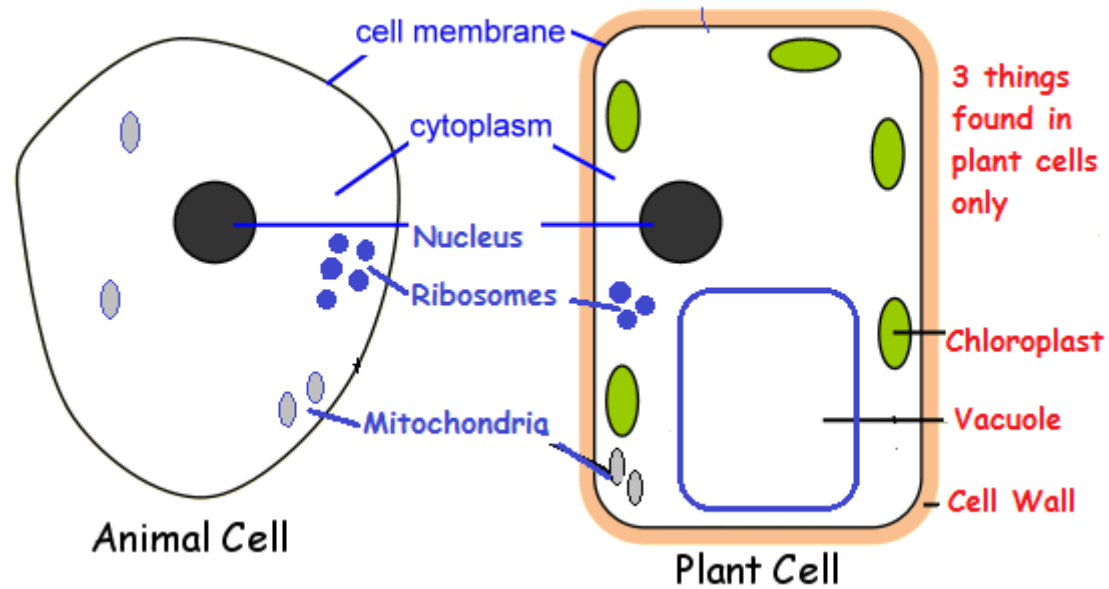


# Cells

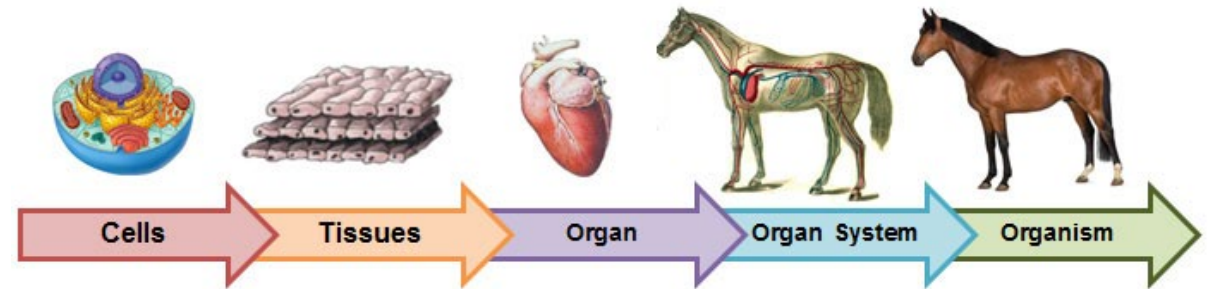


## Keywords:

- **Cell:** The unit of a living organism, contains parts to carry out life processes.
- **Uni-cellular:** Living things made up of one cell.
- **Multi-cellular:** Living things made up of many types of cell.
- **Tissue:** Group of cells of one type.
- **Organ:** Group of different tissues working together to carry out a job.
- **Diffusion:** One way for substances to move into and out of cells.
- **Structural adaptations:** Special features to help a cell carry out its functions.

## Functions of organelles:

- **Cell membrane:** Controls movement of substances in and out.
- **Nucleus:** Contains genetic material (DNA) which controls cell's activities.
- **Vacuole:** contains liquid, and can be used by plants to keep the cell rigid and store substances.
- **Mitochondria:** where energy is released through respiration.
- **Ribosomes:** where proteins are made
- **Cell wall:** Strengthens the cell (made of cellulose)
- **Chloroplast:** Absorbs light energy so the plant can make food, contains chlorophyll (photosynthesis).
- **Cytoplasm:** Jelly-like substance where chemical reactions occur



## Body systems:

- **Immune system:** Protects the body against infections.
- **Reproductive system:** Produces sperm and eggs, and is where the foetus develops.
- **Digestive system:** Breaks down and then absorbs food molecules.
- **Circulatory system:** Transports substances around the body.
- **Respiratory system:** Replaces oxygen and removes carbon dioxide from blood.
- **Muscular skeletal system:** Muscles and bones working together to cause movement and support the body.

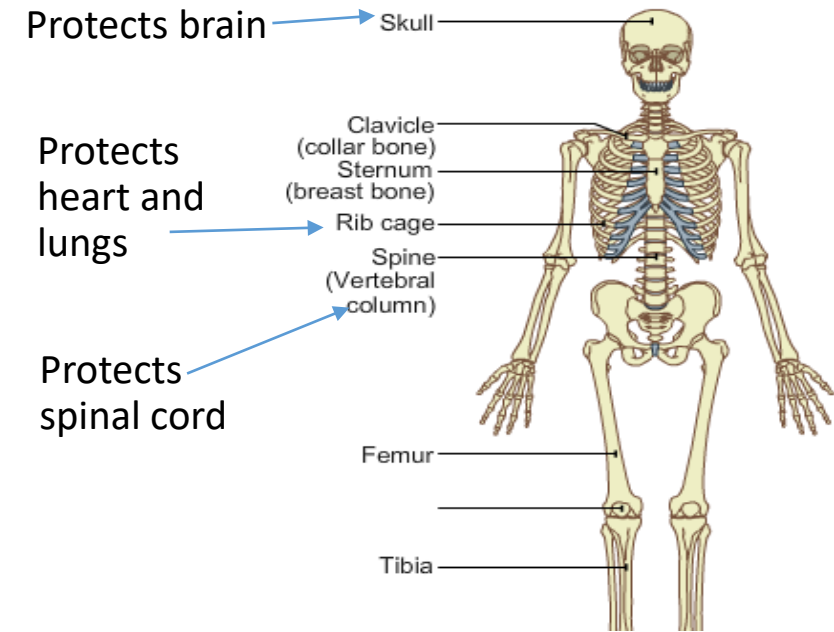
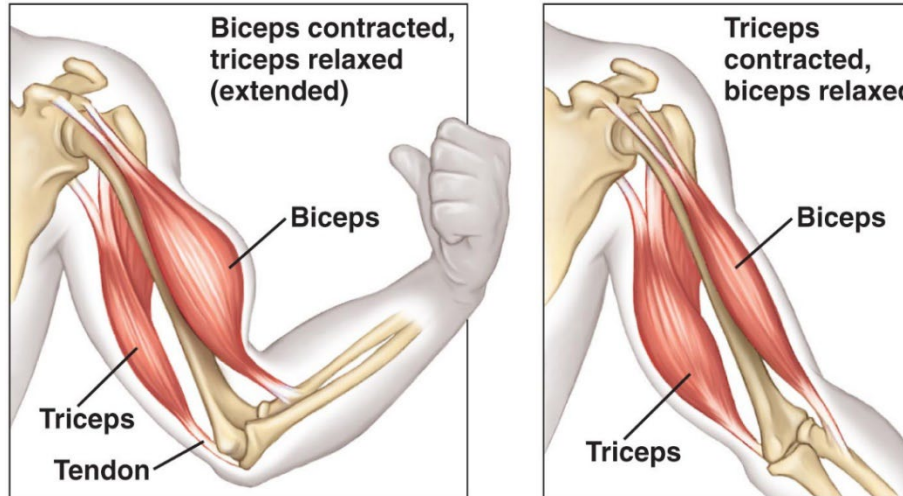
# Movement

## Main jobs of skeleton:

1. Support
2. Movement
3. Protection
4. Production of new blood cells

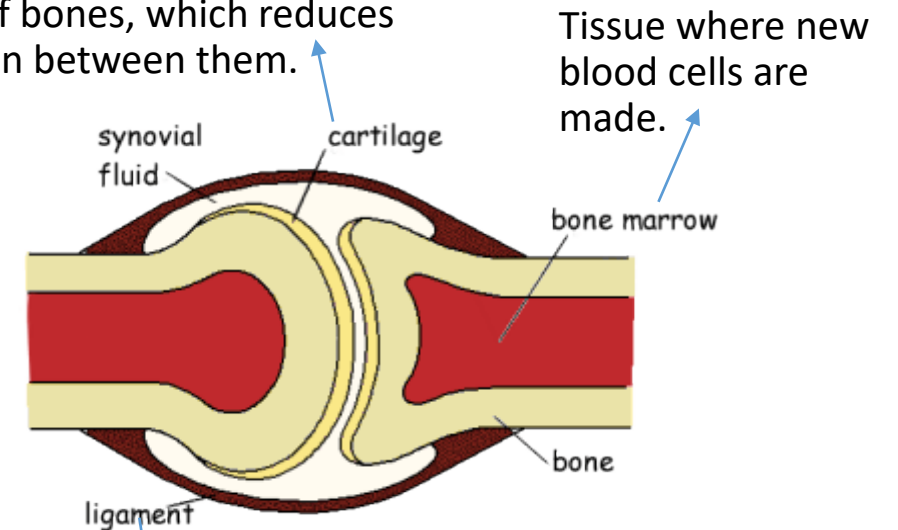
**Antagonistic muscles:** Muscles can only **pull** they cannot push. For a joint to move in two directions you need two muscles.

- When the biceps muscle contracts (gets shorter), the forearm moves up
- When the triceps muscle contracts, the forearm moves down.



## Joints: Places where bones meet.

Smooth tissue found at the end of bones, which reduces friction between them.



**Tendons:** Connect muscles to bones.  
Connect bones in joints

Joint type	Examples	Movement
Hinge	Knee, elbow	Back and forth in one direction – no turning
Ball and socket	Hip, shoulder	Back and forth in all directions – can turn
Fixed	Skull	No movement

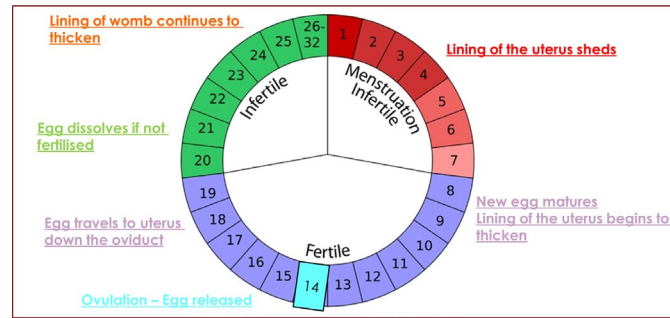
## Common causes of infertility

- A hormone imbalance
- A tumor or cyst (PCOS)
- Eating disorders such as anorexia or bulimia
- Alcohol or drug use
- Thyroid gland problems
- Excess weight
- Stress
- Low sperm count

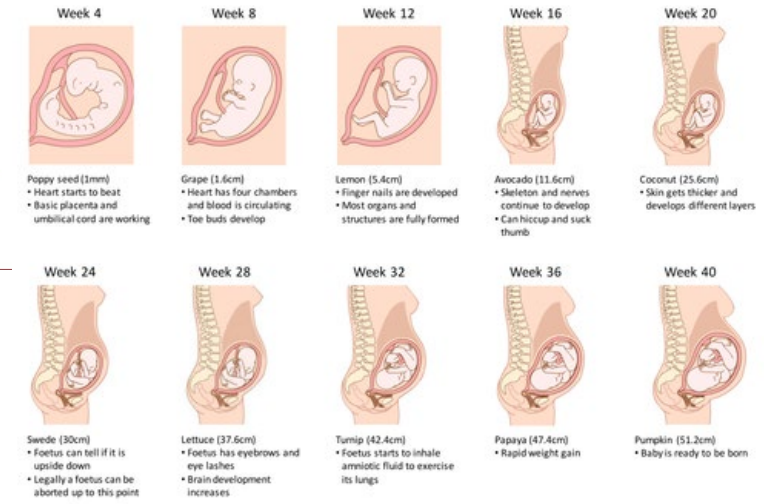
## The Menstrual cycle

The pituitary gland in the brain produces hormones which help to regulate the menstrual cycle. These hormones help to control when the egg is released and the thickening of the womb lining.

## When are females most fertile?



## Development of a foetus

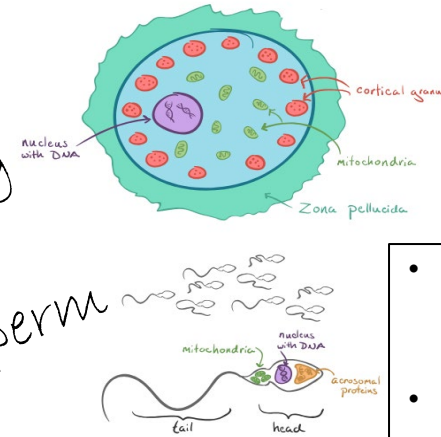


## Reproduction

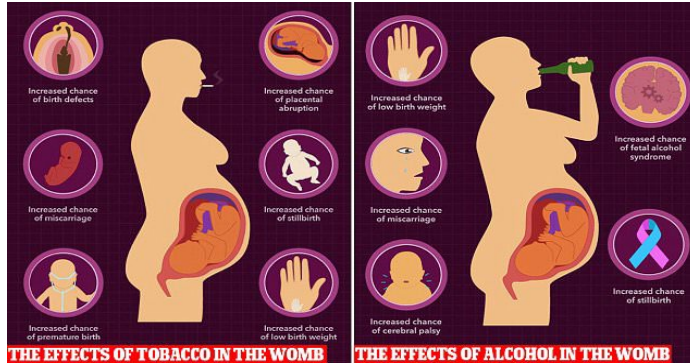
### Different methods of seed dispersal:

- Wind
- Water
- Mechanical
- Animals

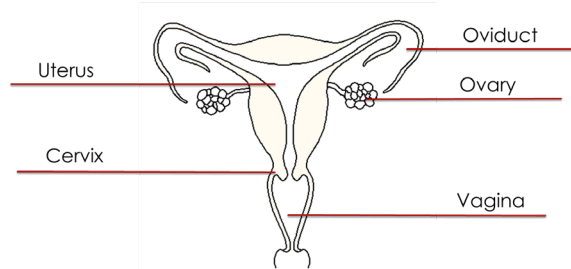
The egg and the sperm



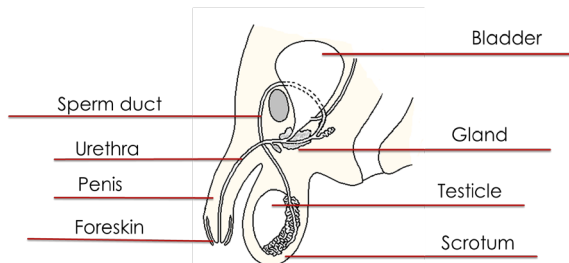
- **Pollination:** Transfer of pollen from the male part of the flower to the female part of the flower on the same or another plant.
- **Fertilisation:** Joining of a nucleus from a male and female sex cell.



