AQA GCSE Biology New Unit 2 Summary Notes

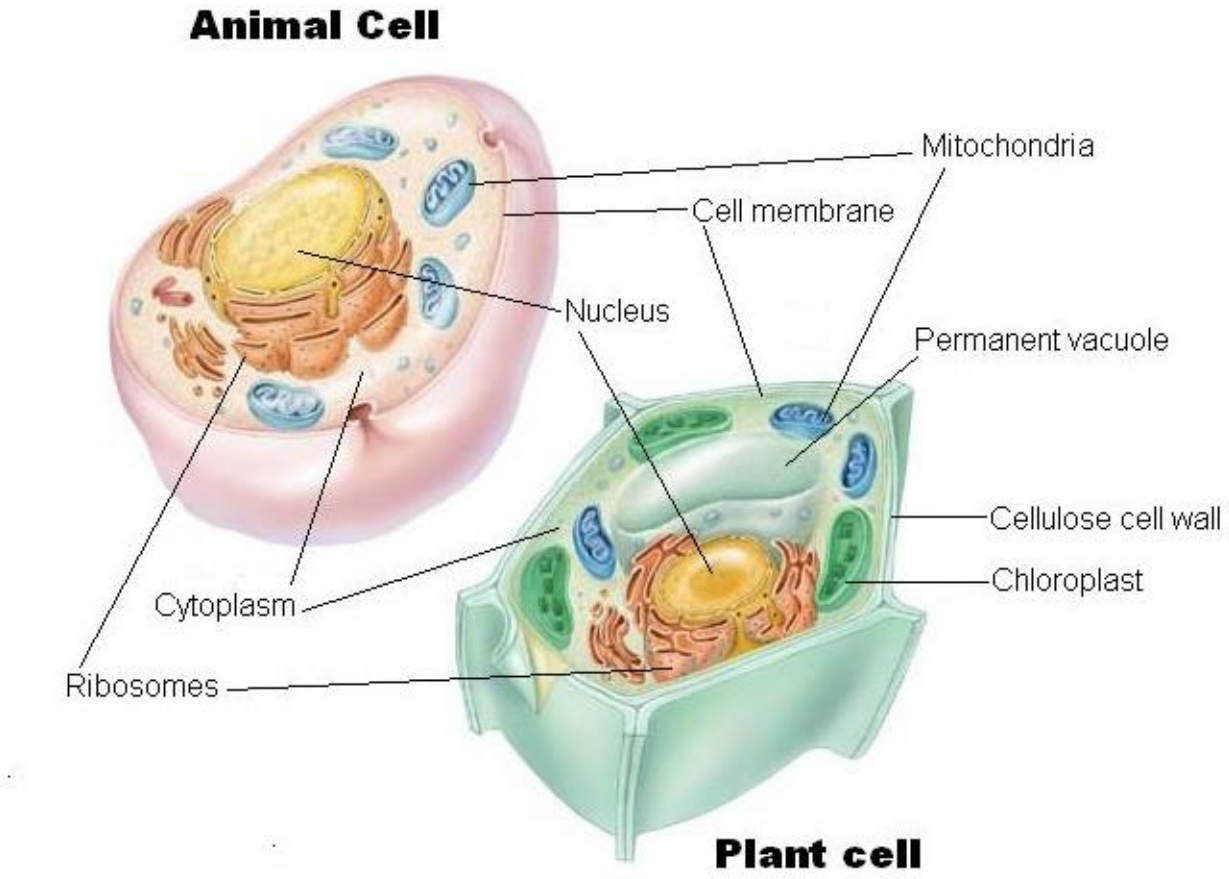
B2.1 Cells and Cell Structures

Summary
All living things are made up of cells. The structures of different types of cells are related to their functions. To get into or out of cells, dissolved substances have to cross the cell membranes.

Cells

- Cells are the smallest unit of life.
- All living things are made of cells.
- Most human cells, like most other animal cells, have the following parts:
    - nucleus
    - cytoplasm
    - cell membrane
    - mitochondria
    - ribosomes

- Plant and algal cells also have:
    - cell wall
    - chloroplasts
    - permanent vacuole



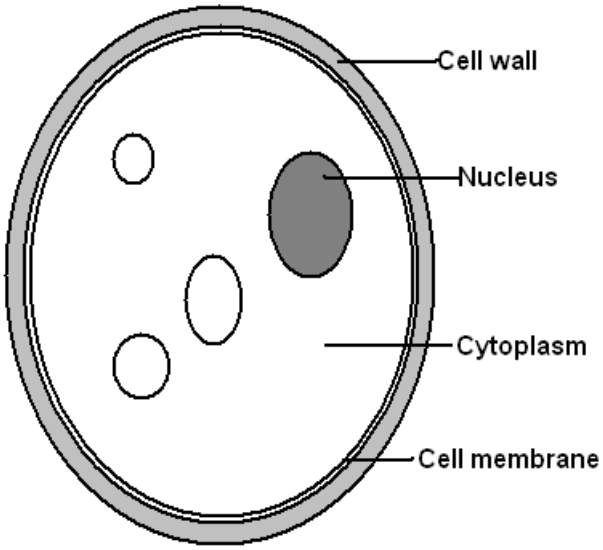
What do these structures do?

- Nucleus – controls the activities of the cell.
- Cytoplasm – where most of the chemical reactions take place.
- Cell membrane - controls the passage of substances in and out of the cell.
- Mitochondria - where most energy is released in respiration.

- Ribosomes - where protein synthesis occurs.
- Cell wall – made of cellulose and strengthens plant cells.
- Chloroplasts - absorb light energy to make food in plant cells.
- Permanent vacuole - filled with cell sap in plant cells.

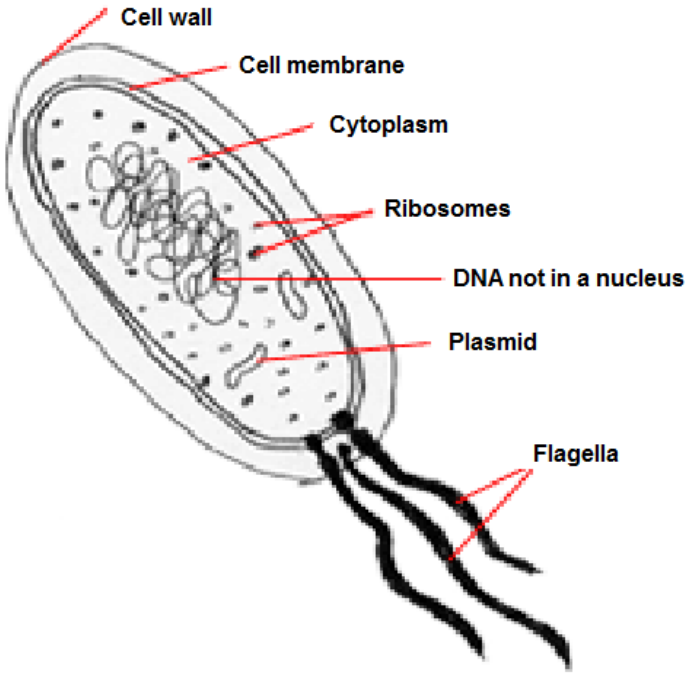
Yeast

- Yeast is a single-celled organism.
- The cells have a nucleus, cytoplasm and a membrane surrounded by a cell wall.



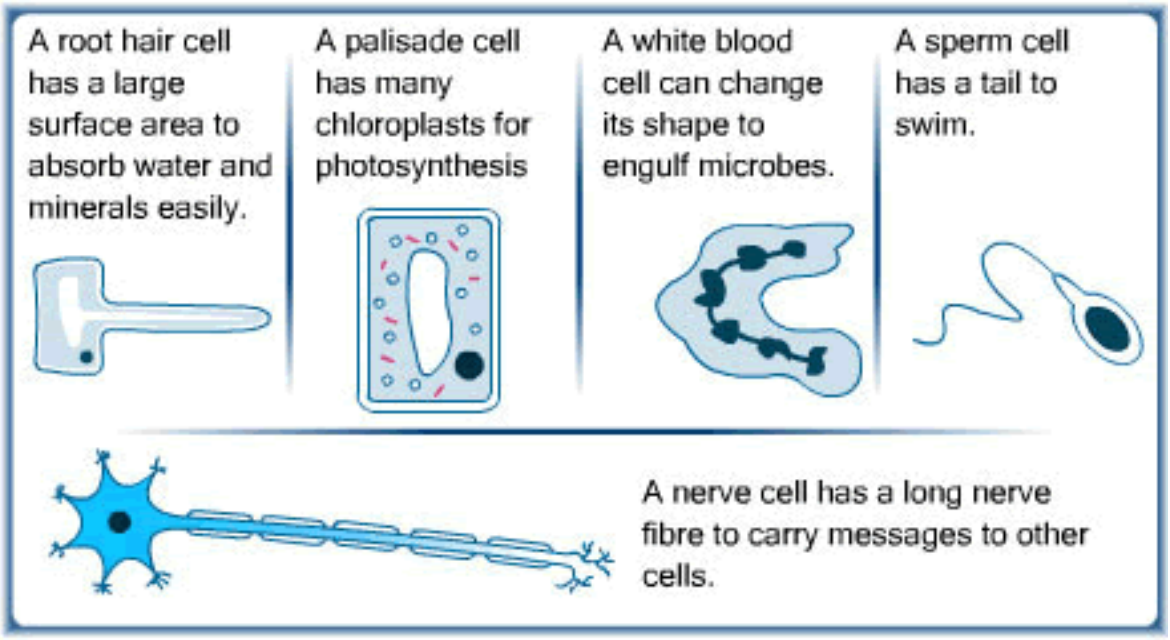
Bacteria

- Bacterium is a single-celled organism.
- A bacterial cell consists of cytoplasm and a membrane surrounded by a cell wall.
- The genes are not in a distinct nucleus.



