Classification

Characteristics of Living Organisms

- **Movement**: an action or part of an organism causing a change of position or place
- **Respiration**: The chemical reactions that break down nutrient molecules in living cells to release energy for metabolism
- **Sensitivity**: Ability to detect or sense stimuli in the internal or external environment and to make appropriate responses
- **Growth**: Permanent increase in size and dry mass by an increase in cell number or cell size or both.
- **Reproduction**: processes that make more of the same kind of organism.
- **Excretion**: removal from organisms of the waste products of metabolism, toxic materials and substances in excess of requirements.
- **Nutrition**: taking in of materials for energy, growth and development

Concept and use of a classification system

- Organisms can be classified into groups by the features that they share
    - Due to being a descendant from a common ancestor
    - Originally classified using morphology (form and shape of the organism) and anatomy (detailed body structure as determined by dissection)
- **Species** are a group of organisms that can reproduce to produce fertile offspring
- Organisms which share a more recent ancestor (closely related) have base sequences in DNA that are more similar than those that share only a distant ancestor.
- The sequence of bases in DNA and amino acids in proteins are used as a more accurate means of classification.
    - DNA base sequences are used to code for amino acids sequences in proteins.
- Binomial naming system
    - Internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and the species
    - The first word (first part): Genus
        - The first letter is always capital
    - The second word: Species
        - All letters are lowercase
- The sequence of Classification (becoming more specific downwards)
    - Kingdom
    - Phylum
    - Class
    - Order
    - Family
    - Genus
    - Species

Features of Organisms

- All living Organisms contain:
    - Cytoplasm
    - Cell membrane
    - DNA as genetic material
    - Ribosomes for protein synthesis
    - Enzymes for respiration

- Five Kingdoms
    - Viruses are not a part of any classification as they are considered non-living
        - Contain only genetic material and a protein contain
    - Animals
        - Multicellular, contain a nucleus
        - Feed on organic substances
    - Plants
        - Multicellular, contain a nucleus
        - Have a cell wall made of cellulose and chloroplast
    - Fungi
        - Multicellular, have a nucleus
        - Have a cell wall
        - Feed on dead or decaying material, saprophytic or parasitic nutrition

    - Protoctists
        - Unicellular, have a nucleus
        - Some have cell walls and chloroplasts

    - Prokaryotes
        - Often unicellular
        - Have cell walls and cytoplasm but **no nucleus or mitochondria**

CLASSIFICATION OF ARTHROPODS

ARACHNIDS

EIGHT LEGS, TWO BODY PARTS, NO ANTENNAE.

(SPIDER, SCORPION)

CRUSTACEANS

MOSTLY SEA CREATURES. MANY LEGS AND TWO SETS OF ANTENNAE.

(CRAB, LOBSTER)

INSECTS

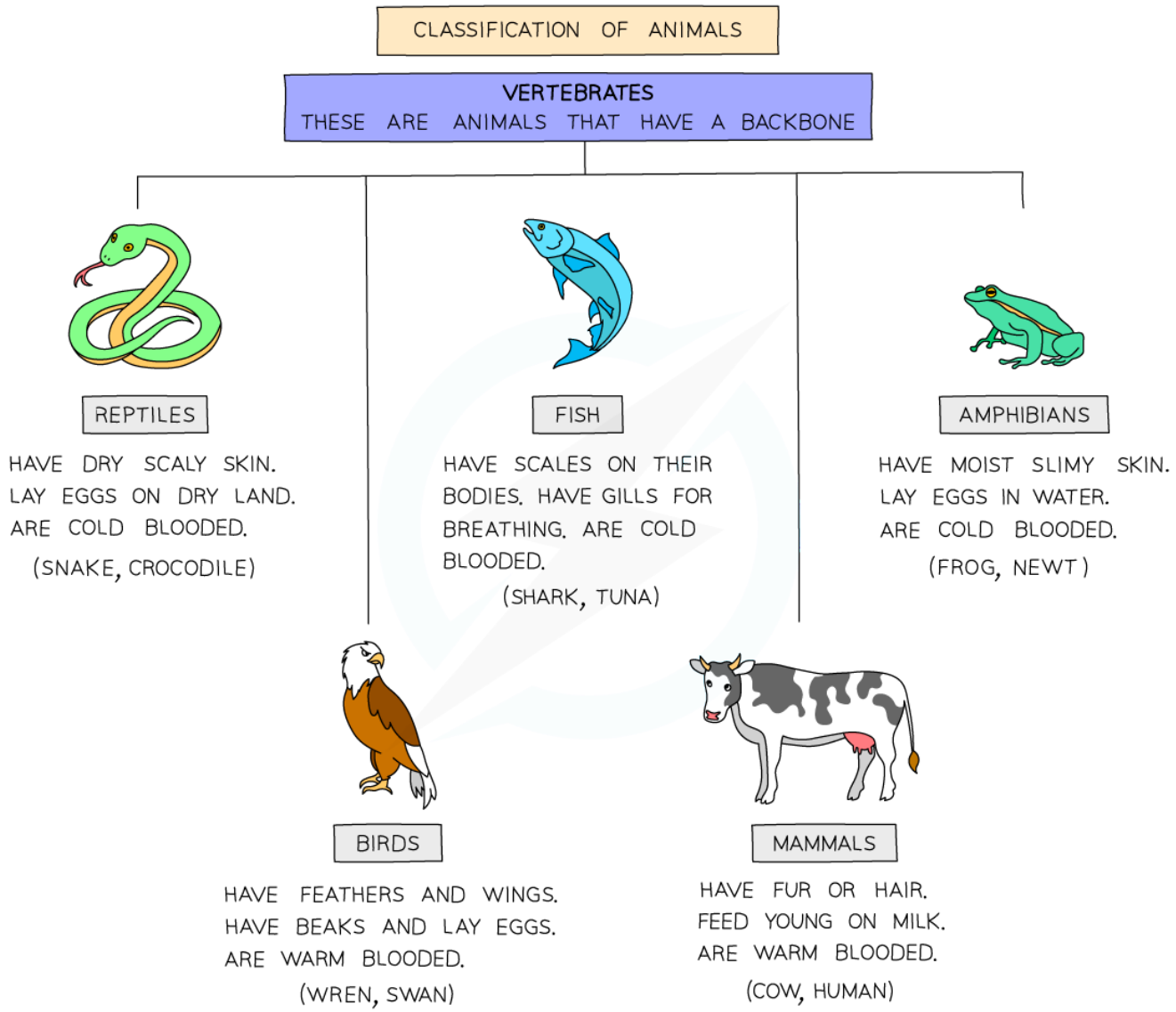
WINGS, SIX LEGS, THREE BODY PARTS, ONE PAIR OF ANTENNAE