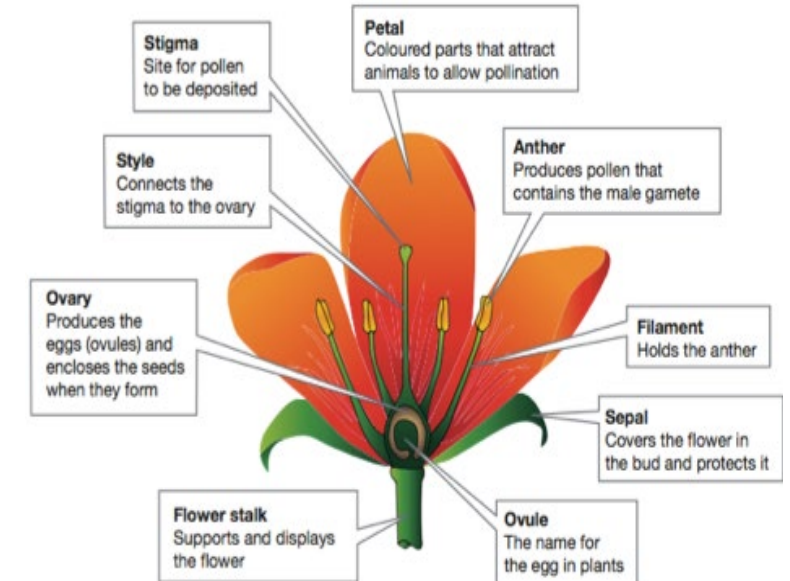
## The female reproductive system



## The male reproductive system



	Insect Pollinated	Wind Pollinated
<b>Petals</b>	Large, brightly coloured – to attract insects	Small, dull in colour – no need to attract insects
<b>Smell</b>	Sweet smell – to attract insects	No scent – no need to attract insects
<b>Nectar</b>	Contains nectar – to attract insects	No nectar – no need to attract insects
<b>Pollen quantity</b>	Not much required – less wastage than with wind pollination	Huge quantities required – most of the pollen doesn't reach another flower
<b>Pollen characteristic</b>	Sticky or spiky – to stick to insects	Light, dry and smooth – so it doesn't clump together and can be blown by the wind
<b>Anthers position</b>	Firm and inside flower – to brush against insects	Loose and outside flower – to release pollen into the wind
<b>Stigma position</b>	Inside flower – so that insect brushes against it	Outside flower – to catch the drifting pollen
<b>Stigma characteristic</b>	Sticky – so that pollen from insect sticks to it	Stick but also feathery and / or net like – to catch drifting pollen



Flowers contain a plant's reproductive organs:

### What is a species?

A group of living things that have more in common with each other than with other groups and can reproduce to produce fertile offspring.



As Liger's are infertile they are not classed as a new species.



Lions and tigers are separate species. Their offspring known as Liger's are infertile.



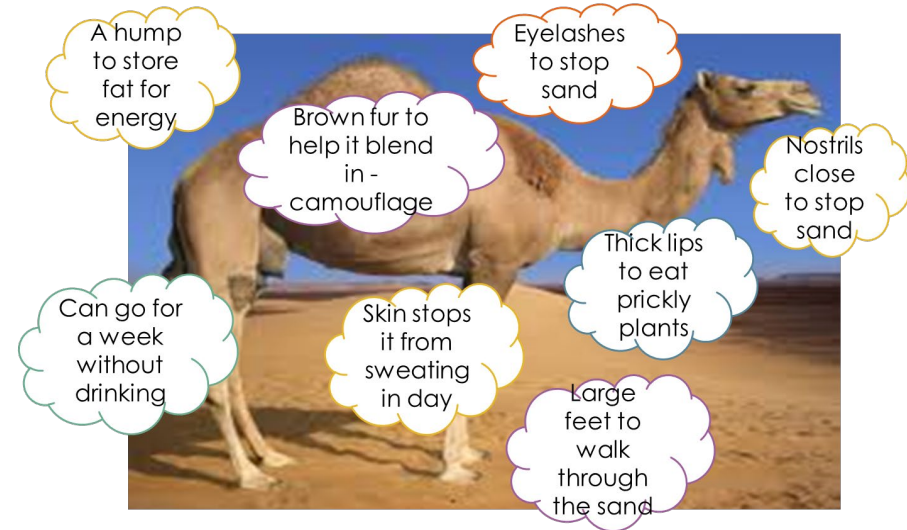
### Variation between individuals of the same species means they are more likely to adapt and survive.



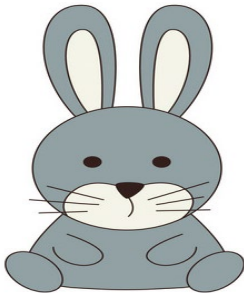
### How does a species become extinct?

- Lack of food or water
- Habitat loss
- Pollution
- New predators
- Disease
- Climate change

### How is a camel adapted to the desert?



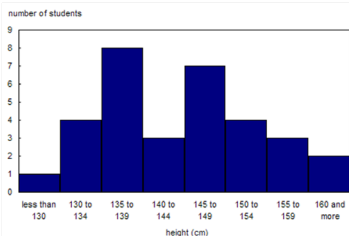
**Darwin's theory of evolution:** The rabbit that has the biggest ears is best adapted to hear the fox. The rabbit will be more likely to survive and reproduce than the rabbits with smaller ears. It will pass on the advantages genes for big ears to the next generation. Over a long period of time a new species evolves.



## Variation

Genetic	Environmental	Both
Eye colour	Scars	Weight
Natural hair colour	Tattoos	Height
Gender	Piercing	Shoe size
	Language you speak	

### Continuous data – has values that can be any number



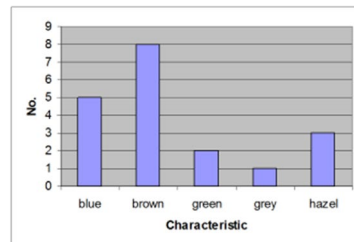
We use a histogram to show continuous data.

There is a continuous range of heights along the X axis.

The y axis shows the number of students in each height range.

We are going to conduct our own experiment and record everybody's heights.

### Discontinuous data – has values that are words or single numbers



We use a bar chart to show discontinuous data.

The x axis shows the characteristic.

The y axis shows the number of students with that characteristic.

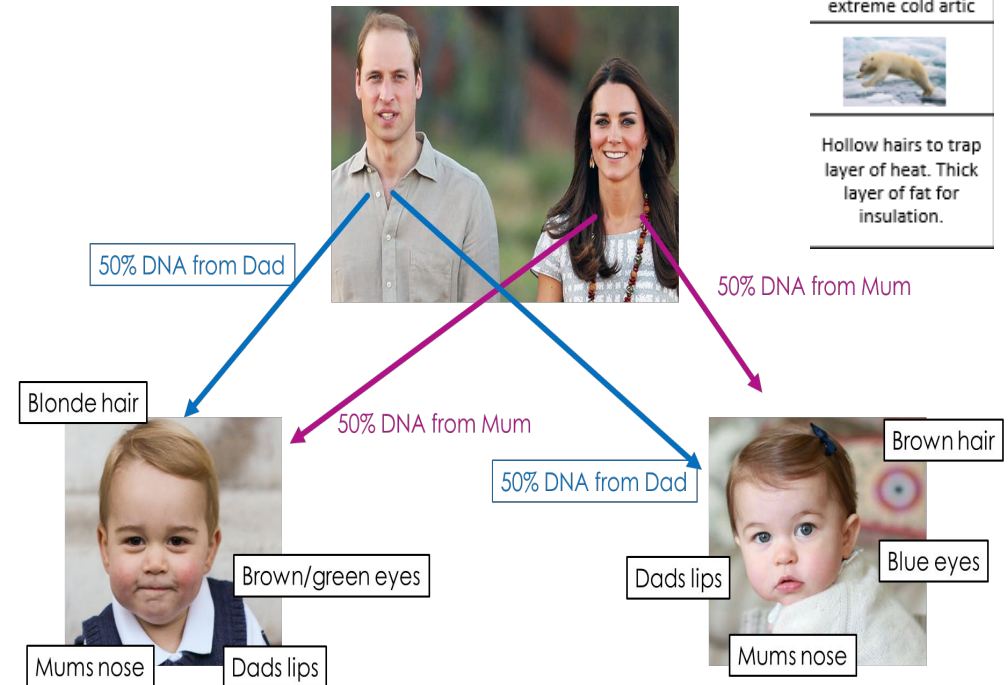
We are going to conduct our own research and record everybody's eye colour.

### Animals

Polar bear in extreme cold arctic



Hollow hairs to trap layer of heat. Thick layer of fat for insulation.



**Keywords:**

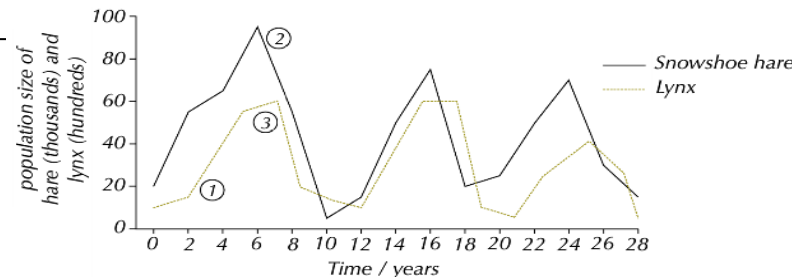
- **Ecosystem:** The living things in a given area and their non-living environment.
- **Environment:** The surrounding air, water and soil where an organism lives.
- **Population:** Group of the same species living in an area.
- **Producer:** Green plant or algae that makes its own food using sunlight.
- **Consumer:** Animal that eats other animals or plants.
- **Decomposer:** Organism that breaks down dead plant and animal material so nutrients can be recycled back to the soil or water.

**Predator** is an animal that eats other animals

**Prey** is the animal that gets eaten by the predator.

**Community:** Populations of different species living

**Habitat:** Place where organisms live e.g. woodland, lake. in a habitat.



A change in one population can impact other populations.

Insects are needed to pollinate some plant crops.

**Interdependence and Evolution**

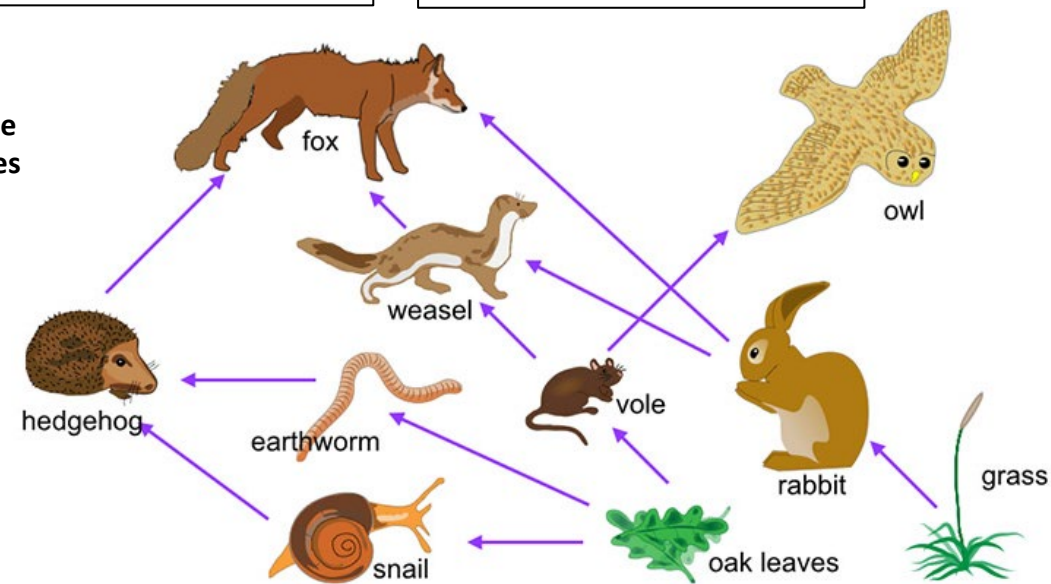
Plants and animals have adapted to survive, like the cactus or the camel to compete for limited resources

**Food Web:** Shows how food chains in an ecosystem are linked.

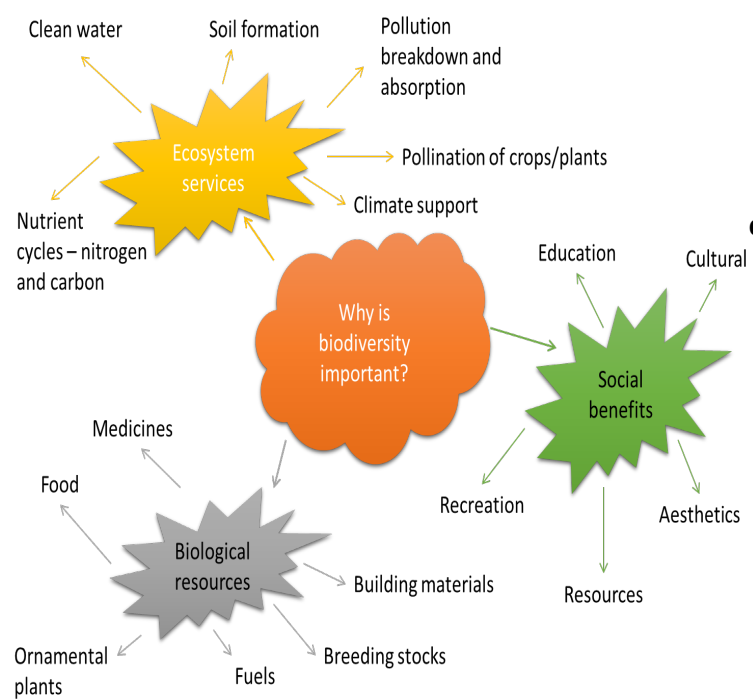
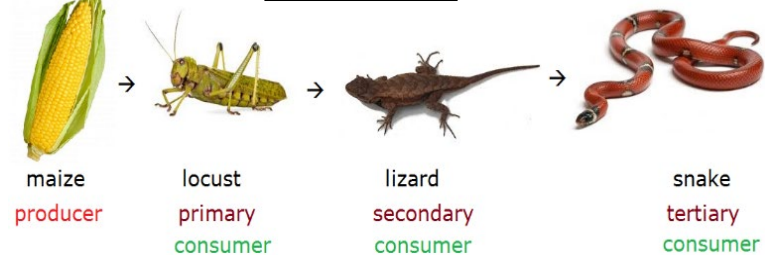
**Red squirrel:**  
Native to Britain.  
Small, shy and non-aggressive.