- Cells may be specialised to carry out a particular function.

  Examples:

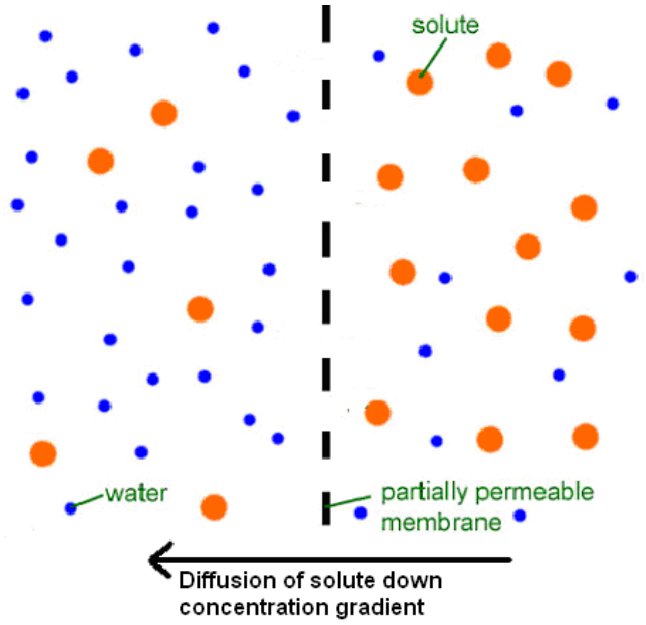


Movement into and out of cells

- To get into or out of cells, dissolved substances have to cross the cell membranes.
- Solutes = particles in solution eg glucose, sodium ions, chloride ions.
- Solvent = liquid in which the particles are dissolved eg water.
- Solute and solvent molecules move around randomly.
- Solutes can move into and out of cells by diffusion.

Diffusion

- Diffusion is the spreading of the particles of a gas, or of any substance in solution, resulting in a net movement from a region where they are of a higher concentration.
- Oxygen required for respiration passes through cell membranes by diffusion.
- The greater the difference in concentration, the faster the rate of diffusion.



B2.1 Tissues, Organs and Organ Systems

Summary

The cells of multicellular organisms may differentiate and become adapted for specific functions. Tissues are aggregations of similar cells; organs are aggregations of tissues performing specific physiological functions. Organs are organised into organ systems, which work together to form organisms.

Multicellular organisms

- Large multicellular organisms develop systems for exchanging materials.
- During the development of a multicellular organism, cells differentiate so that they can perform different functions.
- A tissue is a group of cells with similar structure and function.
- Organs are made of tissues.
- One organ may contain several tissues.
- Organ systems are groups of organs that perform a particular function.

Animal organs

Examples of animal tissues include:

- muscular tissue, which can contract to bring about movement
- glandular tissue, which can produce substances such as enzymes and hormones
- epithelial tissue, which covers some parts of the body.

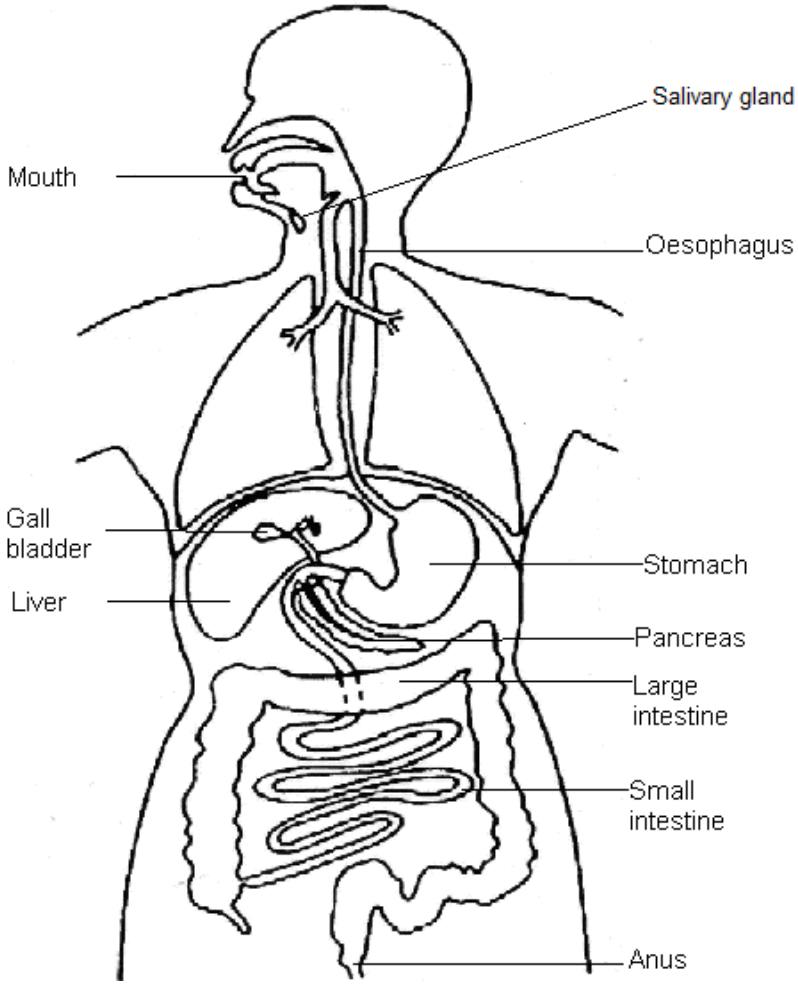
The stomach is an organ that contains:

- muscular tissue, to churn the contents
- glandular tissue, to produce digestive juices
- epithelial tissue, to cover the outside and the inside of the stomach.

The digestive system is one example of a system in which humans and other mammals exchange substances with the environment.

The digestive system includes:

- glands, such as the pancreas and salivary glands, which produce digestive juices
- the stomach and small intestine, where digestion occurs
- the liver, which produces bile
- the small intestine, where the absorption of soluble food occurs
- the large intestine, where water is absorbed from the undigested food, producing faeces.

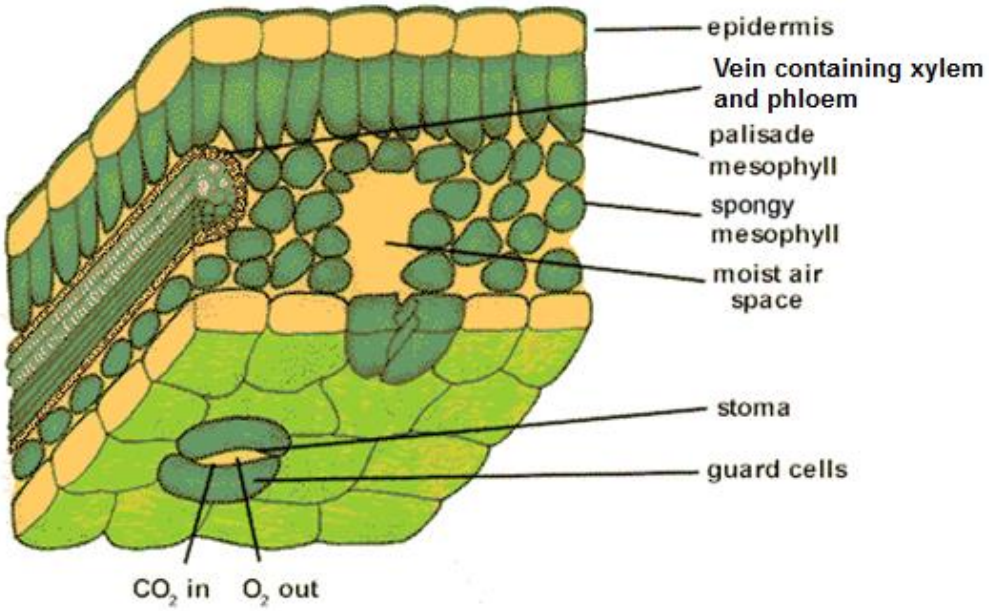


Plant organs

Plant organs include stems, roots and leaves.

Examples of plant tissues include:

- epidermal tissues, which cover the plant
- mesophyll, which carries out photosynthesis
- xylem and phloem, which transport substances around the plant.



