forms of the harder parts of an organism, such as bones;
- traces of organisms such as footprints or burrows.

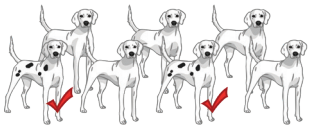
Many early life forms were soft-bodied so have left few traces behind.

Fossils help us understand how much or how little organisms have changed as life developed on earth.

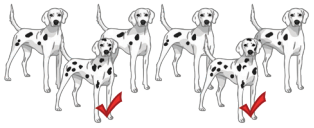
Selective Breeding

- Choose parents who have the desired characteristic.
- Select the best offspring and breed these to make the next generation.
- These offspring are then bred again and again, over many generations, until a desired result is achieved.

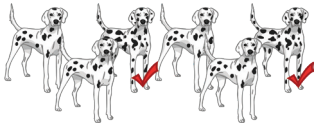
1st Generation



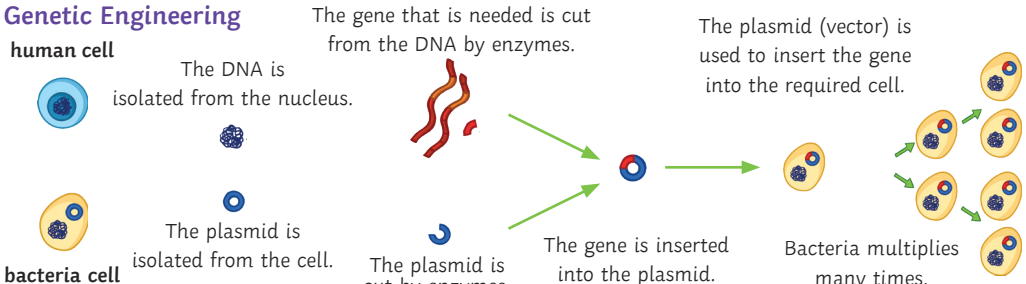
2nd Generation



3rd Generation



Genetic Engineering



Classification

Linnaeus classified living things into kingdom, phylum, class, order, family, genus and species.

Organisms are named by the binomial system of genus and species.

Due to evidence from chemical analysis, there is now a 'three-domain system' developed by Carl Woese.

Domain	bacteria	archaea	eukaryota			
Kingdom	eubacteria	archaebacteria	protista	fungi	plantae	animilia

AQA Inheritance, Variation and Evolution Knowledge Organiser

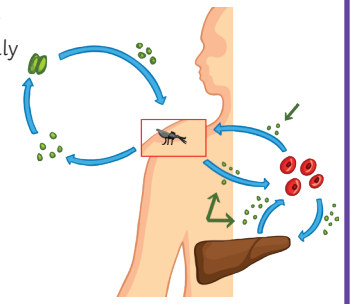
Advantages of sexual reproduction:

- Produces variation in the offspring;
- If the environment changes, variation gives a survival advantage via natural selection;
- Natural selection can be increased by humans in selective breeding to increase food production.

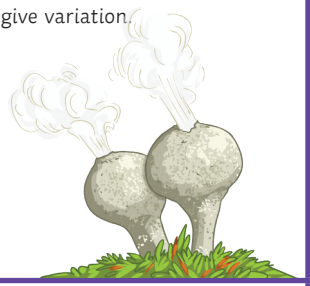
Advantages of asexual reproduction:

- Only one parent needed;
- More time and energy efficient as they do not need to find a mate;
- Faster than sexual reproduction;
- Many identical offspring can be produced when conditions are favourable.

Malarial parasites reproduce asexually in the human host but sexually in the mosquito.



Many fungi reproduce asexually by spores, but also reproduce sexually to give variation.