(BEE, LADYBIRD)

MYRIAPODS

MANY LEGS AND BODY SEGMENTS.

(CENTIPEDE, MILLIPEDE)



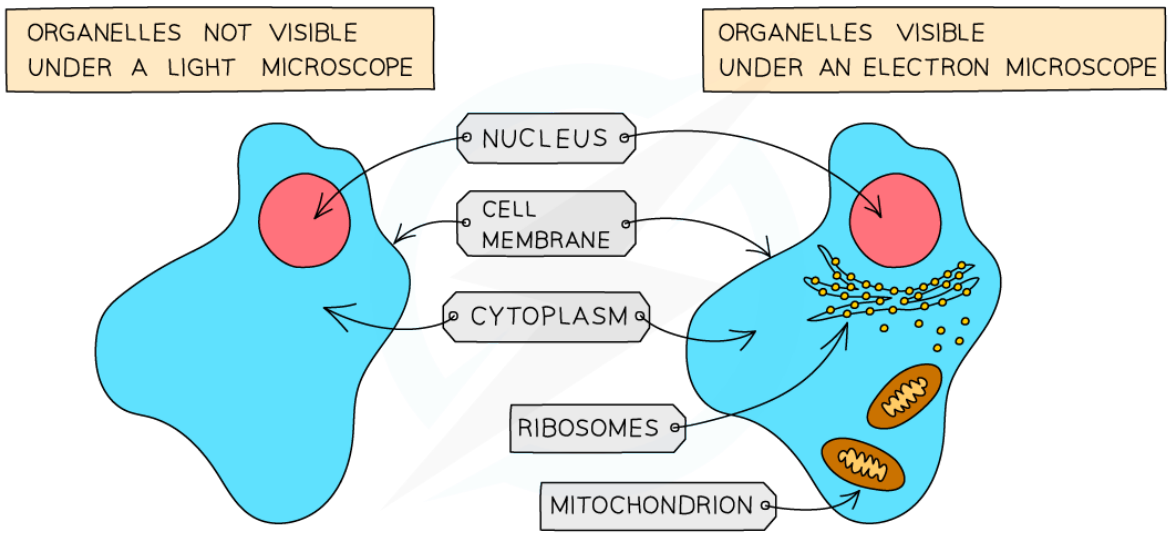
Classifying plants

- 3 main types
  - Ferns
    - Have leaves called fronds
    - Do not produce flowers reproduce by spores
  - Flowering Plants
    - Monocotyledons and Dicotyledons
      - Reproduce by sexually means of flowers and seeds
      - Seeds are produced inside ovary found at the base of the flower
    - Distinguish monocotyledons and Dicotyledons

- Flowers
    - Flowers from monocotyledons contain petals in multiples of 3
    - Flowers from dicotyledons contain petals in multiples of 4 or 5
- Leaves
    - Leaves from monocotyledons have **parallel leaf veins**
    - Leaves from dicotyledons have **reticulated leaf veins**

Cell Structure & Organisation

- The cytoplasm is found inside the cell of all endoplasmic reticulum
    - Contain ribosomes on rough endoplasmic reticulum and vesicles
- The large nucleus is surrounded by a nuclear membrane to separate it from the cytoplasm
- The cell membrane surrounds the cell
- Comparing plant and animal cells