**Grey squirrel:**  
Introduced from America.  
Out competed the Red Squirrel for food and space.  
They are larger and more vicious.  
Destroy red squirrels habitat.  
Carry a disease that can kill Red Squirrels.  
The Grey Squirrels are better adapted to survive in this environment.

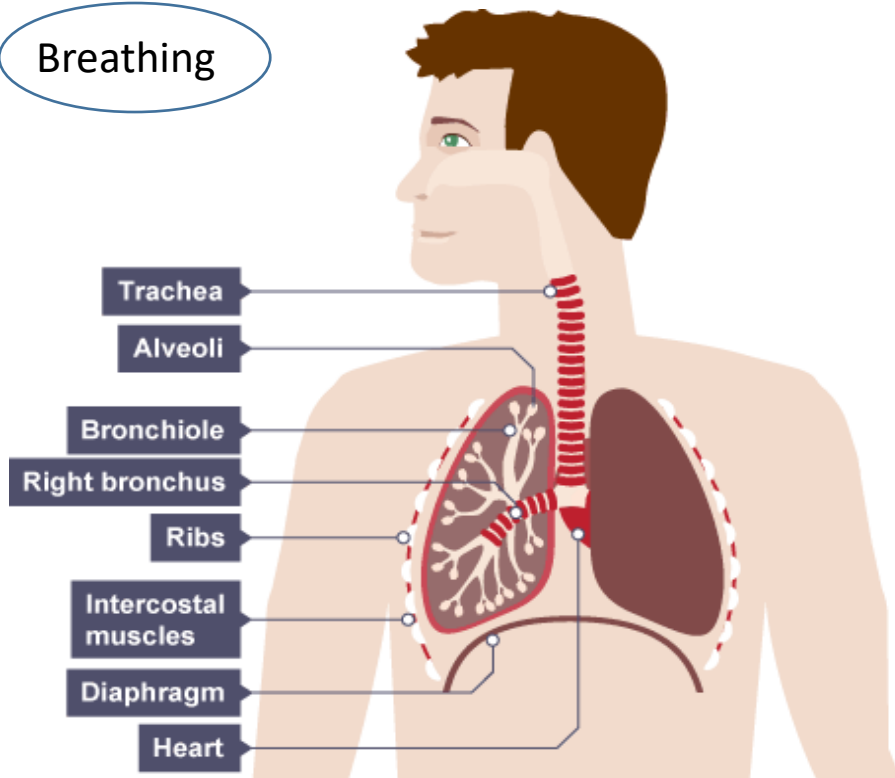


**Food chain:**

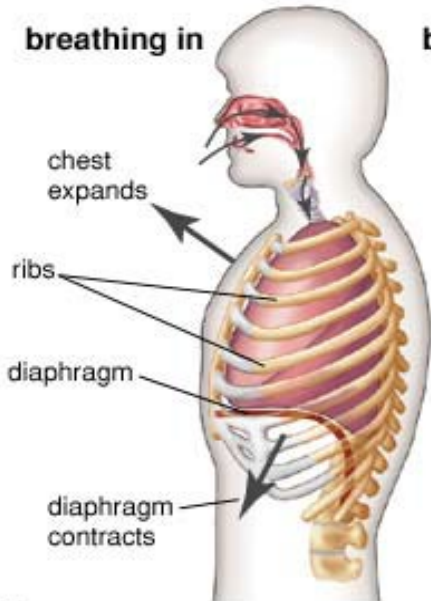


**Evidence for evolution**  
Using the fossil record we can look at changes in anatomy over time and date the rocks

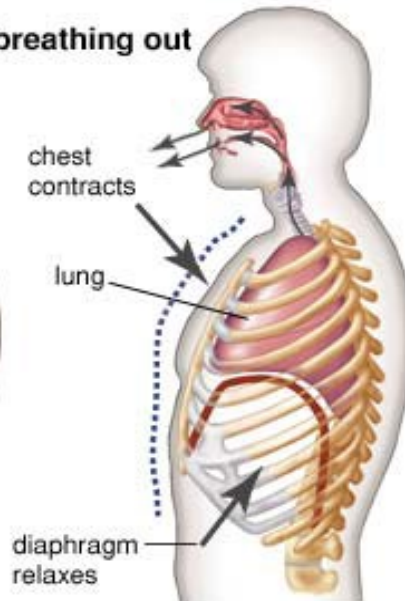
# Breathing



## breathing in

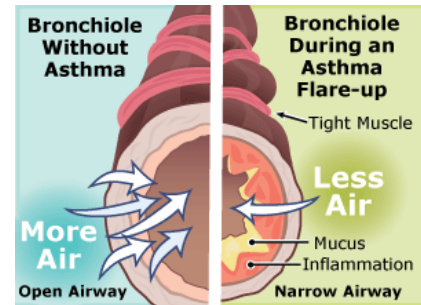


## breathing out



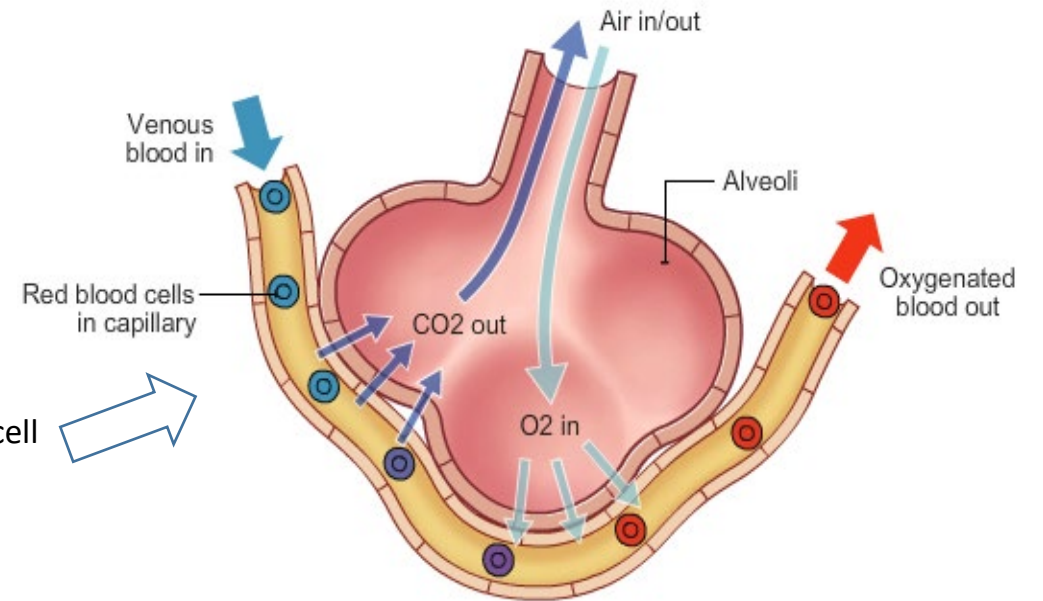
## Keywords:

- **Breathing:** The movement of air in and out of the lungs.
- **Trachea (windpipe):** Carries air from the mouth and nose to the lungs.
- **Bronchi:** Two tubes which carry air to the lungs.
- **Bronchioles:** Small tubes in the lung.
- **Alveoli:** Small air sacs found at the end of each bronchiole.
- **Ribs:** Bones which surround the lungs to form the ribcage.
- **Intercostal muscles:** muscles between the ribs.
- **Diaphragm:** A sheet of muscle found underneath the lungs.
- **Lung volume:** Measure of the amount of air breathed in or out.



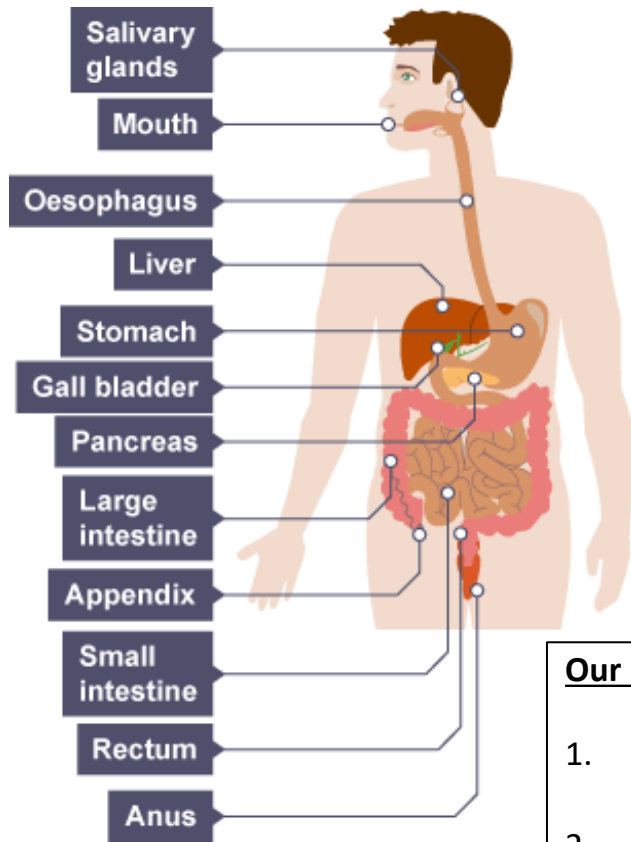
## Adaptations of alveoli

- Large surface area
- Moist, thin walls (just one cell thick)
- Lots of tiny blood vessels called capillaries











## Respiration:





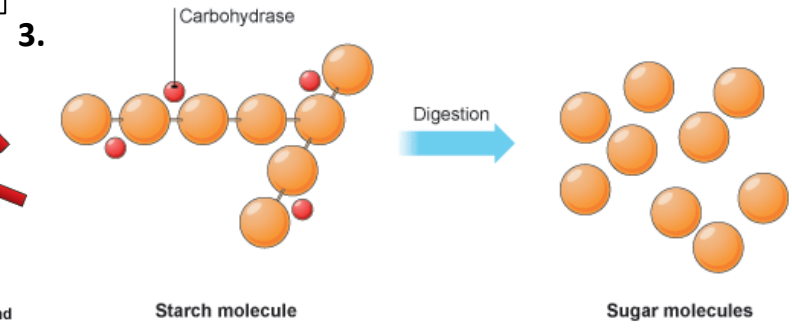
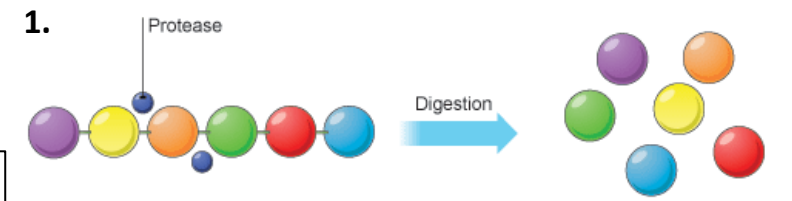
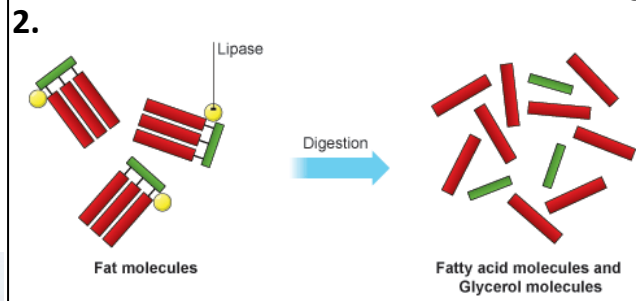
- **Enzymes:** Substances that speed up the chemical reactions of digestion.
- **Dietary fibre:** Parts of plants that cannot be digested, which helps the body eliminate waste.
- **Carbohydrates:** The body's main source of energy. There are two types: simple (sugars) and complex (starch).
- **Lipids (fats and oils):** A source of energy. Found in butter, milk, eggs, nuts.
- **Protein:** Nutrient your body uses to build new tissue for growth and repair. Sources are meat, fish, eggs, dairy products, beans, nuts and seeds.
- **Stomach:** A sac where food is mixed with acidic juices to start the digestion of protein and kill microorganisms.
- **Small intestine:** Upper part of the intestine where digestion is completed and nutrients are absorbed by the blood.
- **Large intestine:** Lower part of the intestine from which water is absorbed and where faeces are formed.
- **Gut bacteria:** Microorganisms that naturally live in the intestine and help food break down.

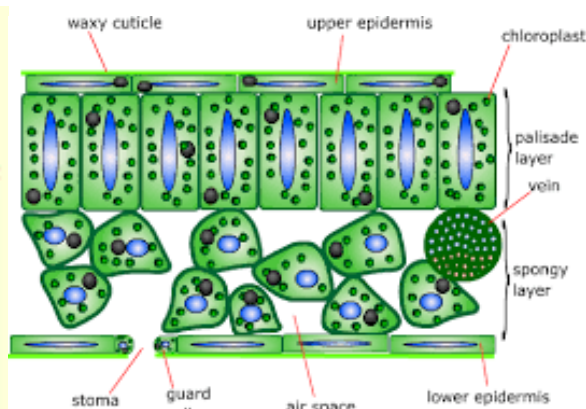
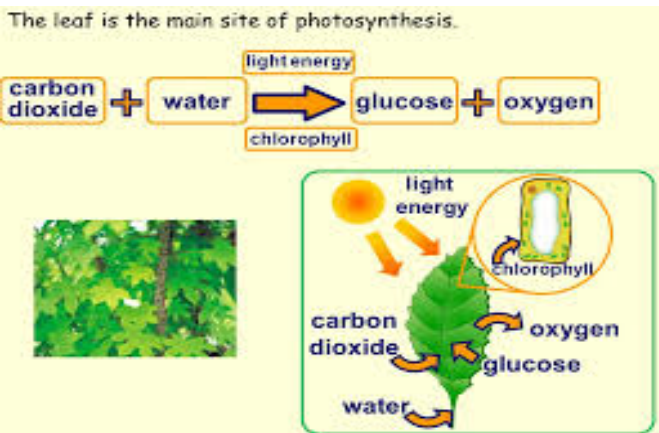
**Our body needs:**

1. Carbohydrates 
2. Proteins 
3. Fat (lipids) 
4. Fibre 
5. Vitamins 
6. Iron 
7. Calcium 
8. Water 

**Digestion**

**Enzymes** are special proteins that break down large food molecules into smaller molecules  
 3 examples:





Type of cell	Function	Adaptations
Root hair cell	Absorb water and minerals from the soil water.	Has a long thin extension, the root hair, which provides a large surface area for absorption to happen.
Xylem vessel	- Transport water in the plant. - Support the plant.	- Xylem cells have no cytoplasm and no end walls. They form a continuous tube in which water can pass freely. - The cell walls are strengthened by lignin, a tough waterproof substance.