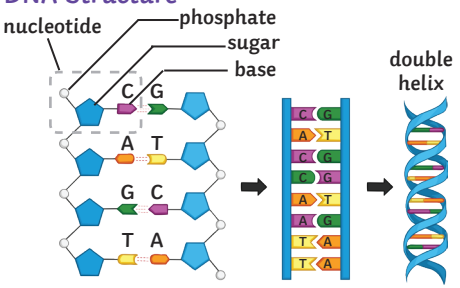


Evolution by Natural Selection

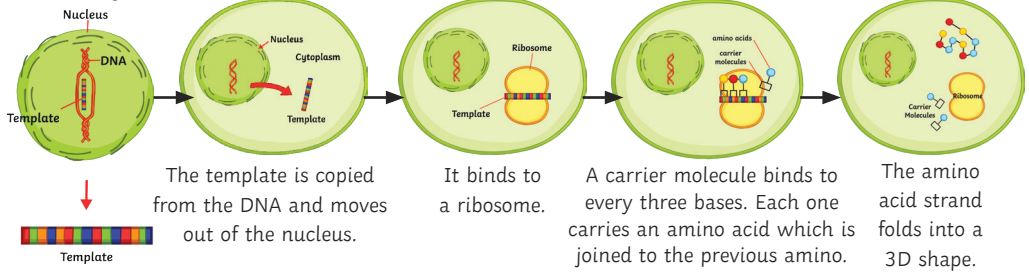
Darwin's theory was only gradually accepted because...

- the theory challenged the idea that God made all the animals and plants that live on earth.
- there was insufficient evidence at the time the theory was published to convince many scientists.
- the mechanism of inheritance and variation was not known until 50 years after the theory was published.

DNA Structure



Protein Synthesis



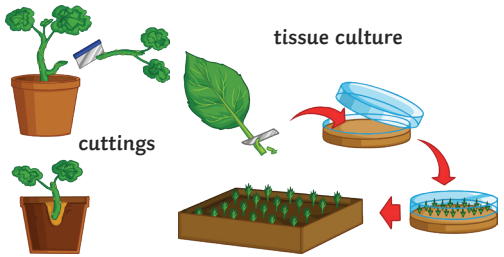
The template is copied from the DNA and moves out of the nucleus.

It binds to a ribosome.

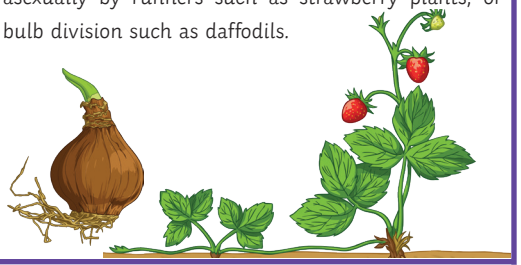
A carrier molecule binds to every three bases. Each one carries an amino acid which is joined to the previous amino.

The amino acid strand folds into a 3D shape.

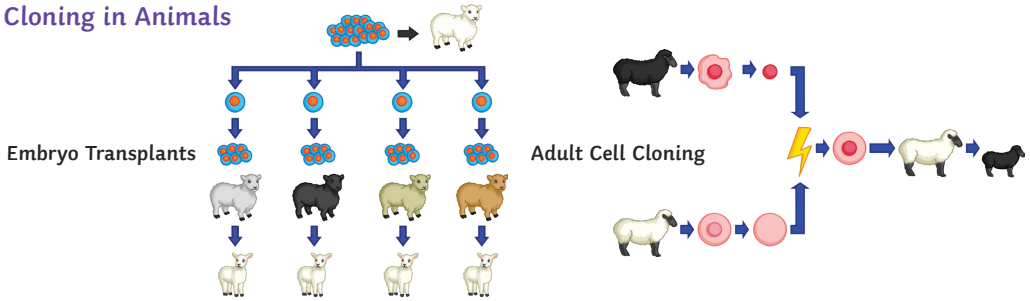
Cloning in Plants



Many plants produce seeds sexually, but also reproduce asexually by runners such as strawberry plants, or bulb division such as daffodils.