B2.3 Photosynthesis

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

Photosynthesis

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

During photosynthesis:

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

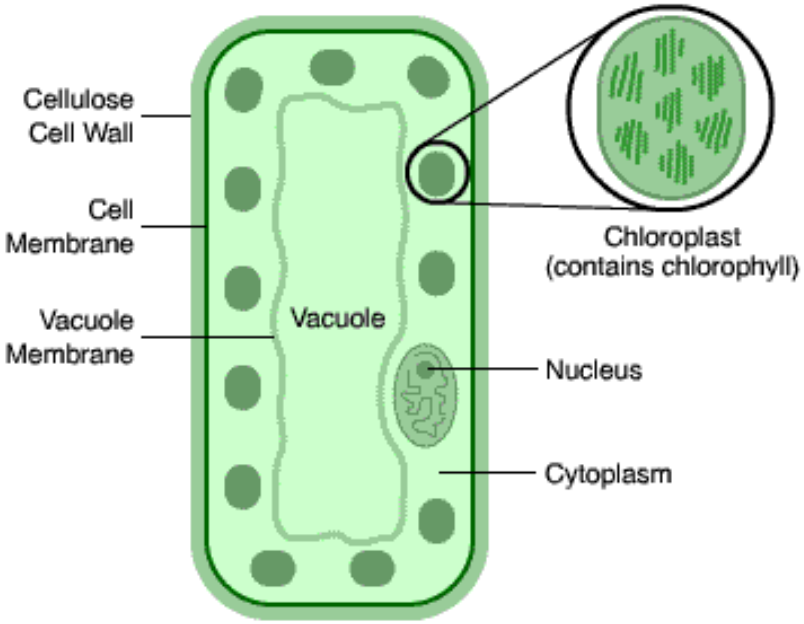
Photosynthesis is summarised by the equation:

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

Where does photosynthesis happen?

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

A palisade mesophyll cell:



Factors that limit the rate of photosynthesis

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

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

3) Light intensity
A shortage of light means there is less energy to power the reaction.

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

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

How do plants and algae use glucose?

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

B2.4 Organisms and their environment

Summary

Living organisms form communities, and we need to understand the relationships within and between these communities. These relationships are affected by external influences.

Physical factors

Physical factors that may affect organisms are:

- Temperature:
  - Temperature affects the rate of an organism's metabolism.
  - Some organisms cannot maintain a constant high body temperature.
  - They cannot tolerate extreme temperatures.
  - Organisms that can maintain a constant high body temperature may also struggle to survive in extreme temperatures.
- availability of nutrients:
  - Nutrients such as nitrates are essential for the growth of plants and microorganisms.
  - If there is a low concentration of these nutrients, these organisms struggle to grow and survive.
- amount of light:
  - Plants require light as an energy source for photosynthesis.
  - In low light intensities plants grow very slowly.
- availability of water:
  - All organisms require water.
  - It is essential because chemical reactions that occur inside and outside cells occur in solution in water.
  - In the absence of water, cells, and therefore organisms, die
- availability of oxygen:
  - Oxygen is essential for aerobic respiration.
  - It can become limited in the soil, so plant roots cannot grow and absorb mineral ions and water.
  - It can also become limited in water, so aquatic organisms struggle to respire and survive.
- availability of carbon dioxide:
  - Carbon dioxide is essential for photosynthesis.
  - This can become limited in an environment where there are many plants.
  - This will reduce the rate of growth of plants.

Collection of quantitative data

Sampling:

- To study the distribution of a species you need to find out:
  - The size of the area being studied.
  - The number of organisms living there.
  - Where those organisms live.
- However, it would be very time consuming to count every individual organism:
  - They may move
  - There may be too many.

- Therefore, a sample of the organisms is counted.
- The techniques chosen should enable this sample to be representative of the whole area.
- It should provide valid data.
- The sample can be used to estimate the total population.
- The technique should be reproducible; if it is carried out again the estimated population should be the same size.

Quadrats

- These are square frames, used to mark off specific areas of ground.
- Typically 0.5m X 0.5m with a grid of 10cm X 10 cm
- They can be used to survey:
    - which species are present,
    - numbers of each species, or
    - percentage cover of a species.

Random Sampling:

- Construct a regular grid using tape across the area.
- Generate random numbers using a calculator or computer.
- Use these to determine coordinates.
- This ensures that there is no bias by the investigator.
- It ensures the results are valid.
- Investigate the population of the species in the quadrat.
- Repeat many times.

Transects

Use when:

- There are changes in the distribution of a population of an organism.
- There are two neighbouring habitat
- eg grassland to woodland
- Or, if a particular factor leads to zonation
- Eg the effect of the tide and coverage by water on a rocky seashore.

Method

i) Choose the start and end positions of the transect.
ii) Determine the direction and length of the transect.
iii) Lay down a tape or string to mark out transect.
iv) Sample the organisms along the line.
v) Perform further parallel transects to ensure results are reliable.
vi) Take recording of the factors that could be influencing the distribution along the transect.

Various types of transect:

1. Record each organism, which is touching the line at suitable, regular intervals.
2. Place a quadrat at the start position and record its contents. Place the subsequent quadrats immediately touching the previous ones along the transect.
3. If the transect is very long, place the quadrats at suitable, regular intervals along the transect.

Analysis of data

Mean:
The average value; calculated by adding all the observations and dividing by the number of observations.

Example 1
25 quadrats were placed.
125 dandelions where found in total.
Mean number of daisies per quadrat = $\frac{125}{25}$

$= 5$

Example 2
5 quadrats were placed.
Percentage cover of grass in each was: 70%, 50%, 80%, 60%, 90%
Mean percentage cover = $\frac{70 + 50 + 80 + 60 + 90}{5}$

$= 70\%$

Median:
The middle value of a list.

Example:
The number of slugs found under discarded bricks were: 5,9,9,8,6,9,3,6

Arrange the data in order: 3,5,6,6,8,9,9,9

The median is the middle number, or the mean of the middle two numbers.

The median number of slugs per brick = $\frac{6 + 8}{2}$ = 7 slugs per brick

Mode:
The most common value in a list.

In the case of the slugs this would be 9 slugs per brick

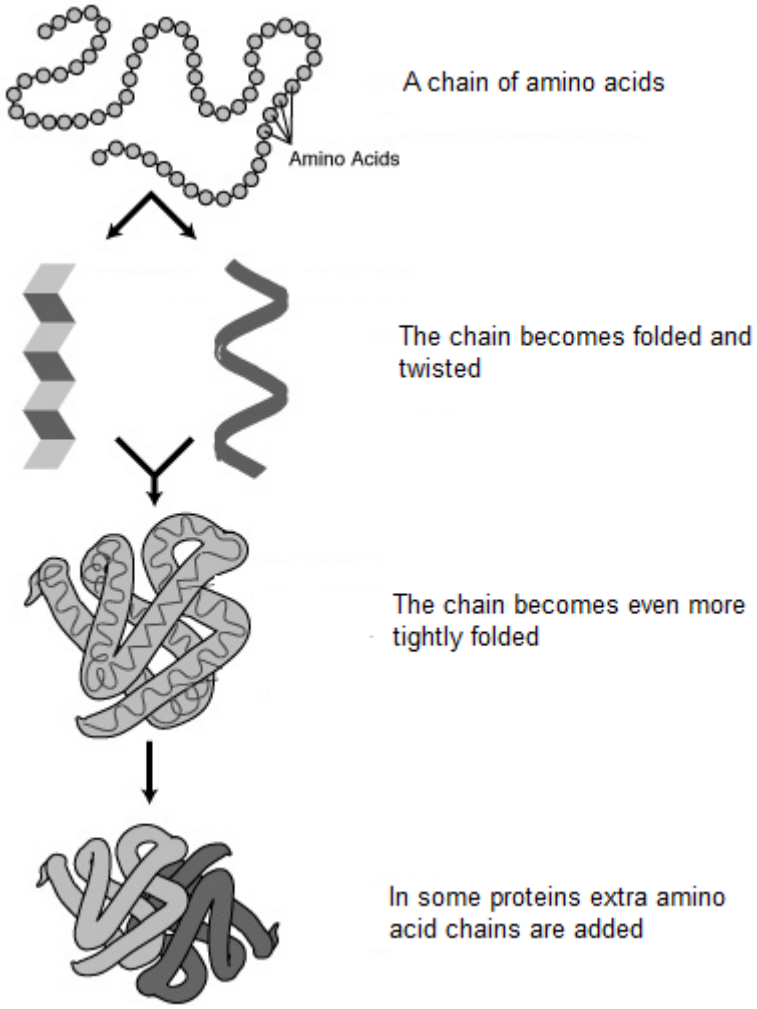
B2.5 Proteins

Summary

Proteins have many functions, both inside and outside the cells of living organisms. Proteins, as enzymes, are now used widely in the home and in industry.