*Glucose used as an energy source, to build new tissue, or store it for later use*

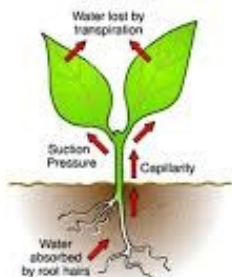
**Diffusion** is the net movement of molecules or atoms from a region of high concentration to a region of low concentration as a result of random motion of the molecules or atoms.

## Photosynthesis

## Leaf adaptations

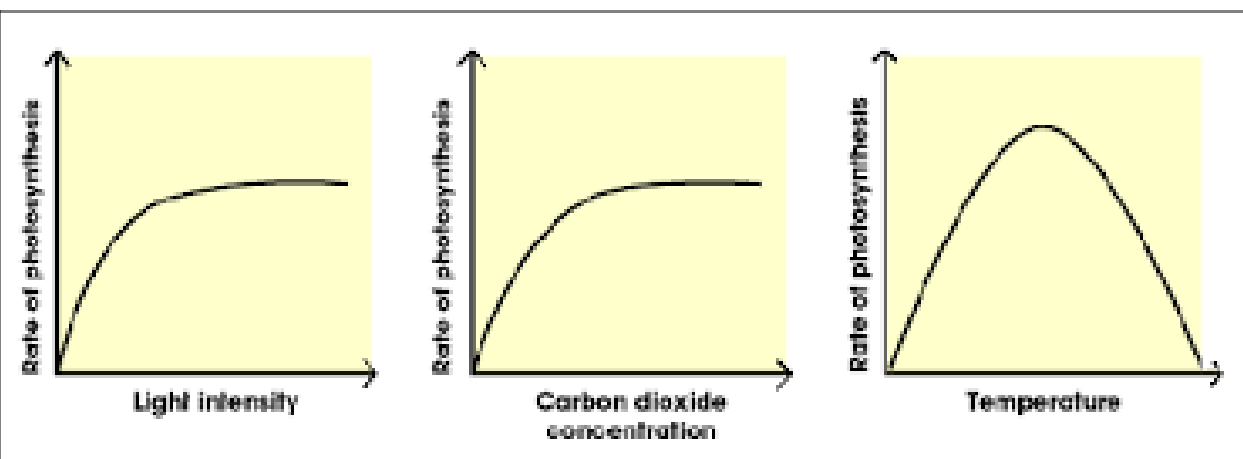
## Respiration

### Transpiration in plants



- \*Broad and flat – capture lots of sunlight
- \* Cells at top of leaf contain lots of chloroplasts – site of photosynthesis.
- \* Small holes called **stomata** in the underside of a leaf allow gases in and out.

### Factors affecting rate of photosynthesis



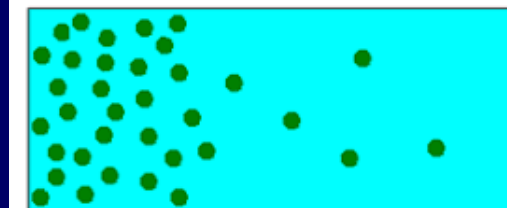
### Aerobic Respiration

When the body can supply the cells with the oxygen and food that they need, We say it is performing **AEROBIC** respiration. The equation for this is:



### Anaerobic Respiration

When the body CANNOT supply the cells with the oxygen and food that they need, then the body must perform anaerobic respiration. The release of energy WITHOUT oxygen:



High Concentration      Low Concentration  
**DIFFUSION**

In plants & fungi glucose makes ethanol and carbon dioxide

**What happens to the pulse rate whilst someone is running?**

The body needs to release more energy:

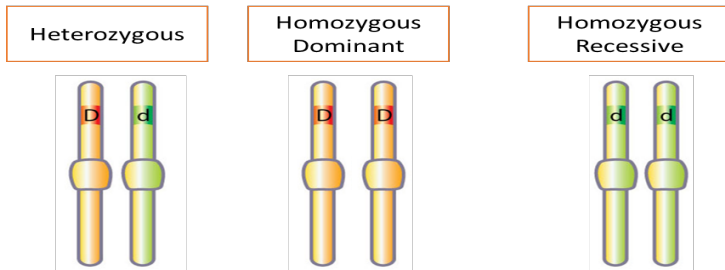
- so oxygen and glucose need to reach muscle cells quickly;
- so blood is pumped around the body faster;
- so the pulse is **faster**.



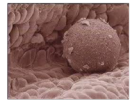


### Key definitions

- **Chromosome:** An organized structure of DNA, which contains genes.
- **Gene:** A hereditary unit consisting of a sequence of DNA. They code for proteins.
- **Alleles:** Different versions of the same gene.
- **Dominant alleles (D):** You only need one dominant allele to have that characteristic (represented by a capital letter).
- **Recessive alleles (d):** You need two recessive alleles to have that characteristic (represented by a lowercase letter).
- **Genotype:** The combination of alleles that results in a particular characteristic
- **Phenotype:** The physical appearance or observed trait of a Genotype



The sex cells - Gametes



Egg cells contain....

23

chromosomes



Sperm cells contain....

23

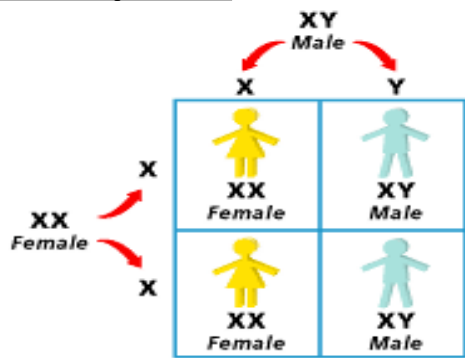
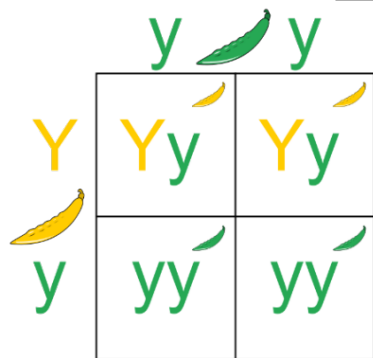
chromosomes

### Selective breeding

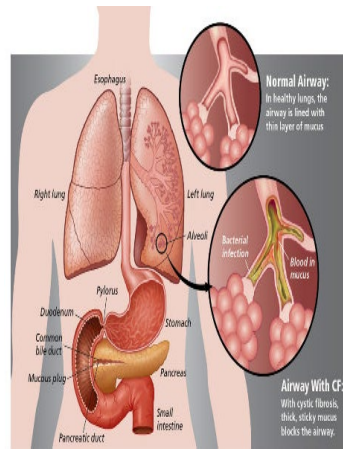
Selecting the characteristics or traits that you want and breeding them over time.



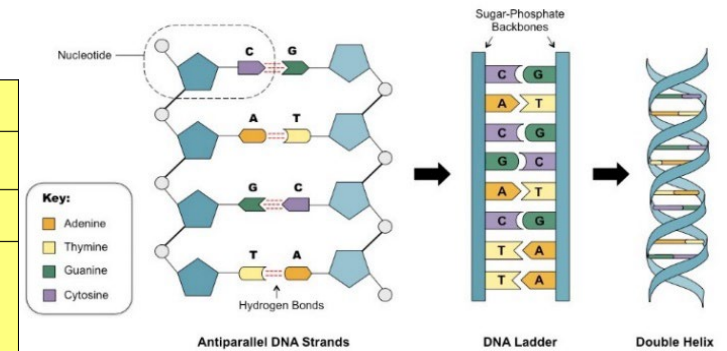
### Punnet squares



### How is Cystic fibrosis inherited?

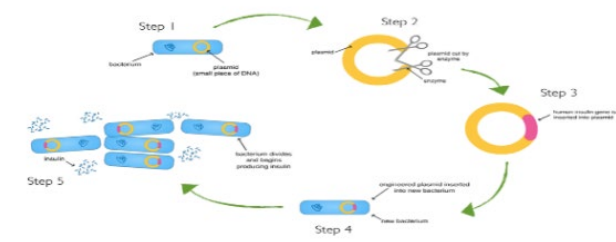


Genetic Disease	Cystic fibrosis
Faulty alleles	Recessive ff
Carriers?	Yes Ff
Symptoms	Thick mucus, difficulty breathing, chest infections, difficulty digesting food
Curable?	No
Treatment	Medication and breathing and massage therapy



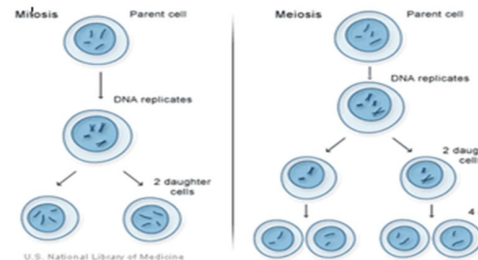
### Genetic engineering

The direct manipulation of an organism's genome using biotechnology. A GMO is a 'Genetically Modified Organism'. We can genetically engineer bacteria to produce insulin to treat people who have diabetes.



## Inheritance

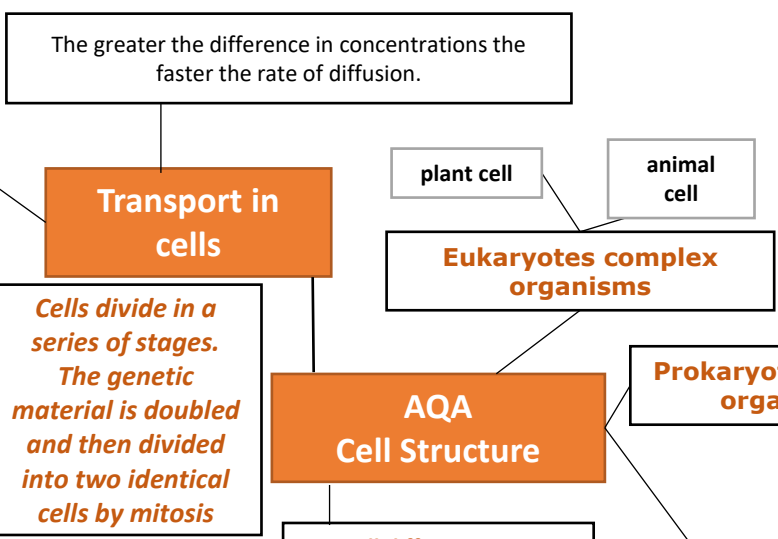
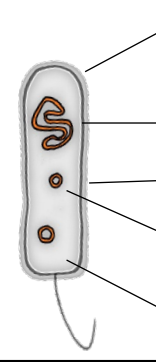
### Spot the differences!!



	Mitosis	Meiosis
Number of cell divisions	ONE	TWO
Number of daughter cells made	TWO	FOUR
Types of cells made (body or gametes)	BODY	GAMETE
Number of chromosomes in each daughter cells	46	23
Are the daughter cells all identical?	YES	NO
Where in the body does this process happen?	EVERYWHERE	OVARIES/TESTES
Asexual or Sexual reproduction?	ASEXUAL	SEXUAL

Genetic	Environmental	Both
Eye colour	Scars	Weight
Natural hair colour	Tattoos	Height
Gender	Piercing	Shoe size
	Language you speak	

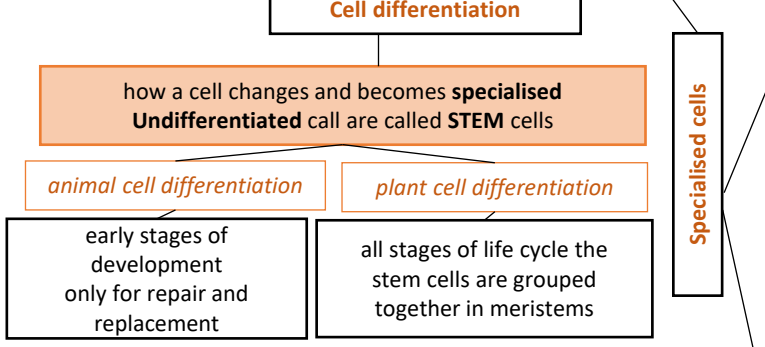
<b>Diffusion</b> <i>No</i> energy required	<b>Movement of particles in a solution or gas from a higher to a lower concentration</b>	E.g. O <sub>2</sub> and CO <sub>2</sub> in gas exchange, urea in kidneys. Factors that affect the rate are concentration, temperature and surface area.
<b>Osmosis</b> <i>No</i> energy required	<b>Movement of water from a dilute solution to a more concentrated solution</b>	E.g. Plants absorb water from the soil by osmosis through their root hair cells. Plants use water for several vital processes including photosynthesis and transporting minerals.
<b>Active transport</b> <b>ENERGY</b> required	<b>Movement of particles from a dilute solution to a more concentrated solution</b>	E.g. movement of mineral ions into roots of plants and the movement of glucose into the small intestines.

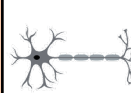


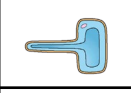
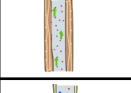
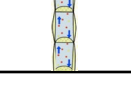
cell membrane	site of chemical reactions in the cell	gel like substance containing enzymes to catalyse the reactions
bacterial DNA	not in nucleus floats in the cytoplasm	controls the function of the cell
cell wall	NOT made of cellulose	supports and strengthens the cell
plasmid	small rings of DNA	contain additional genes
cytoplasm	semi permeable	controls the movement of substances in and out of the cell

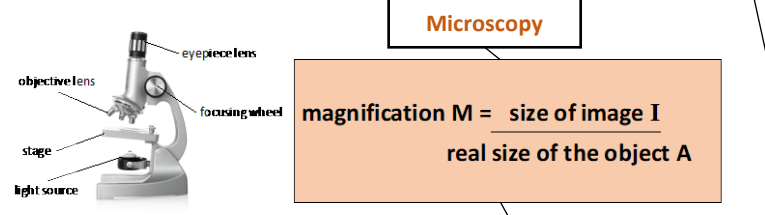
Bacterial cells are much smaller than plant and animal cells

<b>Small intestines</b>	<b>Villi – increase surface area, Good blood supply – to maintain concentration gradient, Thin membranes – short diffusion distance.</b>
<b>Lungs</b>	<b>Alveoli– increase surface area, Good blood supply – to maintain concentration gradient, Thin membranes – short diffusion distance.</b>
<b>Gills in fish</b>	<b>Gill filaments and lamella – increase surface area, Good blood supply – to maintain concentration gradient, Thin membranes – short diffusion distance.</b>
<b>Roots</b>	<b>Root hair cells - increase surface area.</b>
<b>Leaves</b>	<b>Large surface area, thin leaves for short diffusion path, stomata on the lower surface to let O<sub>2</sub> and CO<sub>2</sub> in and out.</b>



**Specialised cells**

specialised animal cells	<b>nerve</b>		carry electrical signals	long branched connections and insulating sheath
	<b>sperm</b>		fertilise an egg	streamlined with a long tail acrosome containing enzymes large number of mitochondria
	<b>muscle</b>		contract to allow movement	contains a large number of mitochondria long
specialised plant cells	<b>root hair</b>		absorb water and minerals from soil	hair like projections to increase the surface area
	<b>xylem</b>		carry water and minerals	TRANSPIRATION - dead cells cell walls toughened by lignin flows in one direction
	<b>phloem</b>		carry glucose	TRANSLOCATION - living cells cells have end plates with holes flows in both directions