Cloning in Animals



The Understanding of Genetics

1866
Mendel published his results, identifying units of inheritance. His work goes largely unnoticed by other scientists.

1884
Mendel dies.

1900
Boveri provides the first evidence that chromosomes are passed on between generations.

1953
The structure of the double helix is discovered by James Watson and Francis Crick, using data from Rosalind Franklin.

1856
Mendel begins his research.

1882
The 'chromosome dance' of mitosis was observed by Walther Flemming.

1902
Chromosomes are observed separating into gametes in meiosis by Walter Sutton. The connection between chromosomes and Mendel's units is made.

Speciation

isolation – Parts of a population become geographically or environmentally isolated from each other.

conditions – If the conditions in each environment are different, then different characteristics will be advantageous.

natural selection – Organisms with this characteristic are more likely to survive and pass on the allele for it to their offspring.

speciation – Eventually, the two populations are so different they can no longer interbreed to produce fertile offspring.

AQA Ecology Knowledge Organiser

Keywords

Biodiversity - the variety of living organisms.

Carrion - decaying flesh and tissue of dead animals.

Community - made up of the populations of different species living in a habitat.

Competition - the negative interaction between two or more organisms which require the same limited resource.

Consumers - feed on other organisms for their energy. Can be primary, secondary or tertiary.

Decomposers - organisms which feed on dead and decaying organisms. They break down the biomass and release nutrients into the soil.

Deforestation - the removal and destruction of trees in forest and woodland.

Ecosystem - the interaction between the living organisms and the different factors of the environment.

Global warming - the increase of the average global temperature.

Habitat - where a living organism lives.

Interdependence - the interaction between two or more organisms, where it is mutually beneficial.

Population - the number of individual organisms of a single species living in a habitat.

Predators - organisms which kill for food.

Prey - the animals which are eaten by the predators.

Producers - convert the sun's energy into useful compounds through photosynthesis. They are green plants or algae.

Scavengers - organisms which feed on dead animals (carrion).

Species - organisms of similar morphology which can interbreed to produce fertile offspring.

Abiotic and Biotic Factors

Abiotic factors are the non-living factors of an environment. E.g. moisture, light, temperature, CO_2, wind, O_2 or pH.

Biotic factors are the living factors of an environment. E.g. predators, competition, pathogens, availability of food.

Adaptations

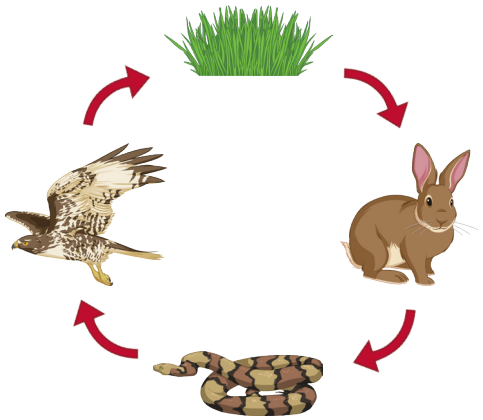
Adaptations are specific features of an organism which enable them to survive in the conditions of their habitat.
Adaptations can be structural, behavioural or functional:

- **Structural adaptations** are features of the organism's body e.g. colour for camouflage.
- **Behavioural adaptations** are how the organism behaves e.g. migration to a warmer climate during colder seasons.
- **Functional adaptations** are the ways the physiological processes work in the organism e.g. lower metabolism during hibernation to preserve energy.

A plant or animal will not physically change to adapt to its environment in its lifetime. Instead, there is natural variation within the species and only organisms whose features are more advantageous in the environment survive. The survivors then go on to reproduce and pass on their features to some of their offspring. The offspring who inherit these advantageous features are better equipped to survive.
Charles Darwin described this process as 'survival of the fittest'.

Food Chains

The source of all energy in a food chain is the sun's radiation. It is made useful by plants and algae which produce organic compounds through photosynthesis.