Protein structure

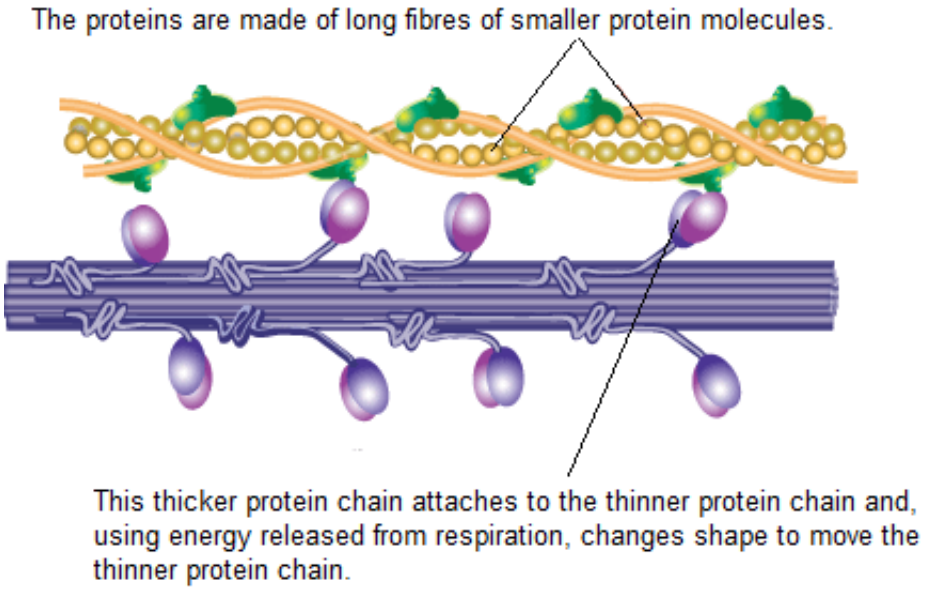
Protein molecules are made up of long chains of amino acids.



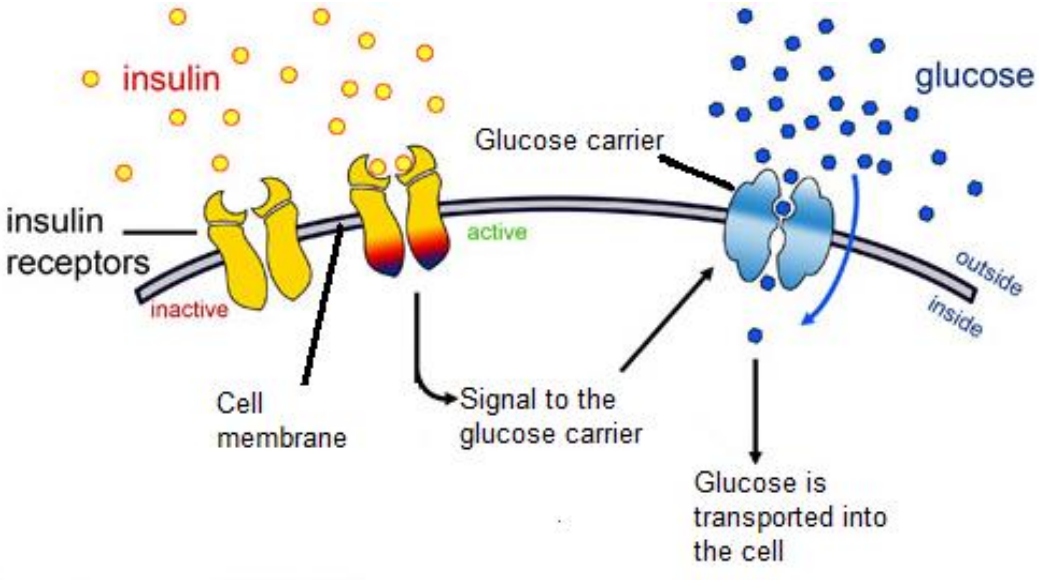
These long chains are folded to produce a specific shape that enables other molecules to fit into the protein.

Proteins act as:

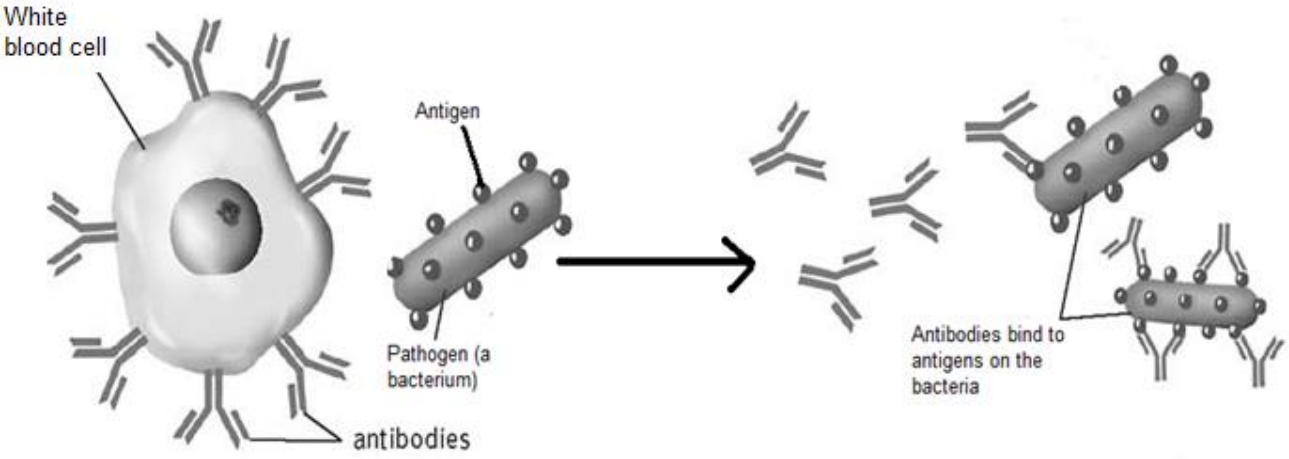
- Structural components of tissues such as muscles:
    - Muscle cells contain interlinking protein fibres.
    - These interact when the muscle contract.



- Hormones:
  - Some hormones are proteins.
  - Example: insulin
  - Hormones are released into the blood from glands.
  - They have specific shapes, and attach to molecules on the cell membrane of specific target cells.
  - Eg when the blood sugar levels increase, insulin is released from the pancreas. It attaches to the cell membrane of cells in the liver, and this causes them to increase rate of glucose uptake.



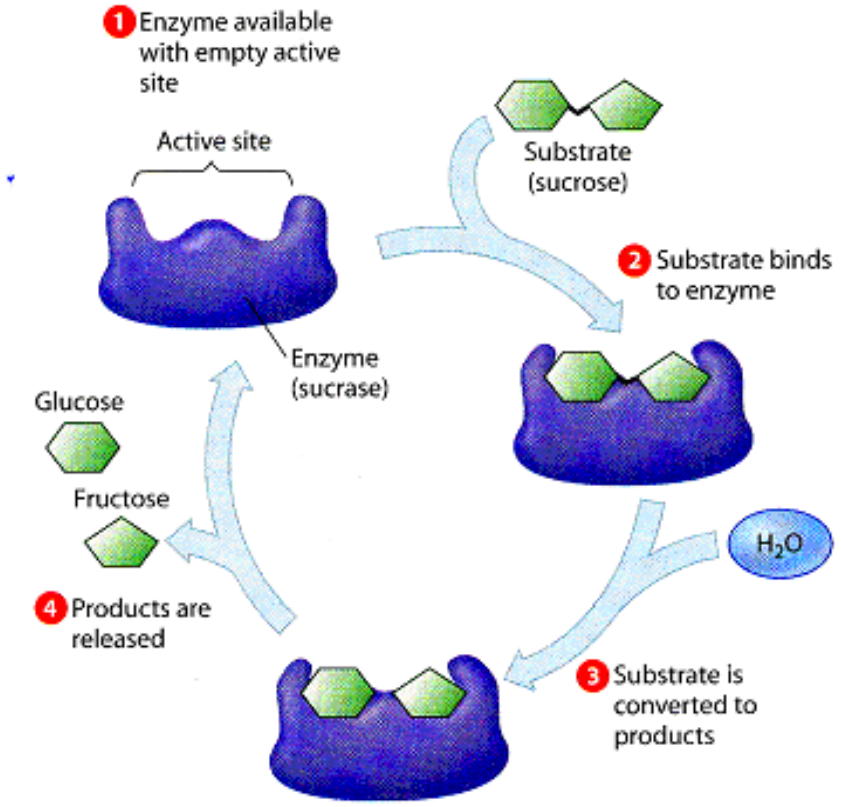
- Antibodies:
  - Antibodies are made of proteins.
  - They are released by white blood cells.
  - They have a specific shape that attaches to antigens.
  - Antigens are chemicals that pathogens carry or release.
  - The antibody prevents the pathogens from damaging our own cells.



- Catalysts:
  - Proteins act as biological catalysts called enzymes.
  - These control and sequence all of the reactions that occur inside and outside cells in all living organisms.

Enzymes structure and function

- Enzymes are biological catalysts.
- Catalysts increase the rate of chemical reactions.
- Enzymes are protein molecules made up of long chains of amino acids.
- These long chains are folded to produce a special shape which enables other molecules to fit into the enzyme.
- This shape is vital for the enzymes function.
- Normally only one type of molecule (the substrate) will fit into the enzyme.
- The active site is the part of the enzyme which the substrate fits into.