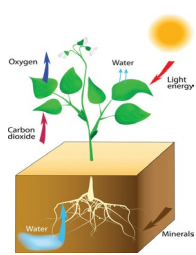


Feature	Light (optical) microscope	Electron microscope
<b>Radiation used</b>	Light rays	Electron beams
<b>Max magnification</b>	~ 1500 times	~ 2 000 000 times
<b>Resolution</b>	200nm	0.2nm
<b>Size of microscope</b>	Small and portable	Very large and not portable
<b>Cost</b>	~£100 for a school one	Several £100,000 to £1 million plus

PREFIXES		
Prefix	Multiple	Standard form
<b>centi (cm)</b>	1 cm = 0.01 m	$\times 10^{-2}$
<b>milli (mm)</b>	1 mm = 0.001 m	$\times 10^{-3}$
<b>micro (µm)</b>	1 µm = 0.000 001 m	$\times 10^{-6}$
<b>nano (nm)</b>	1nm = 0.000 000 001 m	$\times 10^{-9}$

<b>Human Embryonic stem cells</b>	<b>Can be cloned and made to differentiate into most cell types</b>	Therapeutic cloning uses same genes so the body does not reject the tissue. Can be a risk of infection
<b>Adult bone marrow stem cells</b>	<b>Can form many types of human cells e.g. blood cells</b>	Tissue is matched to avoid rejection, risk of infection. Only a few types of cells can be formed.
<b>Meristems (plants)</b>	<b>Can differentiate into any plant cell type throughout the life of the plant.</b>	Used to produce clones quickly and economically, e.g. rare species, crop plants with pest /disease resistance

Treatment with stem cells may be able to help conditions such as diabetes and paralysis. Some people object to the use of stem cells on ethical or religious grounds



Respiration, stored as insoluble starch, fats or oils for storage, cellulose for cell walls, combine with nitrates from the soil to form amino acids for protein synthesis

Plants use the glucose produced in photosynthesis in a variety of ways

### Photosynthetic reaction

**Photosynthesis**  
Plants make use of light energy from the environment to chloroplasts (ENDOTHERMIC) to make food (glucose)

Carbon dioxide + Water  $\xrightarrow{\text{light}}$  Oxygen + Glucose

$\text{CO}_2 + \text{H}_2\text{O} \xrightarrow{\text{light}} \text{O}_2 + \text{C}_6\text{H}_{12}\text{O}_6$

## AQA GCSE BIOENERGETICS (Photosynthesis)

### Rate of photosynthesis

Factor	How the rate is affected	Limiting factors (why the rate stops going up)
Temperature	As the temperature of the environment the plant is in increases rate of photosynthesis increases (up to a point) as there is more energy for the chemical reaction.	Photosynthesis is an enzyme controlled reaction. If the temperature increases too much, then the enzymes become denatured and the rate of reaction will decrease and stop
Light intensity	Light intensity increases as the distance between the plant and the light sources increases. As light intensity increases so does the rate of photosynthesis (up to a point) as more energy is available for the chemical reaction.	At point X another factor is limiting the rate of photosynthesis. This could be carbon dioxide concentration, temperature or the amount of chlorophyll
Carbon dioxide concentration	Carbon dioxide is needed for plants to make glucose. The rate of photosynthesis will increase when a plant is given higher concentrations of carbon dioxide (up to a point).	At point X another factor is limiting the rate of photosynthesis. This could be light intensity, temperature or the amount of chlorophyll
Amount of chlorophyll	Chlorophyll is a photosynthetic pigment that absorbs light and allows the reaction between water and carbon dioxide to occur (photosynthesis)	Another factor could limit the rate of photosynthesis. This could be light intensity, temperature or the carbon dioxide concentration

The extra amount of oxygen required to remove all lactic acids from cells is called the oxygen debt

### Response to exercise

During exercise the human body reacts to increased demand for energy	<b>Heart rate increases</b>	Top pump oxygenated blood faster to the muscle tissues and cells.
	<b>Breathing rate and breath volume increase</b>	This increases the amount of oxygen entering the blood stream.

An organism will receive all the energy it needs for living processes (movement, warmth, chemical reactions) as a result of the energy transferred from respiration

**Metabolism**  
The energy transferred by respiration in cells is used by the organism for the continual enzyme controlled processes of metabolism.

- Conversion of glucose to starch, glycogen and cellulose.
- The formation of lipid molecules from a molecule of glycerol and three molecules of fatty acid.
- The use of glucose and nitrate ions to form amino acids which in turn are used to synthesise proteins.
- Respiration
- Breakdown of excess proteins to form urea for excretion.

Control conditions in greenhouses to reduce limiting factors can improve crop yields	Condition	Description
	<b>Heating</b>	Used to provide optimum temperatures for maximum plant growth.
	<b>Artificial lighting</b>	Enhances the natural sunlight especially overnight and on cloudy days.
	<b>Extra carbon dioxide</b>	Gas can be pumped into the air inside the greenhouse.

Growers must balance the economics of additional costs of controlling the conditions to maximise photosynthesis with making a profit.



### Respiration

Cellular respiration is an exothermic reaction which is continuously occurring in all living cells

Metabolism is the sum of all the reactions in a cell or the body

**Anaerobic respiration**  
Respiration when oxygen is in short supply. Occurs during intensive exercise

During hard exercise, muscle cells are respiring so fast that blood cannot transport enough oxygen to meet their needs.

Glucose is partially oxidised to produce lactic acid which builds up in muscle tissue causing them to become painful and fatigued.

glucose  $\rightarrow$  lactic acid

**Aerobic respiration**  
Respiration with oxygen. Occurs inside the mitochondria continuously

Glucose is oxidised by oxygen to transfer the energy the organism needs to perform its functions.

$\text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$

glucose + oxygen  $\rightarrow$  carbon dioxide + water

**Anaerobic respiration in plant and yeast cells**  
The end products are ethanol and carbon dioxide. Anaerobic respiration in yeast cells is called fermentation

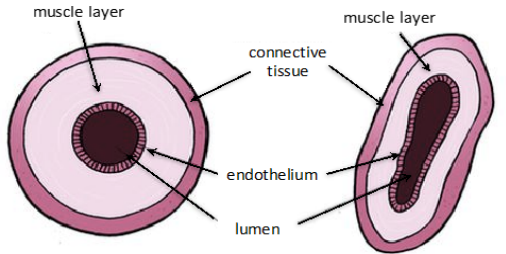
glucose  $\rightarrow$  ethanol + carbon dioxide

This process is economically important in the manufacture of alcoholic drinks and bread.

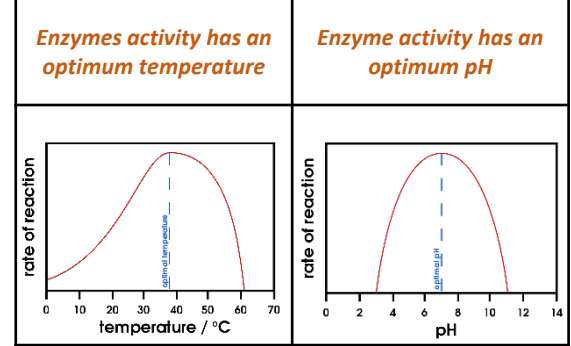
<b>Plasma (55%)</b>	<i>Pale yellow fluid</i>	Transports CO <sub>2</sub> , hormones and waste.
<b>Red blood cells (45%)</b>	<i>Carries oxygen</i>	Large surface area, no nucleus, full of haemoglobin.
<b>White blood cells (&lt;1%)</b>	<i>Part of the immune system</i>	Some produce antibodies, others surround and engulf pathogens.
<b>Platelets (&lt;1%)</b>	<i>Fragments of cells</i>	Clump together to form blood clots.

**Blood is a tissue consisting of plasma, in which blood cells and platelets are suspended**

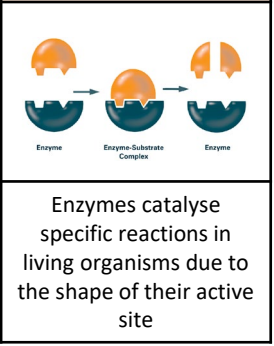
Artery	Vein	Capillary
<i>Carry blood away from the heart</i>	<i>Carry blood to the heart</i>	<i>Connects arteries and veins</i>
Thick muscular walls, small lumen, carry blood under high pressure, carry oxygenated blood (except for the pulmonary artery).	Thin walls, large lumen, carry blood under low pressure, have valves to stop flow in the wrong direction, carry deoxygenated blood (except for the pulmonary vein).	One cell thick to allow diffusion, Carry blood under very low pressure.



**Large changes in temperature or pH can stop the enzyme from working (denature and no longer fit active site)**



**The 'lock and key theory' is a simplified model to explain enzyme action**



<b>Carbohydrases (e.g. amylase)</b>		<i>Made in salivary glands, pancreas, small intestine</i>	Break down carbohydrates to simple sugar (e.g. amylase breaks down starch to glucose).
<b>Proteases</b>		<i>Made in stomach, pancreas</i>	Break down protein to amino acids.
<b>Lipases</b>		<i>Made in pancreas (works in small intestine)</i>	Break down lipids (fats) to glycerol and fatty acids.
<b>Bile (not an enzyme)</b>		<i>Made in liver, stored in gall bladder.</i>	Emulsifies lipids to increase surface area to increase the rate of lipid break down by lipase. Changes pH to neutral for lipase to work

**Enzymes catalyse (increase the rate of) specific reactions in living organisms**

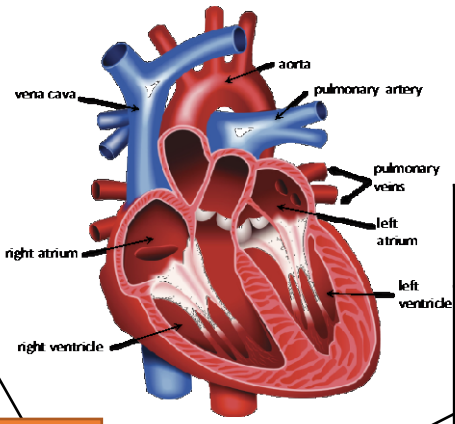
The products of digestion are used to build new carbohydrates, lipids and proteins. Some glucose is used for respiration.

**Food tests**

<b>Sugars (glucose)</b>	<i>Benedict's test</i>	Orange to brick red precipitate.
<b>Starch</b>	<i>Iodine test</i>	Turns black.
<b>Biuret</b>	<i>Biuret reagent</i>	Mauve or purple solution.

**Non-communicable diseases**

<b>More energy consumed in food and drink than used</b>
<i>obesity</i>
Linked to increased rates of cardiovascular disease and development of diabetes type 2.



**The heart is an organ that pumps blood around the body in a double circulatory system**

<b>Trachea</b>	<i>Carries air to/from the lungs</i>	Rings of cartilage protect the airway.
<b>Bronchioles</b>	<i>Carries air to/from the air sacs (alveoli)</i>	Splits into multiple pathways to reach all the air sacs.
<b>Alveoli</b>	<i>Site of gas exchange in the lungs</i>	Maximises surface area for efficient gas exchange.
<b>Capillaries</b>	<i>Allows gas exchange between into/out of blood</i>	Oxygen diffuses into the blood and carbon dioxide diffuses out.

**Different structure in the heart have different functions**

<i>Right ventricle</i>	Pumps blood to the lungs where gas exchange takes place.
<i>Left ventricle</i>	Pumps blood around the rest of the body.
<i>Pacemaker (in the right atrium)</i>	Controls the natural resting heart rate. Artificial electrical pacemakers can be fitted to correct irregularities.
<i>Coronary arteries</i>	Carry oxygenated blood to the cardiac muscle.
<i>Heart valves</i>	Prevent blood in the heart from flowing in the wrong direction.

**Heart**

**Blood**

**AQA GCSE ORGANISATION Part 1**

**Lungs and gas exchange**

**The human digestive system**

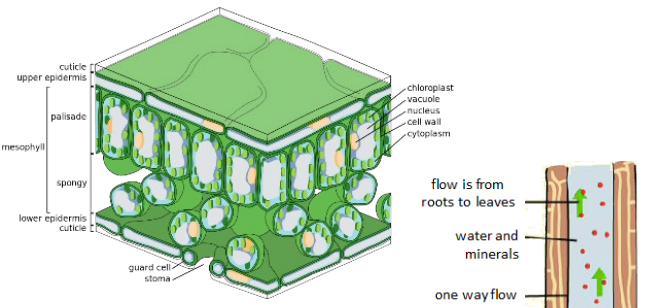
An organ system in which organs work together to digest and absorb food.

**The heart pumps low oxygen/high carbon dioxide blood to the lungs**

Heart failure can be treated with a transplant or artificial heart

Disease	Cause	Effect	Treatment
Coronary heart disease (CHD)	A build up for fatty substances in the coronary arteries (atherosclerosis)	Oxygen-ated blood cannot get to the cardiac muscle.	Stents: inserted into the blocked artery to open it up. Statins: lower harmful cholesterol.
Faulty heart valves	Valves don't open or close properly	Blood can leak or flow in the wrong direction	Biological valve transplant or a mechanical valve can be inserted

## AQA GCSE ORGANISATION Part 2



The roots, stem and leaves form a plant organ system for transport of substances around the plant

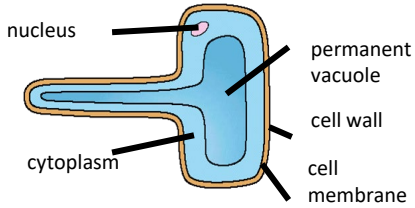
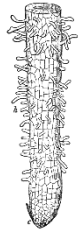
Epidermal tissues	<i>Waxy cuticle (top layer of the leaf)</i>	Reduces water loss from the leaf
	<i>Guard cells and stomata</i>	Guard cells open and close the stomata to control water loss and allow for gas exchange (oxygen and carbon dioxide).
Palisade mesophyll	<i>Palisade cells</i>	Cells near the top surface of the leaf that are packed with chloroplasts that contain chlorophyll. Both adaptations maximize photosynthesis.
Spongy mesophyll	<i>Air spaces in the leaf between cells</i>	Increased surface area for gas exchange so that carbon dioxide can diffuse into photosynthesising cells.
xylem	<i>Hollow tubes strengthened by lignin adapted for the transportation of water in the transpiration stream</i>	Allows transport of water and mineral ions from the roots to the stem and the leaves.
phloem	<i>Cell sap moves from one phloem cell to the next through pores in the end walls</i>	Transports dissolved sugars from the leaves to the rest of the plant for immediate use or storage (translocation).
Meristem tissue	<i>New cells (roots and shoot tips) are made here including root hair cells</i>	Root hair cells have an increased surface area for the uptake of water by osmosis, and mineral ions by active transport.