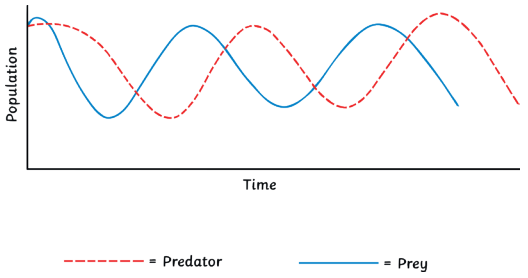


The living organisms use the energy to produce biomass and grow.

When a living organism is consumed, some of the biomass and energy is transferred. Some of the energy is lost.

Remember: the arrow in a food chain indicates the direction of the flow of energy.

Populations of predators and prey increase and decrease in cycles. The size of the predator population depends on the size of the prey population and vice versa. Overall, there is a stable community.



AQA Ecology Knowledge Organiser

Competition

Species will compete with one another and also within their own species to survive and to reproduce.

Mutualism occurs when both species benefit from a relationship.
Parasitism occurs when a parasite only benefits from living on the host.

Animals compete for resources such as food, water and space/ shelter. They may also compete within their own species for mates.
Plants compete for resources including light, water, space and minerals. All these resources are needed for photosynthesis so the plant can make its own food. Plants do not need to compete for food.

Deforestation and Land Use

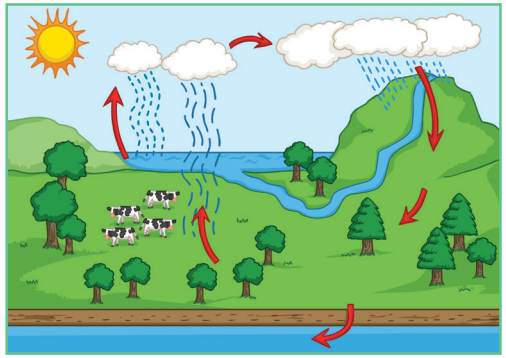
Humans use land for buildings, quarrying, mining, agriculture and landfill. As the human population increases and we take more land, there is less space for other organisms to live.
Deforestation (to use wood as a fuel/material or to clear space for other uses) destroys habitats where other organisms live.

Peat bogs are produced when decomposition occurs over a very long time. Peat stores a lot of carbon and can be extracted for use by gardeners or as an energy source. Burning peat releases a lot of carbon dioxide into the atmosphere which contributes to the greenhouse effect.

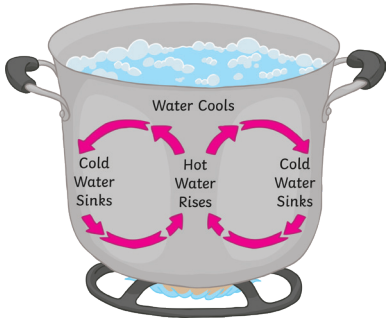
Trees absorb carbon dioxide for photosynthesis, so as they are

cut down and removed, less carbon dioxide is taken from the atmosphere. Furthermore, when the trees are burned, they release carbon dioxide back into the atmosphere. The excess carbon dioxide can lead to global warming and the changes to the ecosystem cause reduced biodiversity.

Water Cycle



Convection is the movement caused within a fluid as the hotter, less dense material rises and colder, denser material sinks under the influence of gravity. This results in the transfer of heat.



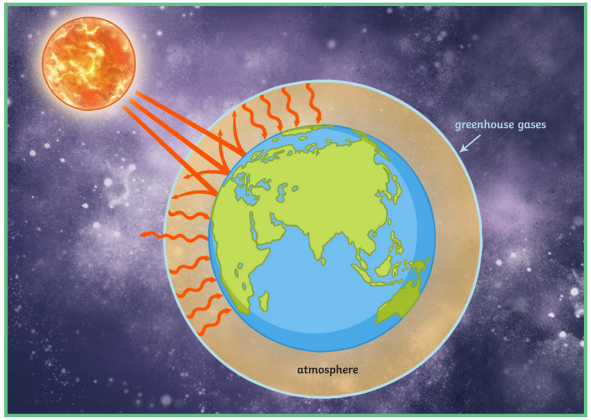
Evaporation occurs when heat energy from the surroundings (or a heat source) is transferred to water particles as kinetic energy. The particles begin to move more rapidly and can turn from a liquid into a gas.