Subcellular structure	Function
Nucleus	• Contain genetic material responsible for cell growth and work • Controls cell division
Cytoplasm	• Supports cell structures • Site of many chemical reactions

Cell membrane	• Holds cell together • Controls substances entering and leaving the cell
Cell wall	• Gives the cell extra support and defines its shape
Chloroplasts	• Site of photosynthesis, providing food for plants • Absorbs light energy for the reaction
Vacuole	• Contains cell sap • Used for storage of certain materials • Helps support the shape of the cell
Mitochondria	• aerobic respiration occurs here • Provides cell with energy • Cells with high rates of metabolism have more mitochondria
Ribosomes	• Site protein produce in protein synthesis
Vesicles	• Used to safely transport substances from one part of the cell to another

Levels of Organisation

- Cells: Basic functional and structural units in a living organism
- Tissues: Groups of cells of similar structure working together to perform the same function
- Organs: Made from different tissues working together to perform specific functions
- Organ systems: Groups of organs with related functions, working together to perform body functions.

Size of specimen calculation

- Magnification = Image size / Actual size
- 1mm = 1000 micrometers
- 1 cm = 10 mm

Movement in & out of cells

- Diffusion
    - Diffusion is the movement of molecules from a region of its higher concentration to a region of its lower concentration
    - Molecules move down a concentration gradient, as a result of their random movement
    - For living cells, the cell membrane is a **partially permeable membrane**
        - Allows some molecules to cross easily

    - Diffusion helps to:
        - Obtain many of their requirements
        - Get rid of their waste products
        - Carry out **gas exchange for respiration**

- Brownian Motion
    - All particles move randomly at all times
    - Energy for diffusion from the kinetic energy of this random movement of molecules and ions.

- Factors that influence diffusion
    - Surface area to volume ratio
        - Smaller the ratio the lower the rate of diffusion
    - Distance
    - Temperature
    - Concentration Gradient

Osmosis

- Osmosis is the net movement of water molecules from a region of higher water potential (dilute solution) to a region of lower water potential (concentrated solution), through a partially permeable membrane.
- Down a concentration gradient.
- When a plant has a very low water potential and the outside has a higher water potential the water moves into the cell this causes the cell to become turgid. If this were an animal cell it would have burst.
- If a cell has a higher water potential than its surroundings, it causes the water to go out and so the cell loses all its water causing it to become plasmolyzed.
- Importance of water in tissues:
    - Pushing the cell membrane against the cell wall
    - Makes cell rigid and firm
    - Provide support and strength for the plant (if very little water is there plant **wilts**)
    - The pressure created by the cell wall stops too much water entering and prevents the cell from bursting.
    - Xylem transports water by maintaining a concentration gradient due to transpiration.

Active Transport

- Active transport is the movement of particles through a cell membrane from a region of lower concentration to a region of higher concentration using energy from respiration
- Energy is required to move against a concentration gradient
- Examples of Active Transport
    - **Uptake of glucose** by epithelial cells in the villi of the small intestine and by kidney tubules in the nephron.

- **Uptake of ions** from soil water by root hair cells in plants

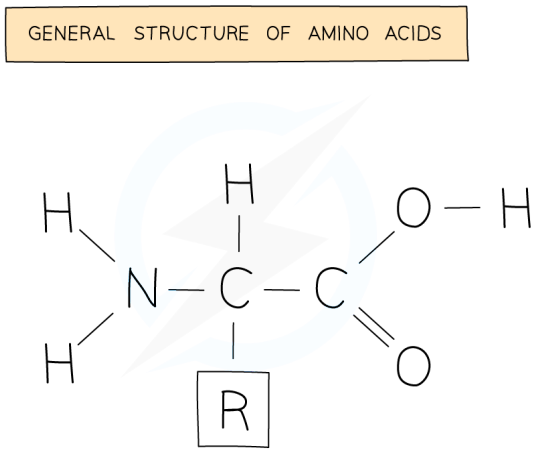
- How Protein Molecules Move particles
  - Active transport works by using carrier proteins embedded in the cell membrane to pick up specific molecules and take them through the cell membrane against their concentration gradient
    - Substance combines with protein molecule in the cell membrane
    - Carrier transports substances across the membrane using energy from respiration to give them the kinetic energy needed to change shape and move the substance through the cell membrane.

Biological Molecules

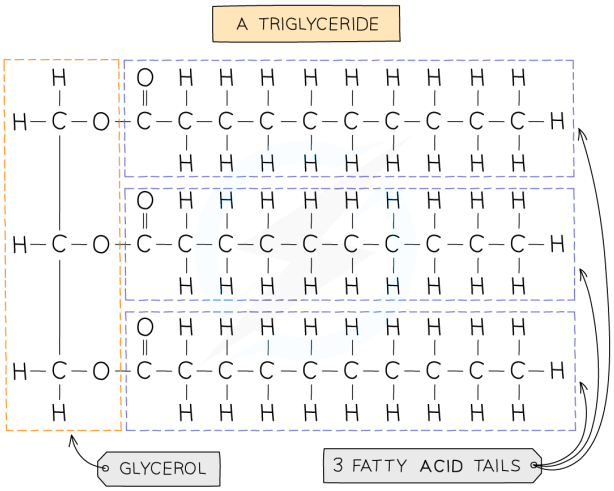
Biological Molecule	Chemical elements
Carbohydrates	Carbon, Oxygen and Hydrogen
Protein	Oxygen, Hydrogen and Nitrogen (some contain other elements)
Lipid	Carbon, Oxygen and Hydrogen

- **Large molecules are made from smaller molecules**
  - Starch, glycogen and cellulose from glucose
    - Carbohydrates
    - Glucose is a simple sugar
    - When lots of **glucose molecules join together** starch, glycogen and cellulose can form. (polysaccharides).