## Non-communicable diseases

Cancer

The result of changes in DNA that lead to uncontrolled growth and division

<i>Benign tumour</i>	Contained in one area of the body (usually by a membrane) – not cancer.
<i>Malignant tumour</i>	Invade tissues and spread to different parts of the body to form secondary tumours.



Some cancers have genetic risk factors.

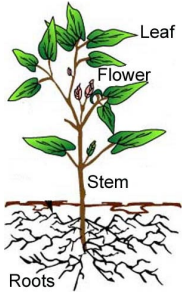
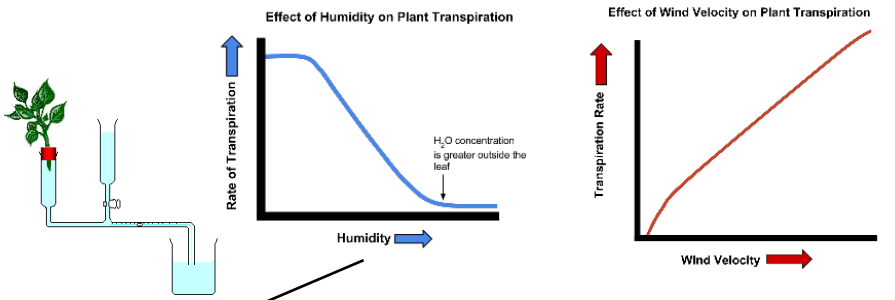
Carcinogens and ionising radiation increase the risk of cancer by changing/ damaging DNA

Risk factors for heart/lung disease and certain types of cancer include drinking alcohol, diet, obesity and smoking

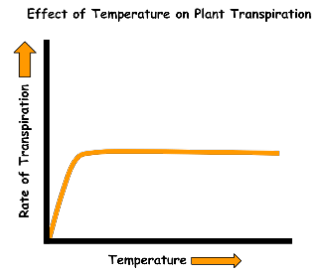
These risks factors can also affect the brain, liver and the health of unborn babies

A potometer is used to measure the amount of water lost over time (rate of transpiration)

## Transpiration

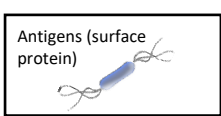


Transpiration	<i>The rate at which water is lost from the leaves of a plant. The transpiration stream is the column of water moving through the roots, stem and leaves</i>	Temperature, humidity, air movement and light intensity affect the rate of transpiration.
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The shape of the graph for light intensity is the same for temperature (energy)

<b>Phagocytes</b>	<b>Phagocytosis</b>	Phagocytes engulf the pathogens and digest them.
<b>Lymphocytes</b>	<b>Antibody production</b>	Specific antibodies destroy the pathogen. This takes time so an infection can occur. If a person is infected again by the same pathogen, the lymphocytes make antibodies much faster.
	<b>Antitoxin production</b>	Antitoxin is a type of antibody produced to counteract the toxins produced by bacteria.



Pathogens are identified by white blood cells by the different proteins on their surfaces **ANTIGENS**.

**White blood cells are part of the immune system**

**Immune system**

**Human defence systems**

**Non-specific defence systems**

The human body has several non specific ways of defending itself from pathogens getting in

	<b>Nose</b>	Nasal hairs, sticky mucus and cilia prevent pathogens entering through the nostrils.
	<b>Trachea and bronchus (respiratory system)</b>	Lined with mucus to trap dust and pathogens. Cilia move the mucus upwards to be swallowed.
	<b>Stomach acid</b>	Stomach acid (pH1) kills most ingested pathogens.
	<b>Skin</b>	Hard to penetrate waterproof barrier. Glands secrete oil which kill microbes

**AQA GCSE INFECTION AND RESPONSE Part 1**

Pathogens may infect plants or animals and can be spread by direct contact, water or air

**Plants have several ways of defending themselves from pathogens and animals**

<b>Physical</b>	<b>Mechanical</b>
Thick waxy layers, cell walls stop pathogen entry	Thorns, curling up leaves to prevent being eaten
<b>Chemical</b>	
Antibacterial and toxins made by plant	

Detection and identification of plant diseases (bio only)

<b>Detection</b>	<b>Identification</b>
Stunted growth	Reference using gardening manual or website, laboratory test for pathogens, testing kit using monoclonal antibodies.
Spots on leaves	
Area of decay	
growths	
Malformed stem/leaves	
Discolouration	
Presence of pests	

**Nitrate ions** needed for protein synthesis – lack of nitrate = stunted growth.

**Magnesium ions** needed to make chlorophyll – not enough leads to chlorosis – leaves turn yellow.

Bacteria may produce toxins that damage tissues and make us feel ill

Viruses	Bacteria (prokaryotes)	Protists (eukaryotes)	Fungi (eukaryotes)
e.g. cold, influenza, measles, HIV, tobacco mosaic virus	e.g. tuberculosis (TB), Salmonella, Gonorrhoea	e.g. dysentery, sleeping sickness, malaria	e.g. athlete's foot, thrush, rose black spot
DNA or RNA surrounded by a protein coat	No membrane bound organelles (no chloroplasts, mitochondria or nucleus). Cell wall. Single celled organisms	Membrane bound organelles. Usually single celled.	Membrane bound organelles, cell wall made of chitin. Single celled or multi-cellular




**Pathogens**

**Pathogens are microorganisms that cause infectious disease**

Viruses live and reproduce inside cells causing damage

**Communicable diseases**

Pathogen	Disease	Symptoms	Method of transmission	Control of spread
<b>Virus</b>	<b>Measles</b>	Fever, red skin rash.	Droplet infection from sneezes and coughs.	Vaccination as a child.
<b>Virus</b>	<b>HIV</b>	Initially flu like systems, serious damage to immune system.	Sexual contact and exchange of body fluids.	Anti-retroviral drugs and use of condoms.
<b>Virus</b>	<b>Tobacco mosaic virus</b>	Mosaic pattern on leaves.	Enters via wounds in epidermis caused by pests.	Remove infected leaves and control pests that damage the leaves.
<b>Bacteria</b>	<b>Salmonella</b>	Fever, cramp, vomiting, diarrhoea.	Food prepared in unhygienic conditions or not cooked properly.	Improve food hygiene, wash hands, vaccinate poultry, cook food thoroughly.
<b>Bacteria</b>	<b>Gonorrhoea</b>	Green discharge from penis or vagina.	Direct sexual contact or exchange of body fluids.	Use condoms. Treatment using antibiotics.
<b>Protists</b>	<b>Malaria</b>	Recurrent fever.	By an animal vector (mosquitoes).	Prevent breeding of mosquitoes. Use of nets to prevent bites.
<b>Fungus</b>	<b>Rose black spot</b>	Purple black spots on leaves.	Spores carried via wind or water.	Remove infected leaves. Spray with fungicide.

Traditionally drugs were extracted from plants and microorganisms		
<i>Digitalis</i>	<i>Aspirin</i>	<i>Penicillin</i>
Extracted from foxglove plants and used as a heart drug	A painkiller and anti-inflammatory that was first found in willow bark	Discovered by Alexander Fleming from the <i>Penicillium</i> mould and used as an antibiotic
		

Drugs have to be tested and trialled before to check they are safe and effective. They are synthesised by chemists in the pharmaceutical industry.

*Bacteria can mutate and become resistant to antibiotics*

Antibiotics have greatly reduced deaths from infectious bacterial disease

Antibiotics and painkillers

antibiotics	<i>e.g. penicillin</i>	Kill infective bacteria inside the body. Specific bacterial infections require specific antibiotics.
Painkillers and other medicines	<i>e.g. aspirin, paracetamol, ibuprofen</i>	Drugs that are used to treat the symptoms of a disease. They do not kill pathogens

Antibiotics cannot be used to treat viral pathogens

It is difficult to develop drugs to kill viruses without harming body tissues because viruses live and reproduce inside cells

Discovery and drug development

## AQA INFECTION AND RESPONSE Part 2

New drugs are extensively tested for:	<i>Efficacy</i>	Make sure the drug works
	<i>Toxicity</i>	Check that the drug is not poisonous
	<i>Dose</i>	The most suitable amount to take



Vaccination

Used to immunise a large proportion of the population to prevent the spread of a pathogen

Preclinical trials - using cells, tissues and live animals - must be carried out before the drug can be tested on humans.

Clinical trials use healthy volunteers and patients



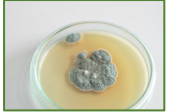
Double blind trial: patients and scientists do not know who receives the new drug or placebo until the end of the trial. This avoids bias.

A placebo can look identical to the new drug but contain no active ingredients

<i>Stage 1</i>	<i>Stage 2</i>	<i>Stage 3</i>	<i>Stage 4</i>
Healthy volunteers try small dose of the drug to check it is safe record any side effects	A small number of patients try the drug at a low dose to see if it works	A larger number of patients; different doses are trialled to find the optimum dose	A double blind trial will occur. The patients are divided into groups. Some will be given the drug and some a placebo.

Vaccination	<i>Small amount of dead or inactive form of the pathogen</i>	<i>1<sup>st</sup> infection by pathogen</i>	White blood cells detect pathogens in the vaccine. Antibodies are released into the blood.
		<i>Re-infection by the same pathogen</i>	White blood cells detect pathogens. Antibodies are made much faster and in larger amounts.

A person is unlikely to suffer the symptoms of the harmful disease and its spread in a population is prevented

Traditionally drugs were extracted from plants and microorganisms		
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Antibiotics and painkillers

Discovery and drug development

AQA INFECTION AND RESPONSE Part 2 (Separates only)

Vaccination

Used to immunise a large proportion of the population to prevent the spread of a pathogen

New drugs are extensively tested for:	<i>Efficacy</i>	Make sure the drug works
	<i>Toxicity</i>	Check that the drug is not poisonous
	<i>Dose</i>	The most suitable amount to take



Double blind trial: patients and scientists do not know who receives the new drug or placebo until the end of the trial. This avoids bias.

Vaccination	<i>Small amount of dead or inactive form of the pathogen</i>	<i>1<sup>st</sup> infection by pathogen</i>	White blood cells detect pathogens in the vaccine. Antibodies are released into the blood.
			<i>Re-infection by the same pathogen</i>

A person is unlikely to suffer the symptoms of the harmful disease and its spread in a population is prevented

Created more side effects than expected (fatal in some cases) and are not as widely used as everybody hoped when first developed.

Preclinical trials - using cells, tissues and live animals - must be carried out before the drug can be tested on humans.

Clinical trials use healthy volunteers and patients

<i>Stage 1</i>	<i>Stage 2</i>	<i>Stage 3</i>	<i>Stage 4</i>
Healthy volunteers try small dose of the drug to check it is safe record any side effects	A small number of patients try the drug at a low dose to see if it works	A larger number of patients; different doses are trialed to find the optimum dose	A double blind trial will occur. The patients are divided into groups. Some will be given the drug and some a placebo.

A placebo can look identical to the new drug but contain no active ingredients

Monoclonal antibodies

Specific to one binding site on the antigen. Can target specific chemicals or cells in the body

Monoclonal antibodies	<i>Identical copies of one types of antibody produced in laboratory</i>	1. A mouse is injected with pathogen
		2. Lymphocytes produce antibodies
		3. Lymphocytes are removed from the mouse and fused with rapidly dividing mouse tumour cells
		4. The new cells are called hybridomas
		5. The hybridomas divide rapidly and release lots of antibodies which are then collected

Monoclonal antibodies can be used in a variety of ways

<i>Diagnosis</i>	<i>Detecting pathogens</i>	<i>Detecting molecules</i>	<i>Treatment</i>
e.g. pregnancy test – measure the level of hormones	Can detect very small quantities of chemicals in the blood	Fluorescent dye can be attached so it can be seen inside cells or tissues	Bound to radioactive substance, toxic drug or chemical Cancer cells are targeted to normal body cells are unharmed



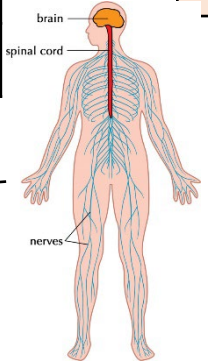
Blood glucose concentration	
<i>Monitored and controlled by the pancreas</i>	
Too high	(HT only) Too low
Pancreas produces the hormone insulin, glucose moves from the blood into the cells. In liver and muscle cells excess glucose is converted to glycogen for storage.	Pancreas produces the hormone glucagon that causes glycogen to be converted into glucose and released into the blood.

**Endocrine system**  
*Composed of glands which secrete chemicals called hormones directly into the bloodstream.*  
 The blood carries the hormone to a target organ where it produces an effect. Compared to the nervous system effects are slower but act for longer.

**Pituitary gland**  
*'Master gland'; secretes several hormones into the blood*  
 Stimulates other glands to produce hormones to bring about effects.

<b>Human control systems include</b>	<b>Cells called receptors</b>	Detect stimuli (changes in environment).
	<b>Coordination centres</b>	e.g. brain, spinal cord and pancreas that receive information from receptors.
	<b>Effectors</b>	Muscles or glands, which bring about responses to restore optimum levels.

**Enables humans to react to their surroundings and to co-ordinate their behaviour**



**Information from receptors passes along cells (neurons) as electrical impulses to the central nervous system (CNS)**

*The CNS is the brain and the spinal cord.*

Coordinates the response of effectors; muscles contracting or glands secreting hormones

**AQA GCSE HOMEOSTASIS AND RESPONSE**

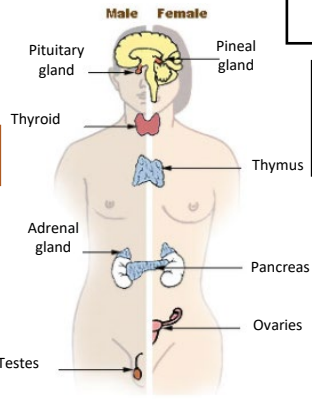
**The human nervous system**

**Homeostasis**

Homeostasis maintains optimal conditions for enzyme action and all cell functions.

**The regulation of internal conditions of a cell or organism to maintain optimum conditions for function.**

<b>Controls in the human body</b>	<b>Blood glucose concentration</b>	These automatic control systems may involve nervous responses or chemical responses.
	<b>Body temperature</b>	
	<b>Water levels</b>	



**Human endocrine system**

**Control of blood glucose concentration**

**Contraception**

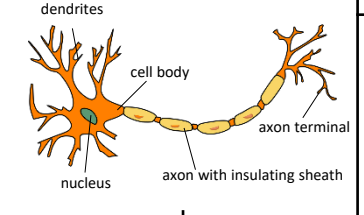
Diabetes	
<b>Type 1</b>	<b>Type 2</b>
Pancreas fails to produce sufficient insulin leading to uncontrolled blood glucose levels. Normally treated by insulin injection.	Obesity is a risk factor. Body cells no longer respond to insulin. Common treatments include changing by diet and increasing exercise.