When moving particles transfer kinetic energy to the surroundings, the particles begin to move more slowly and can turn from a gas into a liquid. This is **condensation**.

Precipitation occurs when rain, snow, sleet, or hail falls to (or **condenses** on) the ground.

Transpiration is the process by which water is carried through plants from roots to the stomata on the underside of leaves and it evaporates into the surroundings.

Global Warming



The greenhouse effect is the natural process where some of the Sun's radiation is trapped within the insulating layer of the atmosphere. This maintains a temperature suitable to support life on Earth.

Most of the radiation from the Sun is absorbed by the Earth when it reaches the surface. The rest of the infrared radiation is reflected from the surface and absorbed by the greenhouse gases and clouds in the atmosphere. This is then re-emitted in all directions.

However, due to many contributing factors, the global temperature is gradually increasing. Several gases, called greenhouse gases, trap the heat around the Earth; the most concerning is carbon dioxide. Human activities contribute to the excess amount of carbon dioxide in the atmosphere and so are a cause of global warming.

Global warming leads to the melting of ice caps, rising sea levels, flooding, changes to climate, changes in migration patterns, changes in species distribution and reduction in biodiversity.

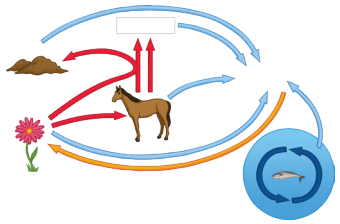
RPI: Field Techniques Quadrats and Transects

The distribution of an organism is affected by the environment and abiotic factors.
Quadrats can be used to measure the frequency of an organism in a given area e.g. the school field. You could count the individual organism or estimate the percentage cover. You must collect data from at least two areas to make a comparison. Quadrats should always be placed randomly.

Transects are used to measure the change of distribution across an area e.g. from the edge of a river and moving further from the water's edge. You could either count the number of organisms touching the transect at regular intervals or use a quadrat placed at regular intervals along the transect.

$$\text{mean} = \frac{\text{total number of organisms}}{\text{number of quadrats}}$$

Carbon Cycle



The main focus on the carbon cycle is its transfer to and from the atmosphere. When carbon is in the atmosphere, it combines with oxygen to form carbon dioxide, a greenhouse gas.

Carbon is transferred from the atmosphere when plants absorb carbon dioxide for photosynthesis and when the gas is dissolved into oceans.

Carbon is transferred to the atmosphere through respiration by animals, plants and bacteria and by combustion of fossil fuels (coal, oil and natural gas).

Dead animals and plants are decomposed and their matter is broken down by microbes and fungi. These organisms are collectively called decomposers. When the organisms are broken down, the microbes and fungi release carbon dioxide into the atmosphere through respiration.

Biodiversity and Waste Management

Biodiversity is the variety of living organisms on the earth or in an ecosystem. It is important in helping to maintain stable ecosystems. Organisms are often interdependent, relying on others as food sources, or to create suitable environmental conditions to survive. Human survival is also dependent on this biodiversity.

The global human population has exceeded 7 billion.
Human population has increased due to modern medicine and farming methods, reducing famine and death from disease.
This means a greater demand for food, resources and water.
It also means more waste and emissions are created.

Sewage, toxic chemicals, household waste and gas emissions pollute the water, land and air, killing plants and animals and reducing biodiversity.