- Proteins from amino acids
  - Long-chain of **amino acids**
  - There are about 20 different amino acids
  - They all contain the same basic structure but the **'R'** group is different for each one
  - The amino acids can be arranged in any order, resulting in hundreds of thousands of different proteins
  - Even a small difference in the order of the amino acids results in a different protein being formed



- Fats and oils from fatty acids and glycerol
    - Most fats (lipids) in the body are made up of **triglycerides**
    - Their basic unit is **1 glycerol molecule chemically bonded to 3 fatty acids chains**
    - Fatty acids vary in size and structure
    - Lipids are divided into **fats** (solids at room temperature) and **oils** (liquids at room temperature)



- Protein shapes
    - Different sequences of amino acids cause the polypeptide chains to **fold in different ways** and this gives rise to different shapes of proteins
    - In this way, every protein has a unique 3-D shape that enables it to carry out its function.

- Why protein shapes matter
    - Enzymes (biological catalysts, made of proteins) have an area in them known as the **active site,** where another molecule fits in if the shape was different this would not occur
        - Every Enzyme has a different shaped active site
    - Antibodies are proteins produced by a certain type of **white blood cell** to attach to antigens on the surface of pathogens
        - The shape of the antibody must watch the shape of the antigen so that it can attach to it and signal it for destruction

Test for glucose (a reducing sugar)	• Add Benedict's solution into sample solution in a test tube • Heat at 60 - 70 Celsius in a water bath for 5 minutes • Take test tube out of the water bath and observe the colour • A positive test will show a colour change from blue to orange or brick red
Test for starch using iodine	• Add iodine solution to the food sample • A positive test will show a colour change from **orange-brown to blue-black** • Colour of iodine: Orange-brown
Test for protein	• Add drops of Biuret solution to the food sample • A positive test will show a colour change from **blue to violet**
Test for lipids	• The food sample is mixed with **2cm^3 of ethanol** and shaken • The ethanol is added to an equal volume of cold water • A positive test will show a cloudy emulsion forming

Test for Vitamin C	● Add **1cm^3 of DCPIP solution** to a test tube ● Add a small amount of food sample (as a solution) ● A positive test will show the blue colour of the dye disappearing

- DNA structures
    - **Deoxyribonucleic acid** is the molecule that contains the instructions for growth and development of all organisms
    - It consists of two strands of DNA wound around each other in what is called a **double helix**
    - Each strand contains chemicals called **bases**
    - Cross-links between strands are formed by a pair of bases
    - The individual units of DNA are called **nucleotides**
    - Cross-links between strands are formed by a pair of bases
    - All nucleotides contain the same phosphate and deoxyribose sugar, but differ from each other in the **base** attached
    - There are four bases:
        - Adenine (A)
        - Cytosine (C)
        - Thymine (T)
        - Guanine (G)
    - Bases on each strand pair up with each other, holding the two strands of DNA in a double helix structure
    - Bases always pair up in the same way
        - Adenine always pairs with Thymine **(A-T)**
        - Cytosine always pairs with Guanine **(C-G)**

    - The phosphate and sugar section of the nucleotides form the **'backbone' of the DNA** strand (like the sides of a ladder) and the base pairs of each strand connect to form the rungs of the ladder
    - It is this sequence of bases that holds the code for the formation of proteins

- Role of Water within Organisms
    - Substances dissolved can be transported around organisms (use in xylem and phloem)
    - Digested food molecules are in the alimentary canal but need to be moved to cells all over the body which requires water
    - A toxic substance such as urea and substances in excess can dissolve in water to make it easy to remove from the body
    - Water is also important for the cytoplasm and plays a role in ensuring a metabolic reaction occurs

Enzymes

- A catalyst is a substance that increases the rate of a chemical reaction and is not changed by the reaction
- Enzymes as proteins that function as a biological catalyst
- Why are Enzymes important?
    - Enzymes are necessary to all living organisms as they maintain reaction speeds of all metabolic reactions at a rate that can sustain life.