<b>Fertility can be controlled by hormonal and non hormonal methods</b>	<b>Oral contraceptives</b>	Contain hormones to inhibit FSH production so that no eggs mature.
	<b>Injection, implant, skin patch</b>	For slow release of progesterone to inhibit the maturation and release of eggs for months or years.
	<b>Barrier methods</b>	Condoms or diaphragms which prevent sperm reaching the egg.
	<b>Intrauterine devices</b>	Prevent implantation of an embryo or release a hormone.
	<b>Spermicidal agents</b>	Kill or disable sperm.
	<b>Abstaining</b>	Avoiding intercourse when an egg may be in the oviduct.
<b>Surgery</b>	Male or female sterilisation.	

<b>Menstrual cycle</b>	<b>Follicle stimulating hormone (FSH)</b>	Causes maturation of an egg in the ovary.
	<b>Luteinising hormone (LH)</b>	Stimulates release of an egg.
	<b>Oestrogen and progesterone</b>	Maintain uterus lining.

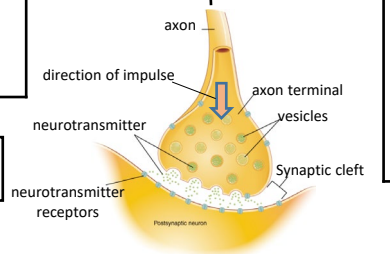
During puberty reproductive hormones cause secondary sexual characteristics to develop	
<b>Oestrogen (main female reproductive hormone)</b>	<b>Testosterone (main male reproductive hormone)</b>
Produced in the ovaries. At puberty eggs begin to mature releasing one every 28 days – ovulation.	Produced in the testes stimulation sperm production.

**Plants produce hormones (auxins) to coordinate and control growth**



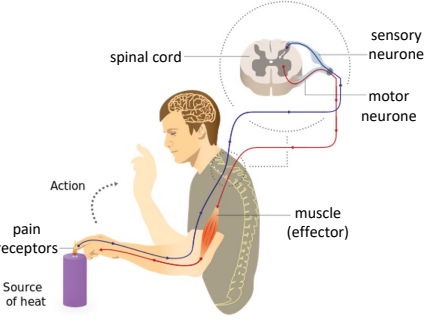
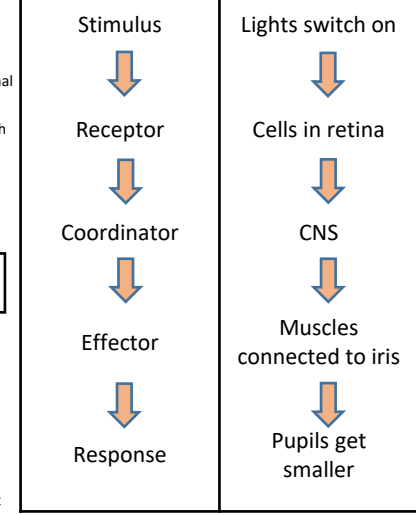
**Typical motor neurone**

Synapse (gap where two neurones meet).



Response to internal and external change

<b>Reflex arc</b>	<b>Receptor</b>	Detect stimuli.
	<b>Sensory neurone</b>	Long axon carries impulse from receptor to spinal cord.
	<b>Synapse</b>	Gap where neurones meet. Chemical message using neurotransmitter.
	<b>Relay neurone</b>	Allows impulses to travel between sensory and motor neurones in the spinal cord.
	<b>Motor neurone</b>	Long axon carries impulse from receptor to effector.
<b>Effector</b>	Muscle or gland that carries out response.	



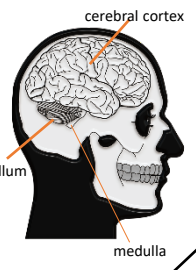
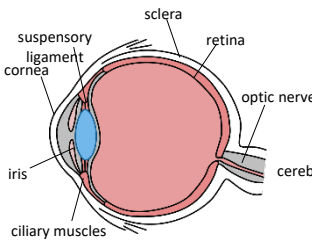
Reflex actions are automatic and rapid; they do not involve the conscious part of the brain and can protect humans from harm.

**Structures of the eye**

<b>Retina</b>	Light sensitive cell layer.
<b>Optic nerve</b>	Carries impulse to brain.
<b>Sclera</b>	Protects the eye.
<b>Cornea</b>	Transparent layer that covers the pupil and iris.
<b>Iris</b>	Pigmented layer, controls size of pupil.
<b>Ciliary muscles</b>	Controls thickness of lens.
<b>Suspensory ligaments</b>	Connects lens to ciliary muscles.

The iris can dilate the pupil (aperture) to let in more light in dim conditions

**Sense organ containing receptors sensitive to light intensity and colour**



**The brain controls complex behaviour. It is made of billions of interconnected neurones.**

The brain has different regions that carry out different functions.

<b>Cerebral cortex</b>	Largest part of the human brain. Higher thinking skills e.g. speech, decision making.
<b>Cerebellum</b>	Balance and voluntary muscle function e.g. walking, lifting.
<b>Medulla</b>	Involuntary (automatic) body functions e.g. breathing, heart rate.

**AQA GCSE HOMEOSTASIS AND RESPONSE Part 2 (Separates only)**

**Water and nitrogen balance**

If body cells lose or gain too much water by osmosis they do no function efficiently.	<b>Uncontrolled water/ion/urea loss</b>	Water exhaled in lungs, water, ions and urea in sweat.
	<b>Controlled water/ion/urea loss</b>	Via the kidneys in urine.



Kidney failure is treated by organ transplant or dialysis.

<b>Kidney function</b>	<b>Maintain water balance of the body.</b>	Produce urine by filtration of the blood and selective reabsorption of glucose, ions and water.
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A dialysis machine removes urea from the blood by diffusion while maintaining ion and glucose levels.

<b>(HT only) ADH</b>	<b>Acts on kidney tubules to control water levels.</b>	Released by pituitary gland when blood is too concentrated. Water is reabsorbed back into the blood from the kidney tubules <b>(NEGATIVE FEEDBACK).</b>
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<b>Potential disadvantages of IVF</b>	Emotional and physical stress.
	Success rates are not high.
	Multiple births risk to mother and babies.

**(HT) The complexity and delicacy of the brain makes investigating and treating brain disorders very difficult**

Neuroscientists have been able to map regions of the brain by studying patients with brain damage, electrical stimulation and MRI.

<b>Monitoring body temperature</b>	<b>Thermoregulatory centre</b>	Contains receptors sensitive to the temperature of the blood.
	<b>Skin</b>	Contains temperature receptors, sends nervous impulses to the thermoregulatory centre.

**Treating brain damage and disease e.g. Lobotomy - cutting part of the cerebral cortex**

<b>Benefit:</b> thought to alleviate the symptoms of some mental illnesses.
<b>Risks:</b> bleeding in the brain, seizures, loss of brain function. Procedure was abandoned in the 1950s due to risk.

**Hormones are used in modern reproductive technologies to treat infertility FSH and LH are used as 'fertility drugs' to help someone become pregnant in the normal way**

<b>In Vitro Fertilisation (IVF) treatment.</b>
<b>Involves giving a mother FSH and LH to stimulate the maturation of several eggs</b>
The eggs are collected from the mother and fertilised by sperm from the father in a laboratory.
The fertilised eggs develop into embryos.
At the stage when they are tiny balls of cells, one or two embryos are inserted into the mother's uterus (womb).

**Plant growth hormones are used in agriculture and horticulture**

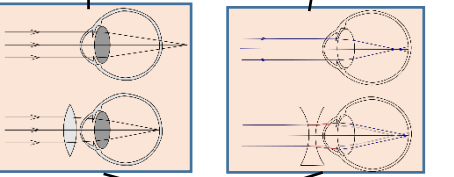
<b>Auxins</b>	Weed killers, rooting powders, promoting growth in tissue culture.
<b>Ethene</b>	Control ripening of fruit during storage and transport.
<b>Gibberellins</b>	End seed dormancy, promote flowering, increase fruit size.

**(HT only) digestion of proteins results in excess amino acids. In the liver they are de-aminated to form toxic ammonia which is converted to urea**

**Accommodation is the process of changing the shape of the lens to focus**

<b>Near object</b>	<b>Far object</b>
Ciliary muscles contract, suspensory ligaments loosed, lens get thicker, light is more refracted.	Ciliary muscles relax, suspensory ligaments pulled tight, lens pulled thin, light is only slightly refracted.

<b>Hyperopia (long sightedness)</b>	<b>Myopia (short sightedness)</b>
Treated using a convex lens so the light is focused on the retina.	Treated using a concave lens so light is focused on the retina.



New technologies now include hard/soft contact lens, laser surgery to change the shape of the cornea and a replacement lens in the eye.

**Meiosis halves the number of chromosomes**

The genome is the entire genetic material of an organism.



**DNA structure**  
Polymer made up of two strands forming a double helix.

Contained in structures called chromosomes. A gene is a small section of DNA on a chromosome. Each gene codes for a sequence of amino acids to make a specific protein.

**Gametes are made in reproductive organs (in animals ovaries and testes) and restore number of chromosomes at fertilisation**

**Cells divide by meiosis to form gametes**

Copies of the genetic information are made.  
The cell divides twice to form four gametes each with single set of chromosomes.  
All gametes are genetically different from each other.

**Meiosis leads to non-identical cells being formed while mitosis leads to identical cells being formed**

**Sexual and asexual reproduction**

**Sexual reproduction involves the fusion of male and female gametes.**

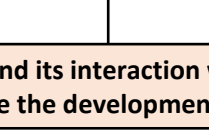
*Sperm and egg in animals.*  
*Pollen and egg cells in flowering plants.*

Produced by meiosis. There is mixing of genetic information which leads to a variety in the offspring.

**Asexual reproduction involves only one parent and no fusion of gametes.**

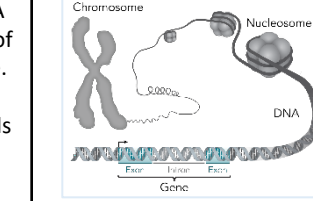
*e.g. cloning of females only in an aphid population.*

Only mitosis is involved. There is no mixing of genetic information. This leads to genetically identical clones.



**Genetic material in the nucleus is composed of a chemical called DNA.**

**DNA and the genome**



**Some disorders are inherited. They are caused by the inheritance of certain alleles, such as Polydactyl and Cystic fibrosis**

**Embryo screening:** small piece of developing placenta removed to check for presence of faulty genes

**Gene therapy:** replacing the faulty allele in somatic cells with a normal allele

**Embryo screening / gene therapy issues**

**Economic** Costly and not 100% reliable.

**Social** Not available to everyone (due to cost).

**Ethical** Should only 'healthy' embryos be implanted following screening.

**Sex determination and inheritance**

**Ordinary human body cells contain 23 pairs of chromosomes**

**One pair of chromosomes carry the genes that determine sex**

	Female	Male
	XX	XY
Gametes	X	Y
X	XX	XY
X	XX	XY

The probability of a male of female child is 50%. The ratio is 1:1

The probability of black fur offspring phenotype is 100%. All offspring genotypes are heterozygous (Bb).

**Crossing two heterozygous mice (Bb)**

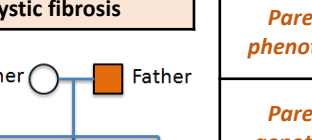
Gametes	B	b
B	BB	Bb
b	Bb	bb

The probability of black fur is 75% and white fur 25%. The ratio of black to white mice is 3:1

**AQA GCSE INHERITANCE, VARIATION AND EVOLUTION Part 1**

**Using a punnet square (using mouse fur colour as an example)**

Parent phenotype	Black fur	White fur
Parent genotype	BB	bb
What gametes are present	In each egg B B	In each sperm b b
Gametes	b	b
B	Bb	Bb
B	Bb	Bb



**Variation – genetic or environmental**

Very rarely a mutation will lead to a new phenotype which if is suited to environmental change can lead to rapid change in the species.

**Mutations occur continuously**

All genetic variation arises in mutation, most have no effect on phenotype, some influence but very few determine phenotype.

**The genome and its interaction with the environment influence the development of phenotypes**

Some characteristics are controlled by a single gene e.g. fur colour, colour blindness.. Though most are multiple genes interacting

The alleles present, or genotype operate at a molecular level to develop characteristics that can be expressed as a phenotype.

# AQA GCSE INHERITANCE VARIATION AND EVOLUTION Part 2

**Classification of living organisms**

The full human classification

Carl Linnaeus classified living things	<b>Kingdom</b>	Animalia
	<b>Phylum</b>	Chordata
	<b>Class</b>	Mammalia
	<b>Order</b>	Primates
	<b>Family</b>	Hominidae
	<b>Genus</b>	<i>Homo</i>
	<b>Species</b>	<i>sapiens</i>

**Carl Woese**

3 domain based on chemical analysis.

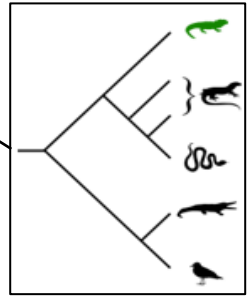
Archaea (primitive bacteria), true bacteria, eukaryota.



Organisms are named by the binomial system of genus and species. Humans are *Homo sapiens*

Evolutionary trees are a method used by scientists to show how organisms are related

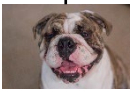
Use current classification data for living organisms and fossil data for extinct organisms



Humans have been doing this for thousands of years since they first bred food from crops and domesticated animals.

Choosing characteristics	
<i>Desired characteristics are chosen for usefulness or appearance</i>	
Disease resistance in food crops.	
Animals which produce more meat or milk.	
Domestic dogs with a gentle nature.	
Large or unusual flowers.	

Selective breeding can lead to 'inbreeding' where some breeds are particularly prone to disease or inherited defects e.g. British Bulldogs have breathing difficulties.



**Selective breeding**

The process by which humans breed plants/animals for particular genetic characteristics

**Selective breeding**

*Choosing parents with the desired characteristics from a mixed population*

Chosen parents are bred together.

From the offspring those with desired characteristics are bred together.

Repeat over several generations until all the offspring show the desired characteristics.

**Concern:** effect of GMO on wild populations of flowers and insects.

**Concern:** effect of GMO on human health not fully explored

**Genes from the chromosomes of humans or other organisms can be 'cut out' and transferred to the cells of other organisms.**

**Fossils and antibiotic resistance in bacteria provide evidence for evolution.**

**Evidence for evolution**

Antibiotic resistant bacteria	<b>Mutations produce antibiotic resistant strains which can spread</b>	Resistant strains are not killed.
		Strain survives and reproduces.
		People have no immunity to strain and treatment is ineffective.

**Extinction**

*When no members of a species survive*

Due to extreme geological events, disease, climate change, habitat destruction, hunting by humans.