Maintaining Ecosystems and Biodiversity

There are many ways that biodiversity and ecosystems are maintained:

- Breeding programmes can help to protect endangered species from extinction.
- Conservation programmes can help to protect and preserve specialised ecosystems and habitats such as peat bogs and coral reefs.
- Reintroduction of hedgerows and field margins on agricultural land can help improve biodiversity by breaking up the monoculture crops.
- Sustainable forestry programmes help to manage the woodlands and reduce the deforestation to a sustainable rate.
- Societies actively encourage recycling and reusing of products and packaging to reduce the household waste going to landfill sites.

Unfortunately these programmes can be difficult to manage. They are often expensive and are difficult to regulate. People who are employed in certain areas, e.g. tree felling, cannot always transfer their skills to an environmentally friendly role and so become unemployed. It is difficult to maintain biodiversity whilst preventing crops being overrun with pests and weeds, which would affect food security for the human population.

Decomposition and Decay

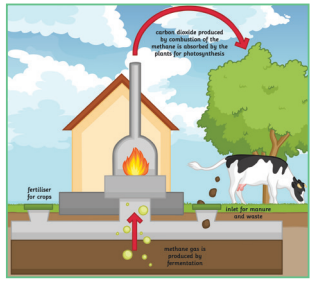
Decomposition is the process of rotting (decay) of a material. The optimum conditions for decay to occur are warm, moist conditions with a plentiful supply of oxygen available. This is because it is microorganisms which are breaking down the larger material into smaller pieces. The microorganisms can digest the material more efficiently and quickly when the conditions are warm, moist and there is a high level of oxygen.

Food can be preserved by many methods to prevent or reduce the rate of decay. These include cooling, canning, freezing, drying, pickling (adding vinegar) or adding salt or sugar.

Some microorganisms ferment waste materials, producing biogas, which can be used as a fuel source. Biogas is produced in a generator (or a digester) using many different microorganisms to ferment the carbohydrates in plant and animal waste. Waste from factories or sewage treatment plants can also be used in a biogas generator. By-products of the fermentation process can be used to fertilise crops and gardens.

There are two main types of generators: batch and continuous.

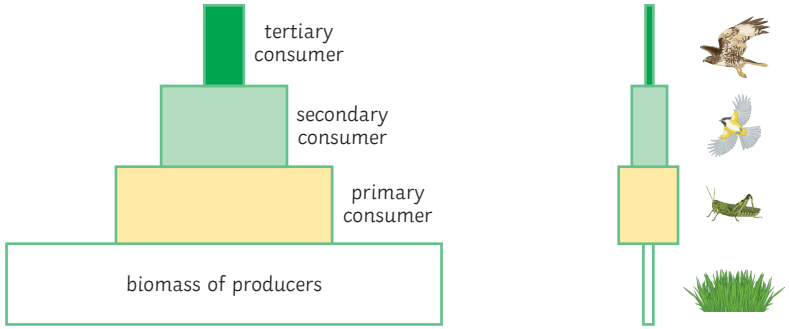
- A batch generator is manually loaded with the waste and emptied by hand afterwards. It only runs for a short while each time.
- A continuous generator is more automated and the waste is continually fed in. The products made are removed at a steady, continuous rate. It is used for more large-scale projects.



Pyramids of Biomass and Biomass Transfer

Biomass is the amount of living matter in a given area.

To find the biomass, we simply multiply the mass of an individual organism by the number of organisms.



A **pyramid of biomass** shows you how much biomass there is in each trophic level. They should be drawn to scale so each bar accurately represents the amount of biomass in that trophic level.

A **pyramid of number** shows you how many of each organism there is in each trophic level.

On average, only 10% of the biomass is transferred to the next trophic level each time.

Energy is lost from trophic levels as heat energy when the organism respires or moves.

Energy is used by the organism for life processes such as homeostasis and growth.

Some of the biomass cannot be eaten e.g. snail shell.

Not all of the organism is eaten by a consumer e.g. stalks and roots.

Biomass and energy are lost in excretions (like poo).

$$\text{Efficiency} = \frac{\text{energy available to the next trophic level}}{\text{energy that was available to the previous trophic level}} \times 100$$

Impact of Environmental Change (HT only)

Changes in the environment can affect the abundance and distribution of the organisms living there.