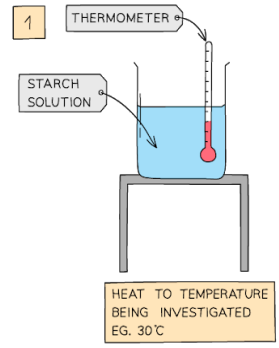
- How Do Enzymes Work?
    - Enzymes are specific to one specific substance called a **substrate** (the substrate is broken down)
        - As the active site (where enzyme and substrate bind)
        - The shape of the active site is the complementary shape of the 3-D Shape
        - This is known as the **lock and key hypothesis**
    - When the substrate moves into the enzyme's active site they became known as the **enzymes-substrate complex**
    - After the reaction has occurred, the products leave the enzyme's active site as they no longer fit and it is free to take up another substrate.
    - Enzymes and substrates randomly move about in solution
    - A **product** forms from the substrate which is then released from the active site.
    - The enzyme is unchanged and will go on to catalyse further reactions

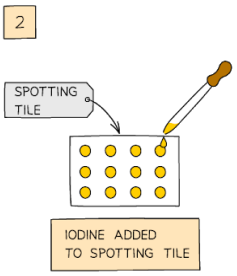
- Effect of Temperature on Enzyme functions
    - Enzymes are **proteins** and have a **specific shape**, held in place by **bonds**
        - This is very important for the active site area as it ensures the substrate will **fit into the active site**

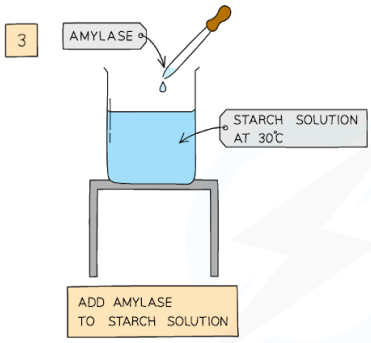
    - Enzymes work fast at their **optimum temperature**, for most enzymes, it is 37℃
    - If enzymes are exposed to very high temperature it causes the bonds in the enzyme to break, this is known as **denaturation**
        - Irreversible process

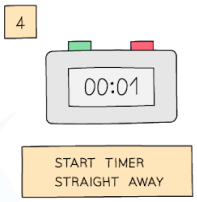
- Effect of pH of Enzyme Functions
    - The optimum pH for **most** enzymes is **pH 7**
    - If pH is too high or low, the bonds that hold the amino acid chain together to make up the protein can be destroyed.
        - This will **change the shape of the active site**, so the substrate can no longer fit into it
        - Moving too far away from optimum pH will cause the **enzyme to denature** and activity will stop

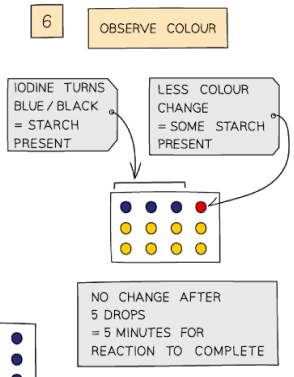
- Enzyme investigations
    - Amylase is an enzyme that digests starch (polysaccharide of glucose) into maltose (a disaccharide of glucose)
    - Starch can be tested for easily using **iodine solution**
    - Testing amylase