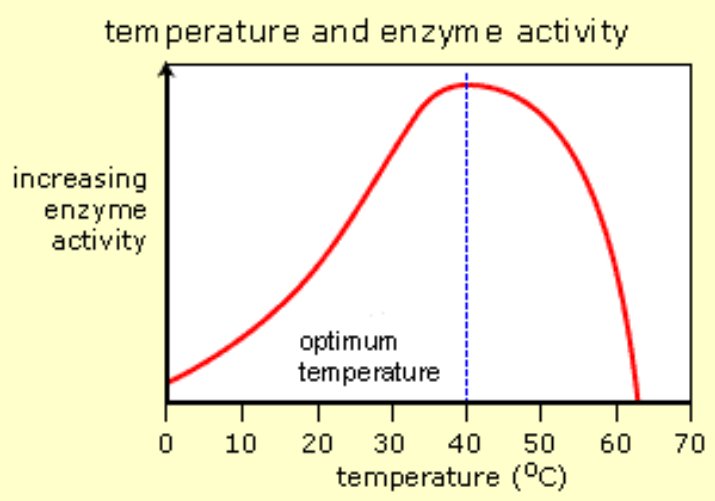


Activation Energy

- In order for a chemical reaction to take place, energy is required.
- This is called the activation energy.
- Enzymes reduce the activation energy of a reaction.

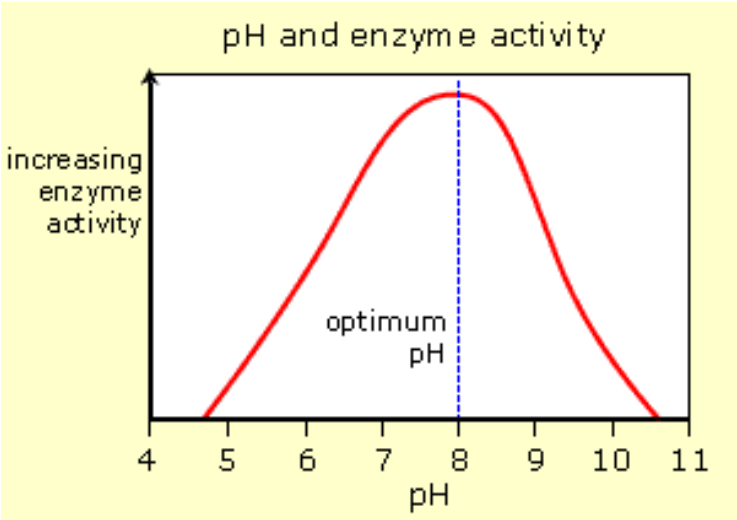
Effect of temperature on enzymes

- Like most chemical reactions, the rate of enzyme-controlled reactions increases as the temperature increases.
- The enzyme and substrates move around faster so they collide more often.
- The temperature when the enzyme is working fastest is called the optimum.
- This is true up to approximately 40˚C, higher than this and the structure of the enzyme changes.
- As a result, the active site becomes a different shape and the substrate no longer fits.
- It is then described as denatured.



The effect of pH on enzymes

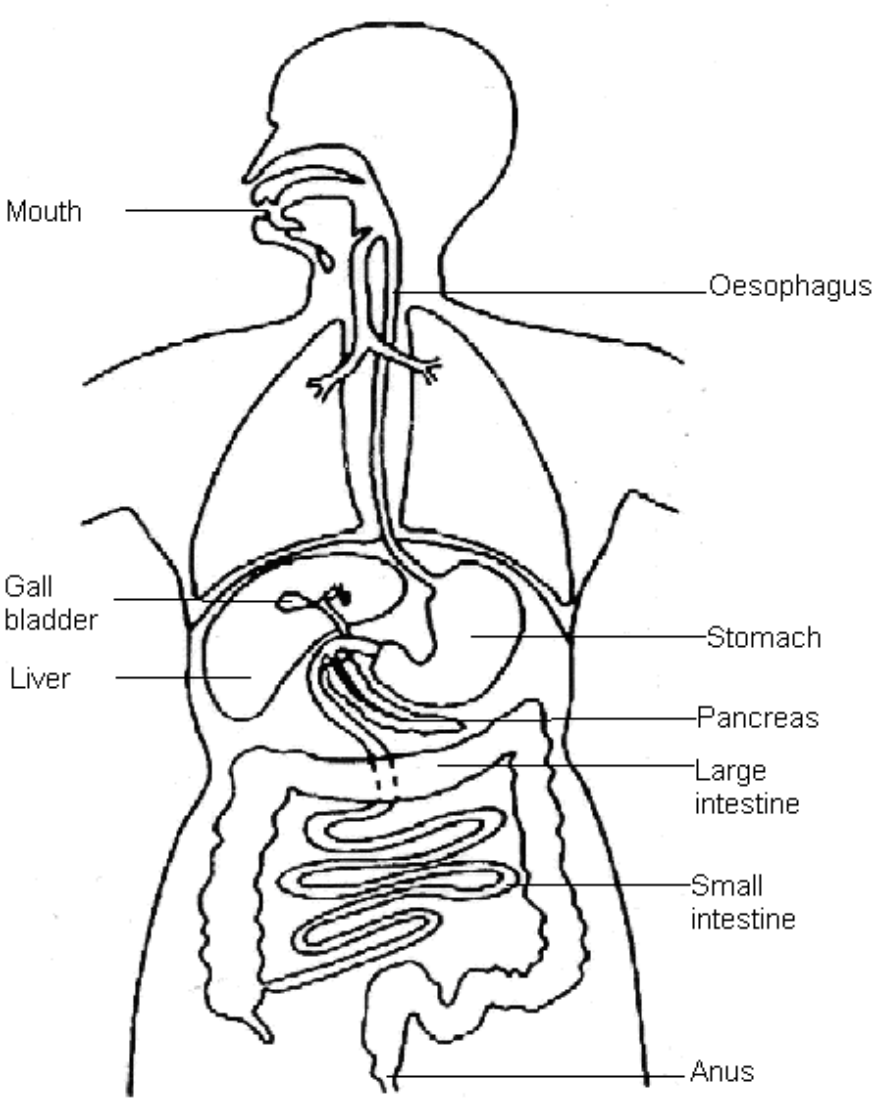
- pH can also affect the shape of the active site.
- It does this by affecting the forces that hold the enzyme molecule together.
- A change in pH denature the enzyme.
- Different enzymes work best at different pH values.
- Eg. Stomach enzymes work best in acidic conditions.
- Mouth enzymes work best in neutral conditions.



Digestion

- Some enzymes work outside the body cells.
- These are called extracellular enzymes.
- The digestive enzymes are produced by specialised cells in glands and in the lining of the gut.
- The enzymes then pass out of the cells into the gut where they come into contact with food molecules.
- They catalyse the breakdown of large molecules into smaller molecules.
- Digestion is the process where food is broken down into substances the body can absorb.
- Nutrition is the process of taking in and using food.

The Human Digestive System



Digestion in the mouth

- Food is chewed to create a larger surface area for the action of enzymes.
- Saliva is released which contains amylase.
- Amylase digests starch into smaller sugars (maltose).
- Further chewing enables swallowing.
- The food enters the oesophagus.

Digestion in the stomach

- Food enters the stomach from the oesophagus.
- The walls of our stomach produce juice.
- This juice contains:
    - A protease enzyme (called pepsin).
        - This digests proteins into amino acids.
    - Hydrochloric acid – this kills bacteria in our food. It creates pH3.
    - Mucus – this protects the wall of our stomach from acid and pepsin.
- The wall of our stomach is muscular, and churns our food.
- The food remains in our stomach for a few hours. The proteins are digested.
- Food leaves our stomach in small squirts into the small intestine.

Digestion and absorption in the small intestine

The small intestine has 2 main jobs:

- To complete the digestion of the food
- To absorb the soluble products of digestion into the blood.

Digestion in the small intestine

3 juices are released:

1. Bile

- Produced by the liver.
- Stored in the gall bladder.
- Released into the small intestine.
- 2 main things in bile:
    - Alkali to neutralise the stomach acid
    - Bile salts which convert large fat droplets – for a large surface area for the enzymes to act on.
    - **There are no enzymes in bile.**

2. Pancreatic juice and
3. Intestinal juice

- Both are released into the small intestine.
- Both contain 3 main enzymes:
    - Amylase to complete the digestion of starch into sugars.
    - Protease to complete the digestion of proteins into amino acids.
    - Lipase to break down fats into fatty acids and glycerol.

Making use of enzymes

- Some microorganisms produce enzymes which pass out of the cells.
- These enzymes have many uses in the home and in industry.

- In the home, biological detergents may contain protein-digesting and fat-digesting enzymes (proteases and lipases).

Advantages	Disadvantages
These are more efficient at removing stains from clothes.	If the clothes are not fully rinsed, protease enzymes may remain in the clothes, which digests protein in the skin.
Lower washing temperatures can be used which saves energy.	This can lead to irritation, allergies and dermatitis.

- In industry:
    - Proteases are used to pre-digest the protein in some baby foods.
        - This reduces how much the baby needs to digest the food.
    - Carbohydrases are used to convert starch into sugar syrup.
        - This is cheaper than extracting sugar from sugar cane.
    - Isomerase is used to convert glucose syrup into fructose syrup:
        - This is much sweeter
        - It therefore can be used in smaller quantities in slimming foods.