**Fossils**

*'remains' of ancient organisms which are found in rocks*

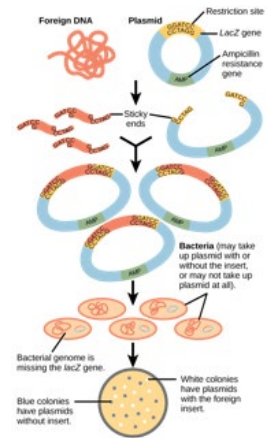
Parts of organism that have not decayed as necessary conditions are absent.

Parts of the organism replaced by minerals as they decay.

Preserved traces of organisms such as footprints, burrows and rootlet traces.

**Genetic engineering**

Modern medical is exploring the possibility of GM to over come inherited disorders e.g. cystic fibrosis



**Genetic engineering process (HT only)**

- Enzymes are used to isolate the required gene.
- Gene is inserted into a vector – bacterial plasmid or virus.
- Vector inserts genes into the required cells.
- Genes are transferred to plants/animals/microbes at an early stage of development so they develop the required characteristics.

<b>Genetically modified crops (GMO)</b>	<b>Crops that have genes from other organisms</b>	To become more resistant to insect attack or herbicides.
		To increase the yield of the crop.

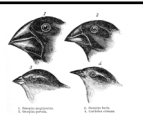
Evolution is widely accepted. Evidence is now available as it has been shown that characteristics are passed on to offspring in genes.

**The theory of evolution by natural selection.**

*Species of all living things have evolved from simple life forms that first developed 3 billion years ago.*

Through natural selection of variants (genotypes) that give rise to phenotypes best suited to their environment or environmental change e.g. stronger, faster. This allows for variants to pass on their genotype to the next generation.

If two populations of one species become so different in phenotype that they can no longer interbreed to produce fertile offspring they have formed two new species.






Darwin's finches

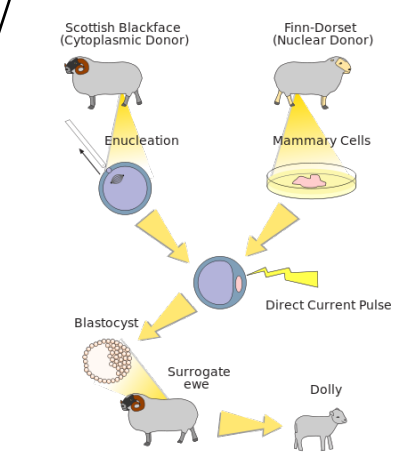
Reproduction advantages/disadvantages	
Sexual	Asexual
Needs two parents.	Only one parent needed (quicker).
Produces variation in the offspring.	Identical offspring (no variation).
If the environment changes variation gives a survival advantage by natural selection.	Vulnerable to rapidly changing conditions due to lack of variation.
Negative mutations are not always inherited.	Negative mutation can affect all offspring.
Natural selection can be speeded up using selective breeding to increase food production.	Food/medicine production can be extremely quick.

**Evidence from around the world, experimentation, geology, fossils, discussion with other scientists (Alfred Wallace) lead to:**

Charles Darwin	<b>Theory of evolution by natural selection. Challenged creation theory but not enough evidence at the time</b>	Individual organisms within a particular species show a wide range of variation for a characteristic.
		Individual most suited to the environment are more likely to breed successfully.
		Characteristics enable individuals to survive are then passed on to the next generation.

Gregor Mendel	<b>In the mid 19<sup>th</sup> century carried out breeding experiments on plants</b>	Inheritance of each characteristic is determined by units that are passed on to descendants unchanged.	<b>Speciation - Due to isolation of a population of a species e.g. species are split across far apart islands.</b>
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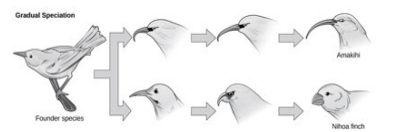
Some organisms use both methods depending on the circumstances	<b>Malarial parasites</b>		Asexually in the human host but sexually in a mosquito.
	<b>Fungi</b>		Asexually by spores, sexually to give variation.
	<b>Plants</b>		Produce seeds sexually, asexually by runners in strawberry plants, bulbs division in daffodils.



**Theory of evolution**

Cloning techniques in plants/animals	
<b>Tissue culture</b>	Small groups of cells to grow new plants. Important for preservation of rare plants and commercially in nurseries.
<b>Cuttings</b>	Part of a plant is cut off and grown into full plant.
<b>Embryo transplants</b>	Splitting apart cells from animals embryo before they become specialised. New clone embryos are inserted into womb of adult female.

<b>Further understanding of genetics</b>
<b>Improving technology allowed new observations.</b>
Late 19 <sup>th</sup> century: behaviour of chromosomes in cell division.
Early 20 <sup>th</sup> century: chromosomes and Mendel's 'units' behave in similar ways. 'units' now called genes must be located on chromosomes.
Mid 20 <sup>th</sup> century: structure of DNA determined. Mechanism of gene function worked out.



**AQA GCSE INHERITANCE, VARIATION AND EVOLUTION Part 3 (Separates only)**

**Advantages and disadvantages of sexual and asexual reproduction**

When the protein chain is complete it folds to form a unique shape. This allows proteins to do their job as enzymes, hormones or new structures such as collagen.

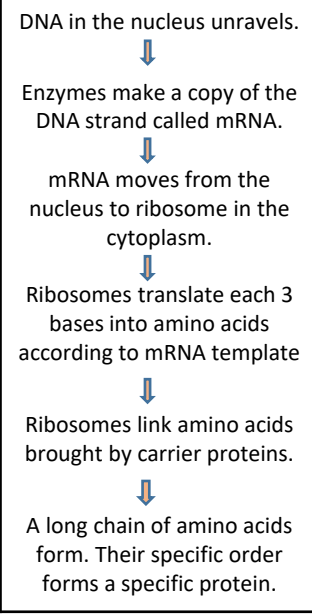
Some change the shape and affect the function of proteins e.g. and enzyme active site will change or a structural protein loses its strength

Most do not alter the protein so that its appearance or function is not changed.

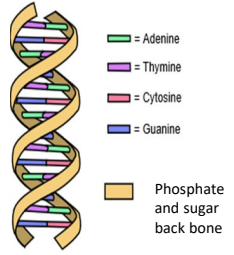
**Mutations occur continuously (HT only)**

**(HT) Making new proteins (protein synthesis)**

*Composed of chains of amino acids. A sequence of 3 bases codes for a particular amino acid.*



**DNA structure**



**DNA is polymer made from four different nucleotides. Each nucleotide consists of a common sugar, phosphate group and one of 4 different bases A, C, G & T**

**Protein synthesis (HT only)**

In DNA the complementary strands C, A, T, G always link in the same way. C always linked to G on the opposite strand and A to T.

**(HT only) Not all parts code for proteins. Non-coding parts can switch genes on and off. Mutations may affect how genes are expressed.**

**Concern:** some people have ethical objections to adult cell cloning e.g. welfare of the animals.

- Adult cell cloning**
1. Nucleus is removed from an unfertilised egg.
  2. Nucleus from body cell is inserted into egg cell.
  3. An electric shock stimulates the egg to divide into an embryo
  4. Embryo cells are genetically identical to adult cells.
  5. When embryo has developed into ball of cells it is inserted into host womb.

**The whole human genome has now been studied.**

- Searching for genes linked to different types of disease.
- Understanding and treatment of inherited disorders.
- Tracing migration patterns from the past.

Farmers optimise conditions for making compost for use as a natural fertiliser.

Bacteria respire when breaking down dead organisms releasing CO<sub>2</sub>.

**Photosynthetic organisms are the producers of biomass for life on Earth and the start of all food chains**

*EXAMPLE:* climate change is leading to more dissolved CO<sub>2</sub> in oceans lowering the pH of the water affecting organisms living there.

*EXAMPLE:* Introduction of grey squirrels to UK increased competition for food for red squirrels. The greys also carry a pathogen that kills reds.

**Materials are recycled to provide the building blocks for future organisms**

**Decomposition and material cycling**

**Abiotic and biotic factors.**

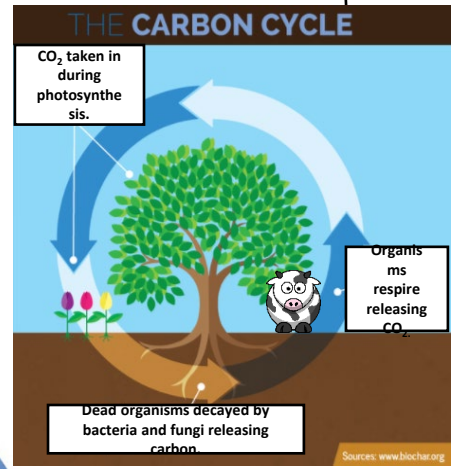
Anaerobic decay in biogas generators produces methane gas, used as a fuel.

Breakdown of dead organisms releases mineral ions can into the soil.

**Factors affecting rate of decay**

**Temperature, water, oxygen**

Increase the rate of decay. In enzyme controlled reactions raising the temperature too high will denature the enzymes.



**AQA GCSE ECOLOGY**

**Global warming**

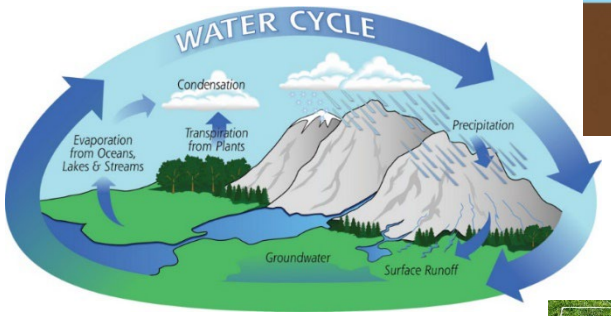
**Organisms adaptations enable them to survive in conditions where they normally live.**

Adaptations may be structural, behavioural or functional.

There is a global consensus about global warming and climate change based on systematic reviews of thousands of peer reviewed publications.

**Biodiversity is the variety of all different species of organisms on Earth, or within an ecosystem**

**Human activity can have a positive impact on biodiversity**



Abiotic	Biotic
<i>Non-living factors that affect a community</i>	<i>Living factors that affect a community</i>
Living intensity.	Availability of food.
Temperature.	
Moisture levels.	New predators arriving.
Soil pH, mineral content.	
Wind intensity and direction.	New pathogens.
Carbon dioxide levels for a plant.	
Oxygen levels for aquatic organisms.	One species outcompeting so numbers are no longer sufficient to breed

Sampling techniques	Quadrats	Transects
	Organisms are counted within a randomly placed square	Organisms are counted along a belt (transect) of the ecosystem.

**Global warming**

*Levels of CO<sub>2</sub> and methane in the atmosphere are increasing.*

Decreased land availability from sea level rise, temperature rise damages delicate habitats, extreme weather events harm populations of plants and animals.

Waste management	Rapid growth in human population and higher standard of living
	More resources used and more waste produced.
	Pollution in water; sewage, fertiliser or toxic chemicals.
	Pollution in air; smoke or acidic gases.
	Pollution on land; landfill and toxic chemicals.

Large scale deforestation
<i>In tropical areas (e.g. rain forest) has occurred to:</i>
Provide land for cattle and rice fields, grow crops for biofuels. This reduces biodiversity and a CO <sub>2</sub> sink

Land use
<i>Humans reduce the amount of land and habitats available for other plants, animals and microorganisms.</i>
Building and quarrying.
Farming for animals and food crops.
Dumping waste.
Destruction of peat bogs to produce cheap compost for gardeners/farmers to increase food production.

Scientists and concerned citizens
<i>Put in place programmes to reduce the negative impacts of humans on ecosystems and biodiversity</i>
Breeding programmes for endangered species.
Protection and regeneration of rare habitats.
Reintroduction of field margins and hedgerows in agricultural areas where farmers grow only one type of crop.
Reduction of deforestation and CO <sub>2</sub> emissions by some governments.
Recycling resources rather than dumping waste in landfill.

The decay or burning of peat release CO<sub>2</sub> into the atmosphere. This conflicts with conserving peat bogs and peatlands as habitats for biodiversity and reduce CO<sub>2</sub> emissions.



Pollution kills plants and animals which can reduce biodiversity.

Some of the programmes potentially conflict with human needs for land use, food production and high living standards.

<b>Factors affecting food security</b> <i>Enough food is needed to feed a changing population</i>	Increasing birth rate.
	Changing diets in developing countries.
	New pests and pathogens affecting farming.
	Environmental changes e.g. famine when rains fail.
	Cost of agriculture input.
	Conflicts (war) affecting water or food availability

<b>Environmental changes affect the distribution of species</b>	<i>Temperature</i>	These changes might be seasonal, geographic or caused by human interaction.
	<i>Availability of water</i>	
	<i>Composition of atmospheric gases</i>	

**AQA GCSE ECOLOGY Part 2 (Separates only)**

**Food production**

**Impact of environmental change**

*Example:* Several species of bird migrate from cold winter conditions to warmer conditions closer to the equator.

**Farming techniques**  
*Increasing efficiency of food production*  
Reduce energy waste, limiting movement, control temperature, high protein diet to increase growth.



**Sustainable fisheries**  
*Fish stocks in oceans are declining*  
Maintain/grow fish stocks to a sustainable level where breeding continues or certain species may disappear. By controlling net size, fishing quotas.



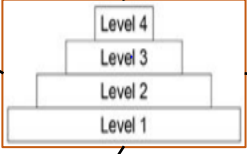
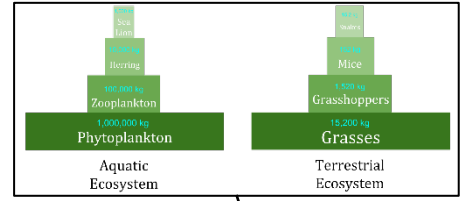
Some people have concerns about the treatment of animals.

**Biotechnology**  
*Meeting the demands of a growing population*  
Fungus *Fusarium* to produce mycoprotein. Requires glucose syrup, aerobic conditions. Biomass is harvested and purified.  
GM bacterium produces insulin to treat diabetes.  
GM crops to provide more/nutritional food (golden rice).



Decomposers break down dead plants and animal matter by secreting enzymes. Small soluble food molecules than diffuse into the microorganism.

**Trophic levels and biomass**



**Transfer of biomass**  
*Biomass is lost between the different trophic levels*  
Producers transfer about 1% of the incident energy from light for photosynthesis.  
Approximately 10% of the biomass from each trophic level is transferred to the level above.  
Large amounts of glucose is used in respiration, some material egested as faeces or lost as waste e.g. CO<sub>2</sub>, water and urea in urine.

**Trophic levels can be represented by numbers and biomass in pyramids.**  
*Trophic levels are numbered sequentially according to how far the organisms is along the food chain.*

Level 1	Producers	Plants and algae.
Level 2	Herbivores	Primary consumers.
Level 3	Carnivores	Secondary consumers.
Level 4	Carnivores	Tertiary consumers.

Apex predators are carnivores with no predators.