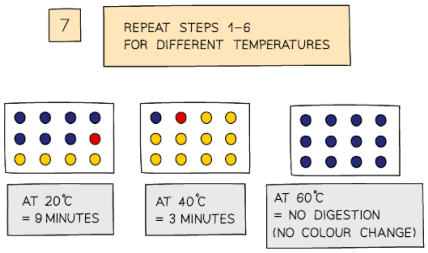


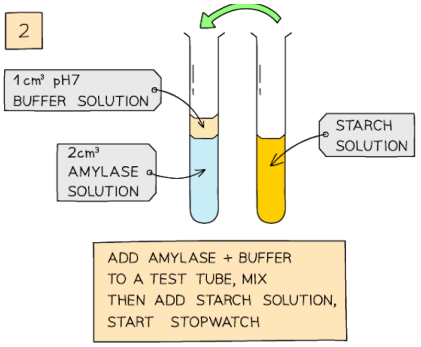


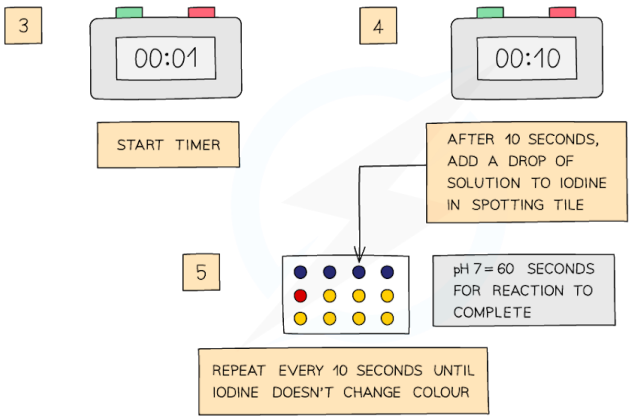


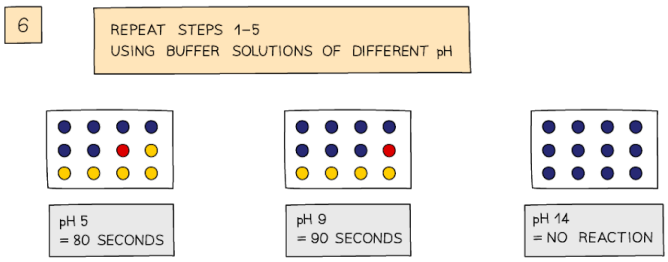












Plant Nutrition

- Photosynthesis is the process by which plants manufacture carbohydrates from raw materials using energy from light
- Carbon dioxide + Water => Glucose + Oxygen
- $6CO_2 + 6H_2O \Rightarrow C_6H_{12}O_6 + 6O_2$
    - Put the light on top of the arrow and chlorophyll at the bottom
- Occurs in presence of chlorophyll and sunlight
- The **light energy** is converted into **chemical energy** in the **bonds** holding the atoms in the glucose molecules together
- Uses of glucose made in photosynthesis
    - Plants use the glucose they make as a **source of energy** in **respiration**
    - They can also convert it into **starch** for storage
    - Converted into cellulose to make the cell wall
    - Or into amino acids when they combine with nitrogen and other mineral ions

Investigating Photosynthesis

- Plants make glucose but it is not easy to test for glucose so instead, we test for starch
- Procedure:
    - The leaf is first dropped in boiling water
        - Kills and breaks down cell wall
    - It is left for 10-15 minutes in hot ethanol
        - Removes chlorophyll
    - The leaf is dipped in boiling water
        - Softens it
    - The leaf is spread out on a white tile and covered with iodine solution
        - Starch test
    - In all parts of the leave that have starch due to photosynthesis, the colour will change to blue/black
- This method can be used to test for **Carbon dioxide and light**
- Investigating the rate of photosynthesis
    - Easier to use aquatic plants such as Elodea or Camboba
    - As photosynthesis occurs oxygen is produced
        - So oxygen the volume or the number of bubbles of oxygen can be used to find the rate of reaction

- Limiting factors
    - Limiting factor as something present in the environment in such short supply that it restricts life processes
- Limiting factors are
    - Temperature
        - Required for enzymes to function properly but if it is too high the enzyme can denature
            - Enzymes help the reaction occur so without the rate of reaction is reduced
    - Light intensity
        - The more light it receives, the faster the rate of photosynthesis
            - This trend will continue until some other factor required for photosynthesis prevents the rate from increasing further because it is now short in supply
        - After a certain intensity of light, the rate will become constant
        - In a graph the line goes up and then becomes constant
            - Y = rate of reaction, X = carbon dioxide concentration
            - Carbon dioxide concentration
                - More carbon dioxide, faster the rate of reaction
                - This trend will continue until some other factor is required for photosynthesis
                - In a graph the line goes up and then becomes constant
                    - Y = rate of reaction, X = carbon dioxide concentration

- Changing Glasshouse Condition
    - Control factors in glass houses are used to ensure maximum crop yields for farmers
    - How conditions are manipulated:
        - Artificial heating
        - Artificial lighting
        - Increasing carbon dioxide content
        - Regular watering
    - Farmers have to consider the extra cost of these against the increased income
    - In tropical countries where temperatures are much hotter, glasshouses may still be used to control other conditions however they may need to be ventilated to release hot air and avoid temperatures **rising too high**
        - The enzymes could denature if not done

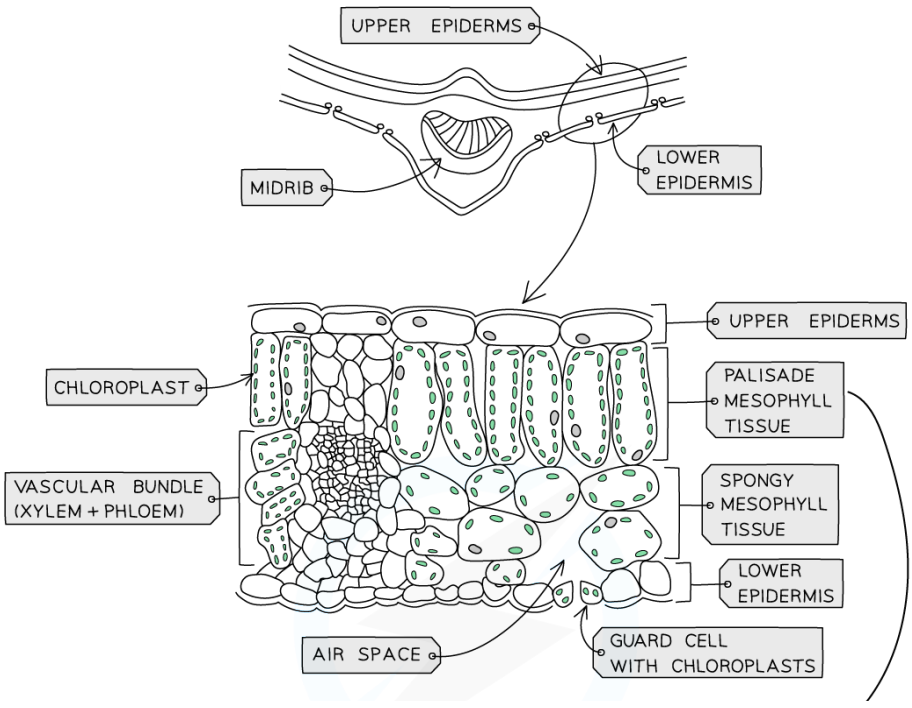
- Effect of light on Net Gas exchange
    - Plants are respiring all the time during the day
    - During the night, plants do not photosynthesis
    - So plants are photosynthesising at a faster rate than they are respiring,
    - The rate of photosynthesis is greater than the rate of respiration
    - We can investigate the effect of light on net gas exchange in an aquatic plant using the pH of the plant
        - Carbon dioxide is slightly acidic
    - We use a hydrogencarbonate indicator
    - The indicator is added to the the water (only for aquatic plants)
    - Other indicators are Phenolphthalein,