Advantages	Disadvantages
Enzymes enable industrial reactions to take place at lower temperatures.	Enzymes are sensitive to temperature and pH changes.
Supplying heat is expensive. When enzymes are used, industrial processes can be cheaper.	Temperature and pH need to be carefully monitored and controlled, which can be expensive.

B2.6 Respiration

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

Respiration

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

Aerobic respiration

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

Word equation:

Glucose + Oxygen ⟶ Carbon dioxide + Water + Energy

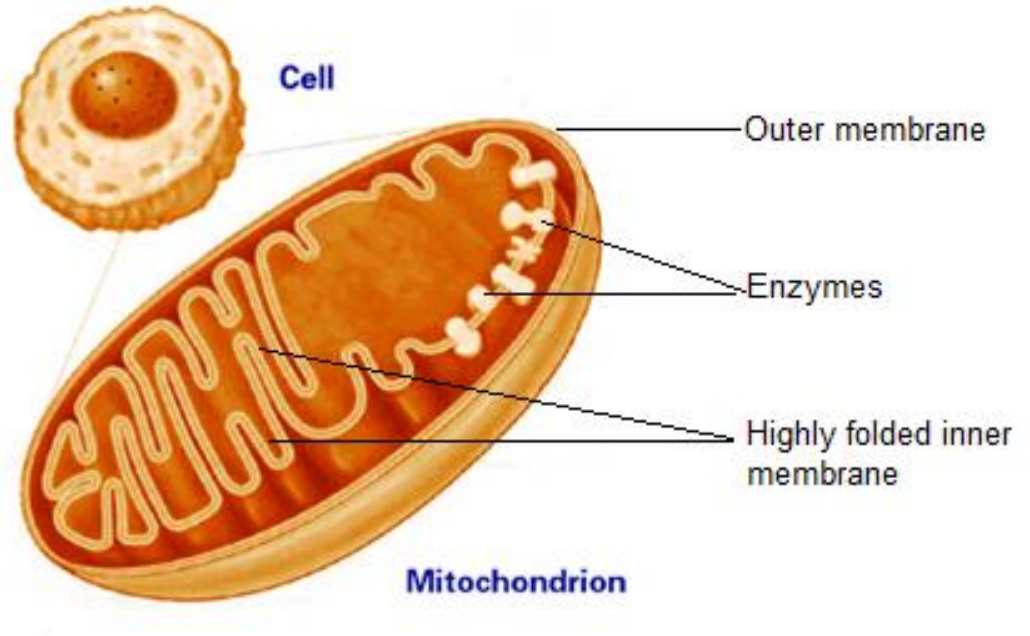
Chemical equation (do not need to learn!):

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

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

Mitochondria

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



Energy use

The energy that is released during respiration is used:

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

The role of respiration during exercise

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

Changes during exercise

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

Glycogen

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

Anaerobic respiration

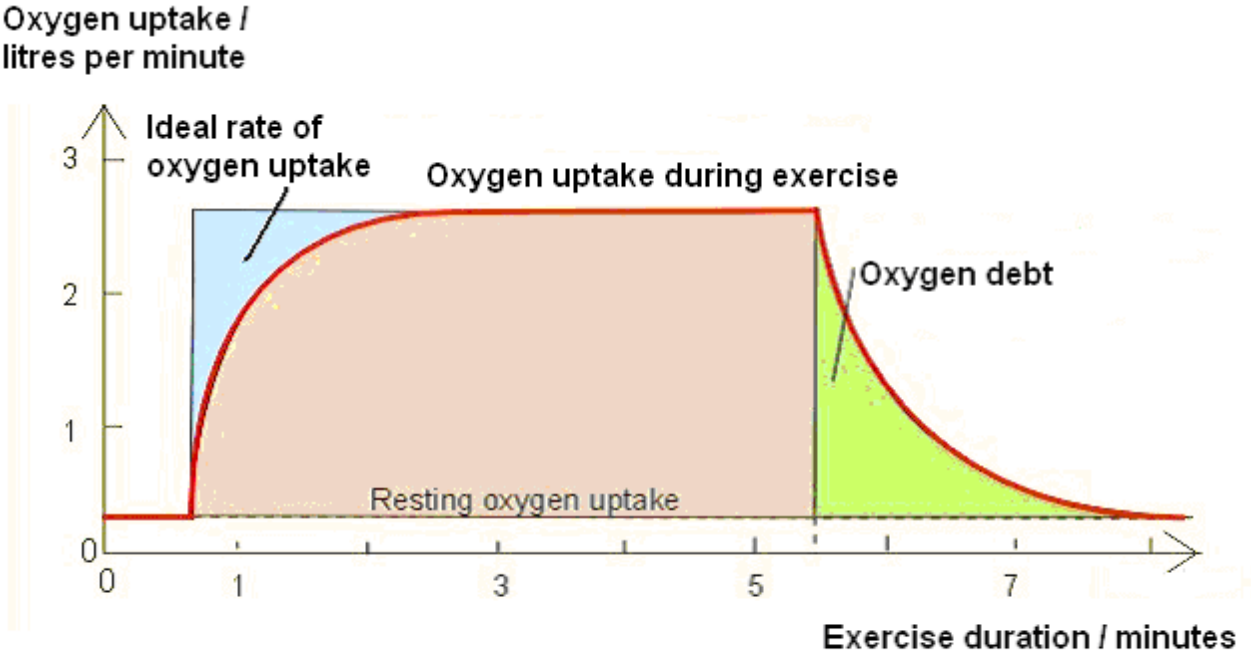
- During exercise, if insufficient oxygen is reaching the muscles they use anaerobic respiration to obtain energy.
- Anaerobic respiration is the incomplete breakdown of glucose and produces lactic acid.
- As the breakdown of glucose is incomplete, much less energy is released than during aerobic respiration.

glucose $\longrightarrow$ lactic acid + small amount of energy released

- However, lactic acid is poisonous. We can only tolerate small amounts in our body.
- If muscles are subjected to long periods of vigorous activity they become fatigued, ie they stop contracting efficiently.
- One cause of muscle fatigue is the build up of lactic acid in the muscles.
- Blood flowing through the muscles removes the lactic acid.
- During and after exercise, we breathe heavily to take in extra oxygen to oxidise the lactic acid:

lactic acid + oxygen $\longrightarrow$ carbon dioxide + water

- The extra oxygen is called the **oxygen debt.**
- The heart continues to pump faster.
- The breathing rate remains high.
- This delivers the extra oxygen to the muscles.
- This pays back the oxygen debt.

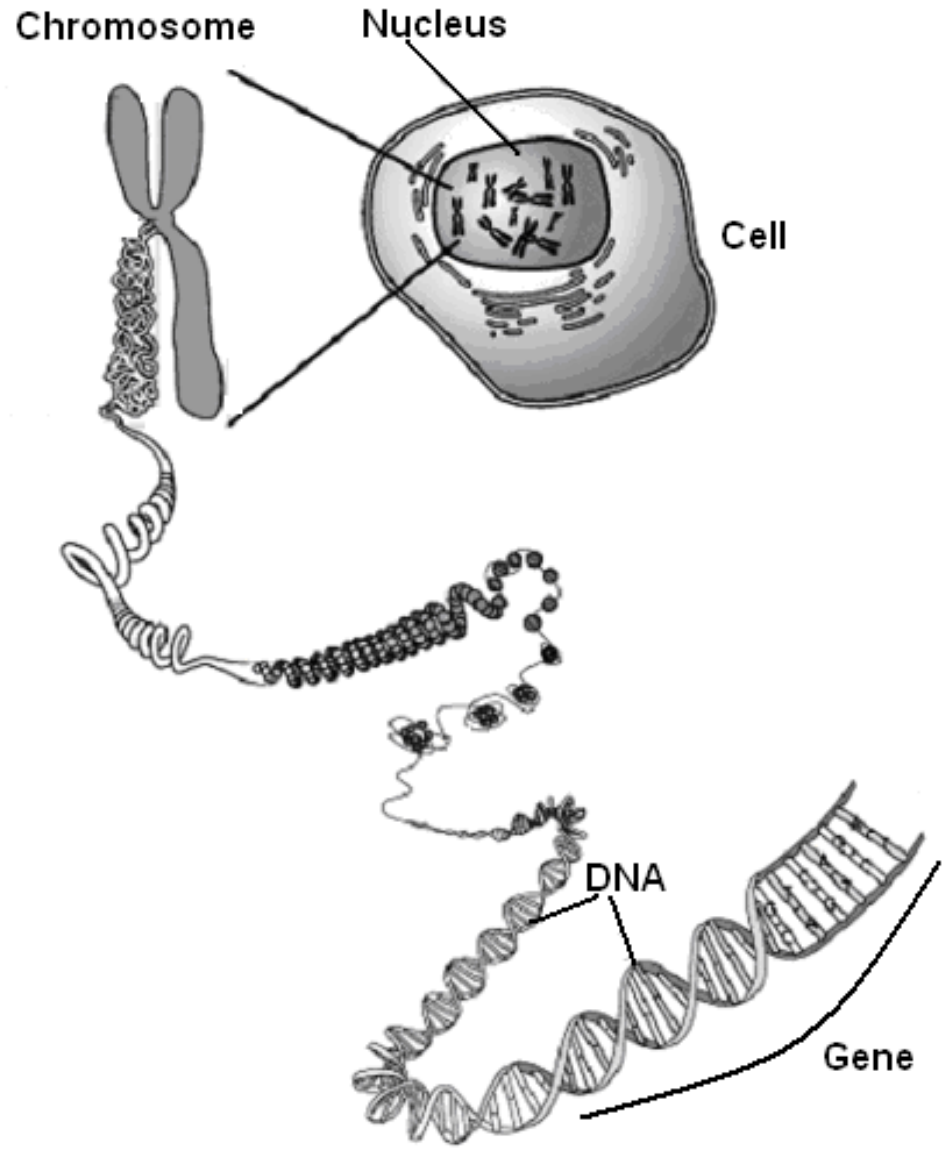


B2.7 Cell Division and inheritance

Summary
Characteristics are passed on from one generation to the next in both plants and animals. Simple genetic diagrams can be used to show this. There are ethical considerations in treating genetic disorders.