Abundance means a very large number of organisms.

Distribution means the way in which the organisms are spread over an area.

The changes can be **seasonal**, **geographical** or caused by **human interaction** with the environment. The changing seasons mean that factors including temperature and availability of water can change. These factors impact the organisms living in the ecosystem.

- Birds such as geese migrate south from Europe during the winter months when the temperatures are colder.
- Whales migrate south through the oceans to breed in warmer waters near the equator.
- Worms bury themselves deeper into the earth during the winter to avoid the effects of frost and cold temperatures.
- Land animals such as caribou migrate to find warmer temperatures and food during the colder months.

Some species depend on certain conditions to thrive and give us an indication of factors, such as oxygen availability or pollution. For example, lichens: there are three types of lichens. A lichen is a plant species which grows in exposed areas such as rock surfaces or tree bark. They are adapted to absorbed nutrients from sparse sources, such as rain water. Depending on the level of pollution, different types of lichen are more abundant. We call these types of organisms **bioindicators** and they can help us to monitor the level of pollution or the different factors affecting an ecosystem.

Intensive Farming and Sustainable Fishing

To increase the efficiency of the energy transfer, farmers employ techniques to reduce the amount of energy lost between the trophic levels. These techniques are collectively known as **intensive farming**.

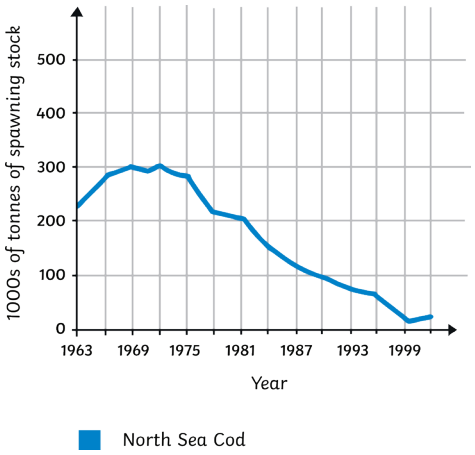
- Animal enclosures are covered and heated to regulate the temperature of the surroundings. This reduces heat loss and energy use for homeostasis and growth.
- Plant-growing spaces are covered and heated to regulate the temperature. This improves the growth and enables the environmental conditions to be controlled more closely.
- Some animals are fed high-protein foods and supplements to their usual diet to increase their growth and produce higher yields of meat, milk or eggs.

Although these methods increase the output, many people believe it is unnecessarily cruel to the animals. Due to the crowded nature of the enclosures, animals are given antibiotics to prevent disease. These antibiotics can be transferred to humans through our food, and scientists claim this is a possible cause of increasing bacterial resistance to antibiotics.

Ocean fish stocks are declining across the world. If the population size is depleted too much, then the breeding rate will no longer sustain a stable population and the species may become extinct.

Fishing regulations are enforced by many countries to help promote the recovery of natural fish stocks in the oceans and to help maintain populations at sustainable levels.

Regulations control the size of the nets allowed to be used and the introduction of fishing quotas helps to limit overfishing in some areas.



RPI: Decay - Investigating the Effect of Temperature on the Rate of Decay of Milk by Measuring pH Change

Milk is an alkaline solution.

- Phenolphthalein (an indicator) is pink in solutions with a pH of 10 or above.
- If the pH drops to about 8, the solution will become colourless.
- Lipase is an enzyme that will break down the fat in milk.
- As lipase breaks down fat to fatty acids, the pH of the solution lowers.

Independent variable – temperature (controlled by water baths and measured using a thermometer).
Dependent variable – time taken for indicator to change colour (measured using a timer).

To calculate the mean:

$$\frac{\text{total time taken for pink colour to disappear (s)}}{\text{number of trials}}$$

Remember to check for any anomalies. If there is an anomaly, discard it and do not add it to your total. Collecting repeated results and calculating an average allows you to identify any anomalous results and improves the reliability of your data.