CONCENTRATION OF CARABON DIOXIDE	COLOUR OF HYDROGEN CARBON INDICATOR		CONDITIONS IN PLANT
HIGHEST	YELLOW		MORE RESPIRATION > PHOTOSYNTHESIS – LOWER pH (MORE ACID)
HIGHER	ORANGE		
ATMOSPHERIC LEVEL	RED		PHOTOSYNTHESIS = RESPIRATION
LOWER	MAGENTA		MORE PHOTOSYNTHESIS > RESPIRATION – HIGHER pH (MORE ALKALINE)
LOWEST	PURPLE		

TUBE	CONTENTS	CONDITIONS	INDICATOR TURNS	CONCLUSION
A	LEAF	LIGHT	PURPLE	THERE IS A NET INTAKE OF OXYGEN BY A LEAF IN LIGHT
B	LEAF	DARK	YELLOW	THERE IS A NET INTAKE OF CARBON DIOXIDE BY A LEAF IN THE DARK
C	NO LEAF	LIGHT	RED	THIS IS THE CONTROL – THE TWO OTHER TUBES CAN BE COMPARED WITH IT

Leaf structure

- A leaf contains Multiple types of cells



Structure	Description
Wax Cuticle	**Protective layer** on top of the leaf, prevents water from evaporating
Upper epidermis	Thin (for quick diffusion) and transparent to allow light to enter palisade mesophyll layer underneath
Palisade Mesophyll	Column shaped cells tightly packed with chloroplasts to absorb more light for maximising photosynthesis, chloroplasts contain chlorophyll to absorb light energy for photosynthesis
Spongy Mesophyll	Contains internal air spaces that increases the surface area to volume ratio for the diffusion of gases (mainly carbon dioxide)
Lower epidermis	Contains guard cells and stomata
Guard cell	Absorbs and loses water to open and close the stomata to allow carbon dioxide to diffuse in, oxygen to diffuse out
Stomata	Where gas exchange takes place; opens during the day, closes during the night, evaporation of water also takes place from here. In most plants, found in much greater concentration on the underside of the leaf to reduce water loss. Allows gaseous exchange carbon dioxide (in) and oxygen (out)
Vascular bundles	Contains Xylem and Phloem to transport substances to and from the leaf, The thick cells walls of the tissue in the bundles help to support the stem and leaf
Xylem	Transports water into the leaf for mesophyll cells to use in photosynthesis and for transpiration from stomata. They lose their end walls so the xylem forms a continuous hollow tube and have tough walls containing a material called lignin
Phloem	Transports sucrose and amino acids around the plant

- Leaves have large surface area for the diffusion of carbon dioxide and absorption of light for photosynthesis

Mineral requirements

- Plants need to make proteins as they cannot consume them
    - the ions required to make them are absorbed through the soil by root hair cells
        - Combine with carbohydrates from photosynthesis to make require substances

Mineral Ion	Function	deficiency
Magnesium	Magnesium is needed to make chlorophyll	Causes the yellowing between the veins of leaves
Nitrate	Nitrates are a source of nitrogen needed to make amino acids to build proteins	Causes stunted Growth and yellowing of leaves

Human Nutrition

- Balanced Diet
    - Consists of all of the food groups in the proportions required
    - The necessary food groups are:
        - Carbohydrates
            - Source of energy
            - Bread, Cereals, pasta, rice
        - Proteins
            - Growth and repair
            - Meat, fish, eggs
        - Lipids
            - Insulation and energy storage
            - Butter or nuts
        - Vitamins
            - Needed in small quantities to maintain health
            - Fruits and vegetables
        - Minerals
            - In small quantities to maintain health
        - Dietary Fibre
        - Water
            - Needed for chemical reactions to take place in the cell
            - Juice, milk, water, fruits and vegetables

    - Vitamins/minerals
        - Vitamin C
            - Forms an essential part of collagen protein, which makes up skin, hair, gums and bones
            - Citrus fruits, strawberries, green vegetables
        - Vitamin D
            - Helps the body to absorb calcium and so required for strong bones and teeth
            - Oil fish, liver, dairy products, also made naturally by the body in sunlight
            - Deficiency causes **Rickets** - Bones become soft and deformed
        - Calcium
            - Needed for strong teeth and bones and involved in the clotting of blood
            - Milk, cheese, eggs