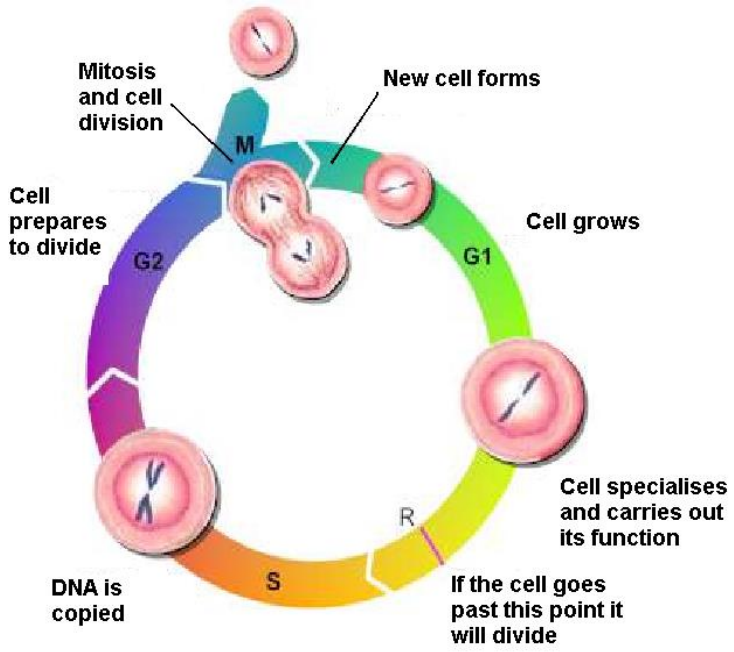
Genetic material

- In the nucleus of a typical human body cell there are 23 pairs of **chromosomes**.
- We inherit one set of 23 chromosomes from each of our parents.
- Chromosomes are made from a large molecule called **DNA** (deoxyribose nucleic acid).
- DNA consists of two strands coiled into a double helix structure.
- DNA has 2 main roles:
    1. It can replicate prior to cell division (mitosis or meiosis).
    2. Its code is used to synthesise proteins.
- A **gene** is a small section of DNA.
- Each gene codes for a particular combination of amino acids which make a specific **protein**.
- These proteins determine our characteristics.
- Some characteristics are controlled by a single gene.



Cell Division and Growth

- New body cells are produced:
  - When the animal is growing.
  - To repair damaged tissues.
  - To replace worn out tissues.
- Mitosis occurs:
  - All of the chromosomes are replicated.
  - The nucleus is divided in 2.
- This results in two **genetically identical** nuclei.
- The cell divides in 2 to form 2 genetically identical cells.
- Some cells undergo cell division again and again.
- Some cells carry out their function then die.



Asexual reproduction

- The cells of the offspring produced by asexual reproduction are produced by mitosis from the parental cells.
- They contain the same genes as the parents.

Cell differentiation

- Differentiation results when some genes are turned on, some are turned off.
- Once the cells are specialised they carry out their role.
- Most types of animal cells differentiate at an early stage.
- Many plant cells retain the ability to differentiate throughout life.
- In mature animals, cell division is mainly restricted to repair and replacement.

Stem cells

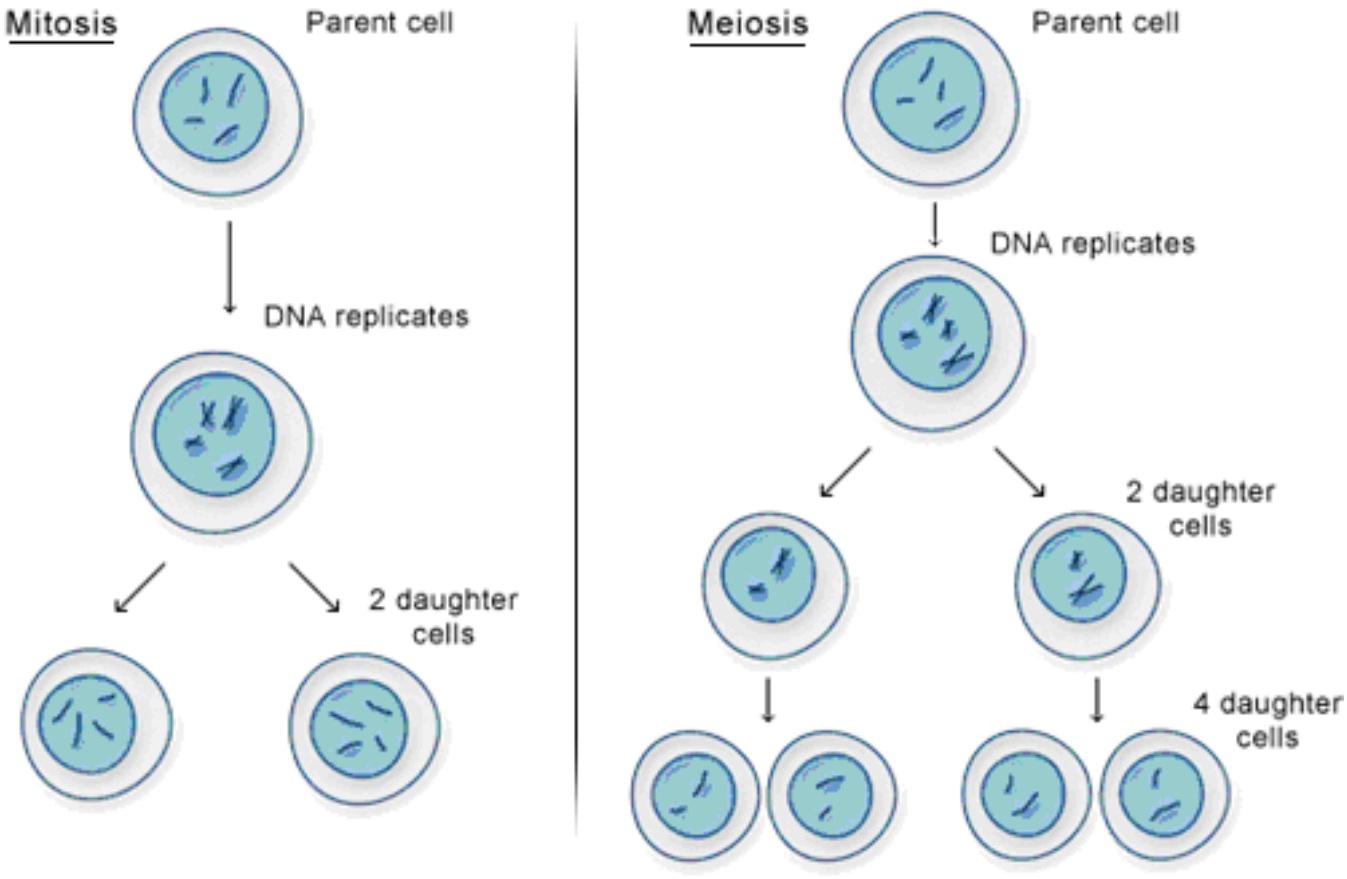
- **Stem cells** can be made to differentiate into many different types of cells e.g. nerve cells.
- There are very few stem cells in an adult.
- There is currently a lot of research involving the use of stem cells to treat various diseases and injuries.
- Cells can be taken from human embryos, adult bone marrow and umbilical cords.

- Treatment with these cells may help cure conditions such as paralysis.
- However, many people are concerned about the use of human embryos to treat diseases.
- They feel that all embryos have got the potential to become a baby, and that they should not be used in this way.

Sexual reproduction

Gamete formation

- Gametes are sex cells (sperm and egg cells).
- Sperm formed in the testes.
- Egg cells are formed in the ovaries.
- A cell containing a full set of chromosomes (chromosomes in pairs) divides to form cells with half the number set of chromosomes (a single set):
    - Meiosis occurs:
        - Copies of the chromosomes are made.
        - The nucleus divides twice to form 4 nuclei.
    - Then the cell divides twice to form four gametes.
        - Each has a single set of chromosomes.



Fertilisation

- When gametes join at fertilisation, a single body cell with new pairs of chromosomes is formed.
- A new individual then develops by this cell repeatedly dividing by mitosis.

Variation

Asexual reproduction leads to very little variation:

- Organisms that reproduce asexually create new individuals by mitosis.
- They are genetically identical to the parent.
- They may develop differently due to differences in their environment.