1. The investigation is carried out at five different temperatures: 0, 20, 40, 60 and 80°C.
2. Label five test tubes as 'lipase' and add 1cm^3 of lipase to each one.
3. Take another five test tubes and add five drops of phenolphthalein to each one.
4. Add 5cm^3 of full fat milk to the test tubes containing phenolphthalein solution and label them 'milk'.
5. Using a clean pipette, add 7cm^3 of sodium carbonate solution to the milk (the solution should turn pink).
6. Place a test tube of lipase and a milk test tube into the water baths until they are both of the desired temperature.
7. To achieve 0°C, place the test tubes in a beaker of ice.

Biotechnology

Biotechnology and agriculture can be combined to provide some possible solutions. These include the following:

- Mass production of mycoprotein which is a protein-rich food suitable for vegetarians.
- Genetically modified bacterium which produce human insulin which is a chemical used in the treatment of diabetes.
- Genetically modified crops, such as golden rice, which provide higher yields or greater nutritional values per unit.

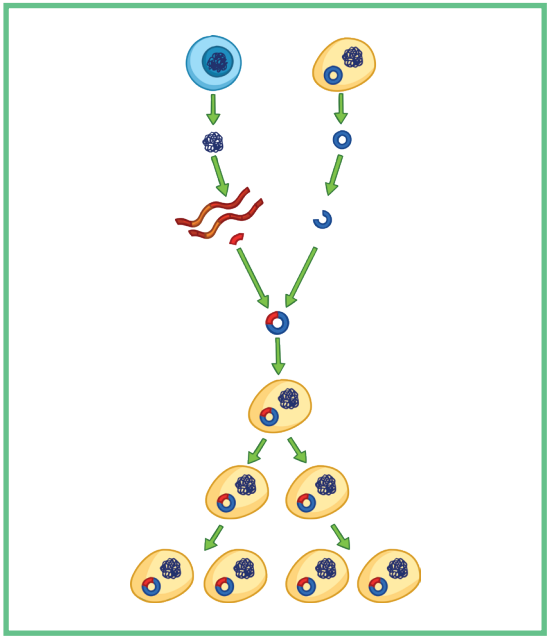
Mycoprotein Fermenters

- Mycoprotein is a protein product.
- It is made by the fungus *Fusarium*.
- The fungus is grown in 40m-high fermenters which run continuously in 5-week cycles.
- After the growth cycle, the fungus is harvested, purified, dried and prepared for food products.
- The fermenter is sterilised and ready to repeat the process with a new batch of fungi.

- Genetic modification uses technology to transfer genes from one species to another.
- It can be used to improve food production.
- Genes can be transferred to give plants increased resistance to herbicides, for example.

Genetically modified organisms may present a hazard to human health. They could lead to allergic reactions or have higher than natural levels of toxins.

Recombinant DNA technology involves the transfer of genes from one species to another. It can be used to make another organism, usually bacteria, produce a protein. The bacteria are grown in fermenters and can produce huge amounts of the protein. Human insulin is now produced using recombinant DNA technology, as described below.



Food Security

Food security means a whole population have access to enough nutritious food to sustain a healthy lifestyle. This is achieved using methods which the planet can continue to sustain for further generations of the population.
However, there are several biological factors which can threaten food security.

These factors include:

- increasing birth rate
- changing diets
- new pests and pathogens
- widespread famine
- drought
- increasing costs
- war and conflicts

Trophic Levels

Trophic levels describe the position of an organism within the food chain.

They can be represented by numbers.

The higher the number, the further along the food chain.

Trophic levels only represent the living organisms (so the sun isn't included).

Scavengers and decomposers are not represented in the trophic levels either.

Level 1: Producers

Level 2: Primary Consumers

Level 3: Secondary Consumers

Level 4: Tertiary Consumers