Sexual reproduction leads to much more variation:

- Meiosis ensures that all gametes contain the same genes, but have a different selection of alleles.
- Also, it is random which sperm fertilises which egg.
- Therefore all individuals (except for identical twins) produced sexually are genetically different.

Mendel's discoveries

- Mendel worked out the main principles of inheritance in the 19th century.
- He studied inheritance in pea plants.
- He noticed that certain characteristics that were shown by 2 pea plants were not always shown in their offspring.
- However, when he crossed these offspring together, the characteristics sometimes reappeared in the next generation.
- He carried out thousands of crosses with pea plants, and he found that many characteristics were inherited in predictable patterns.
- He proposed the idea of separately inherited factors:
    - Each individual inherits a set of factors from each of their parents.
    - It is the combination of these characters that determines the characteristics of an individual.
- Mendel's discoveries were not recognised until after his death – Why?
    - He published his work in an obscure journal
    - DNA, chromosomes and genes were not yet discovered
    - People could not accept the link between plants and humans.

Inheritance

- Each gene may have different forms called **alleles**.
- Eg. There is a gene for eye colour. Everyone has 2 copies of this gene. Alleles for eye colour may be blue, brown, green etc.
- Therefore each person may have 2 different alleles for eye colour.
- When we are conceived, we receive one copy of each gene from each parent.
- Therefore we have two copies of every gene, but they may be 2 different alleles.
- Different combinations of alleles may lead to differences in the characteristic.
- An allele, which controls the development of a characteristic when it is present on only one of the chromosomes, is a **dominant** allele.
- An allele, which controls the development of characteristics only if the dominant allele is not present, is a **recessive** allele.
- **Phenotype** is a description of how a characteristic is expressed. This can be influenced by genetic or environmental factors.
- **Genotype** is a description of the alleles an individual possesses for a characteristic.
- A **homozygous** genotype has 2 identical alleles.
- A **heterozygous** genotype has two different alleles for a gene.

Eg tongue rolling

- There is a gene that control our ability to roll our tongues.
- There are 2 alleles for this gene:
    - The allele that allows us to roll our tongues is dominant (R)
    - The allele that prevents tongue rolling is recessive (r)

Possible parent combination 1:

Parents' phenotypes:	tongue roller	X	non-tongue roller
Parents' genotypes:	RR	X	rr
Possible alleles in gametes:	R and R	X	r and r

At fertilisation, possible offspring genotypes:

	R	R
r	Rr	Rr
r	Rr	Rr

(This is called a Punnett square)

Offspring phenotypes: All tongue rollers (that carry the non-tongue rolling allele).

Possible parent combination 2:

Parents' phenotypes:	tongue roller (both carrying the non-tongue rolling allele)	X	tongue roller
Parents' genotypes:	Rr	X	Rr
Possible alleles in gametes:	R and r	X	R and r

At fertilisation, possible offspring genotypes:

	R	r
R	RR	Rr
r	Rr	rr

Offspring phenotypes: 3 tongue rollers : 1 non-tongue roller

- These are approximate ratios
- There is a 75% **chance** of a tongue roller being born in this family.
- There is a 25% chance of a non-tongue roller being born in this family.

Possible parent combination 3:

Parents' phenotypes: tongue roller (carrying the non-tongue rolling allele) X non-tongue roller

Parents' genotypes: Rr X rr

Possible alleles in gametes: R and r X r and r

At fertilisation possible offspring genotypes:

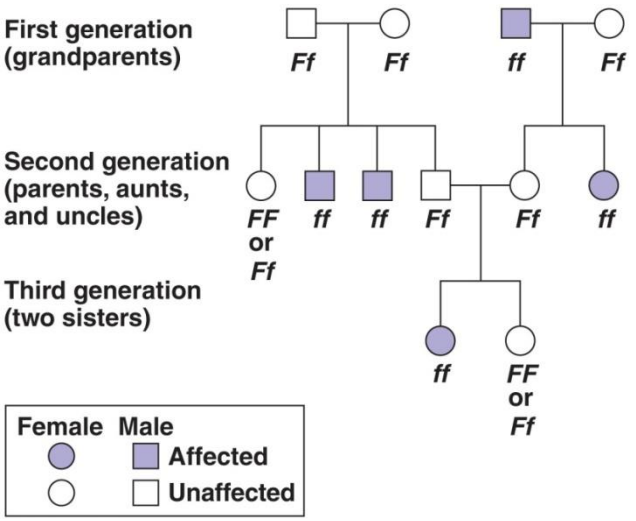
	R	r
r	Rr	rr
r	Rr	rr

Offspring phenotypes: 1 tongue roller : 1 non-tongue roller

- There is a 50% chance of a tongue roller being born in this family.
- There is a 50% chance of a non-tongue roller being born in this family.

<u>Family Trees</u>

- The inheritance of traits in families can be illustrated using a family tree
- In this example, the allele for attached earlobes is recessive.
- F = allele for detached earlobes
- f = allele for attached earlobes
- FF and Ff = genotypes for detached earlobes
- ff = genotype for attached earlobes



Inherited Conditions in Humans

Polydactyly:
- People that inherit this condition have extra fingers or toes.
- It is caused by a dominant allele of a gene.
- If someone inherits one copy of this allele, they will develop the disorder.
- It can therefore be passed on by only one parent who has the disorder.

Cystic fibrosis
- A disorder of cell membranes.
- It causes thick, sticky mucus to accumulate in the lungs and the digestive system.
- This causes:
    - Lung infections
    - Problems with breathing
    - Problems with digestion and absorption.
- It is caused by a recessive allele of a gene.
- The parents may be carriers of the disorder without actually having the disorder themselves.
- It can therefore be passed on by parents, neither of whom has the disorder.
- To develop the disease, the allele must be inherited from both parents.

Embryo screening
- People in families that have had certain genetic disorders can have a genetic test to see if they carry the allele for the disease.
- If they do carry the allele, their embryos can be screened to see if it is affected.
- They can then decide whether to have an abortion.
- This is very controversial.
- Also, many people are concerned about this because in the future it may enable people to choose other characteristics in their children.

Sex determination
- In human body cells, one of the 23 pairs of chromosomes carries the genes which determine sex.
- In females the sex chromosomes are the same (XX).
- In males the sex chromosomes are different (XY).

Parents' sex:	male	X	female
Parents sex chromosomes:	XY	X	XX
Possible chromosomes in gametes:	X and Y	X	X and X

At fertilisation:

	X	Y
X	XX	XY
X	XX	XY

- There is a 50% possibility of being a girl or a boy.
- As a foetus, we all start off with female characteristics.
- Presence of Y chromosome causes male development.
- Absence of Y chromosome continues female development.
- The sex of the baby is determined by the sex chromosome inherited from the father.

DNA Fingerprinting

- Each person (apart from identical twins) has unique DNA.
- Samples of DNA can be found in blood, semen and saliva.
- Special techniques are used to cut the DNA and then separate them according to length across a gel.
- Sequences within the DNA can be identified.
- Each individual's DNA produces a specific pattern.
- This can be used:
    - To identify criminals
    - To decide whether someone is the biological father of a child.

B2.8 Speciation

Summary

Changes in the environment of plants and animals may cause them to die out. The fossil record shows that new organisms arise, flourish, and after a time become extinct. The record also shows changes that lead to the formation of new species.

Origins of life

- The first organisms were very simple single-celled organisms, similar to bacteria.
- However, these rarely survive as fossils.
- Therefore, Scientists cannot be certain about how life began on Earth.
- It is only possible to develop theoretical models that show how life may have started.

Fossils

- We can learn from fossils how much or how little different organisms have changed as life developed on Earth.
- However, many early forms of life were soft-bodied, which means that they have left few traces behind.
- What traces there were have been mainly destroyed by geological activity.
- Fossils may be formed in various ways:
  - from the hard parts of animals that do not decay easily
  - from parts of organisms that have not decayed because one or more of the conditions needed for decay are absent
  - when parts of the organism are replaced by other materials as they decay
  - as preserved traces of organisms, eg footprints, burrows and rootlet traces.

Extinctions

- Various events can make it difficult for individuals to survive:
  - changes to the environment over geological time
  - new predators may arise
  - new diseases may arise
  - new, more successful, competitors may arise
  - a single catastrophic event, eg massive volcanic eruptions or collisions with asteroids**.**
- If the organisms cannot evolve quick enough to become better adapted to the change they may become extinct.
- If they do evolve, they are likely to develop into new species.

Speciation

- A species is defined as a group of organisms that are capable of breeding together to produce fertile offspring.
- New species arise as a result of:
  - Isolation – two populations of a species become separated, eg geographically.
  - Genetic variation – each population has a wide range of alleles that control their characteristics.
  - Natural selection - In each population, the alleles that control the characteristics which help the organism to survive are selected:

- The individuals with the most beneficial alleles are more likely to survive.
- They are more likely to reproduce and pass on their genes.
- Therefore, the beneficial alleles become more common in future generations.

- Over a long period of time, the populations may become so different that successful interbreeding is no longer possible.
- They have no become separate species.
- Speciation has therefore occurred.