        - Iron
            - Needed to make hemoglobin
                - The pigment in red blood cells
            - Red meat, liver, leafy green vegetables like spinach
            - Deficiency causes **Anemia** - Where there are not enough blood cells this causes tissues to not receive enough blood

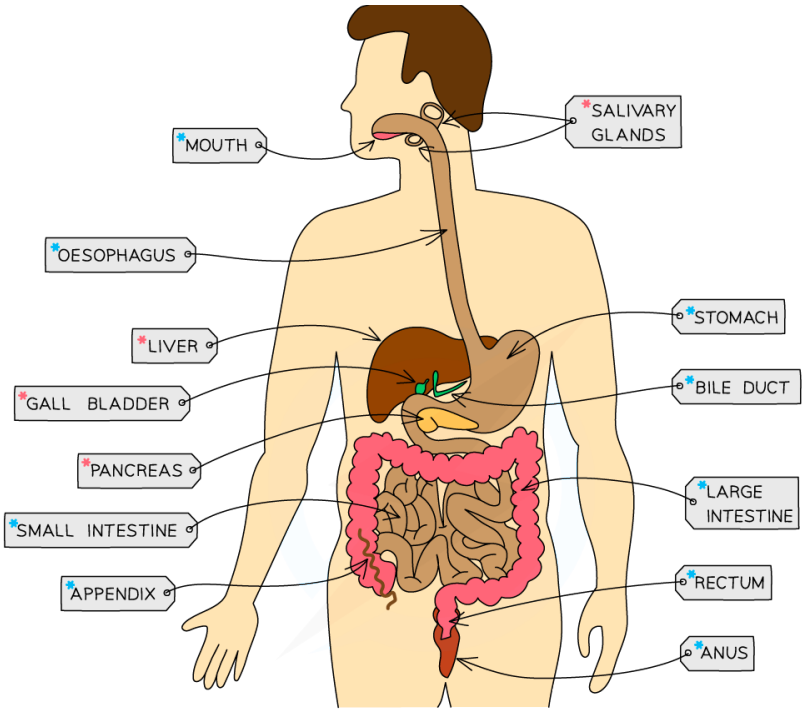
- Effects of Malnutrition
    - Caused by not eating a balanced diet
    - There are different types of malnutrition depending on the cause of the imbalance
        - Starvation,
            - Taking in less energy than used over a long period of time
            - Body starts to break down energy stores - First fat and then muscle tissue, leading to severe weight loss and eventually damage to heart and immune system increasing the risk of many diseases
        - CHD
            - Diet too high in saturated fat and cholesterol
            - Fat deposits build up around the coronary artery and thus blocking the supply of blood heart
        - Constipation,
            - Lack of fibre in the diet
            - Food lacks bulk for muscles to push it through the alimentary canal and so risk of diseases such as bowel cancer are increased
        - Obesity
            - Taking more energy than used
            - Weight increase, contribute to heart disease and diabetes
- Protein energy malnutrition
    - Very common type of malnutrition
        - Kwashiorkor
            - Caused by lack of protein,
                - People who suffer from this are underweight and they often have a swollen abdomen as their diet may contain a lot of carbohydrate
        - Marasmus
            - Lack of protein and energy
                - People who have this have a much lower body weight and look emaciated

- Dietary needs of different individuals
    - Age
        - Young people need more energy to grow so their intake increases over time
        - Adults require less energy as they age
    - Activity levels
        - More activity done, the more energy required as more energy is used up during activity

- Pregnancy
    - During pregnancy, energy requirements increase as energy is needed to support the growth of the developing foetus, as well as the larger mass that the mother needs to carry around.
    - Extra calcium and Iron are also needed in the diet to help build bones, teeth and blood of the fetus
- Breastfeeding
    - Energy requirements increase and extra calcium still needed to make high quality breast milk

Alimentary canal

- **Ingestion** is the taking of substances into the body through the mouth
- **Mechanical digestion** is the breakdown of food into smaller pieces without chemical change
- **Chemical digestion** is the breakdown of large, insoluble molecules into small, soluble molecules
- **Absorption** is the movement of of small food molecules and ions through the wall of the intestine into the blood
- **Assimilation** is the movement of digested food molecules into the cells of the body where they are used, becoming part of the cells
- **Egestion** is the passing out of food that has not been digested or absorbed, as faeces, through the anus



Mouth/Salivary glands	The mouth is where **mechanical digestion** takes place, teeth chew food to break it into smaller pieces and increase its surface area to volume ratio
Oesophagus	Tube that **connects the mouth to the stomach** where the food bolus goes after being swallowed
Stomach	Food is mechanically digested by **churning** actions while **protease enzymes** start to chemically digest proteins. Hydrochloric acid is present to kill bacteria in food and provide the optimum pH for protease enzymes to work. Also releases thick layer of mucus to protect stomach cells from HCl

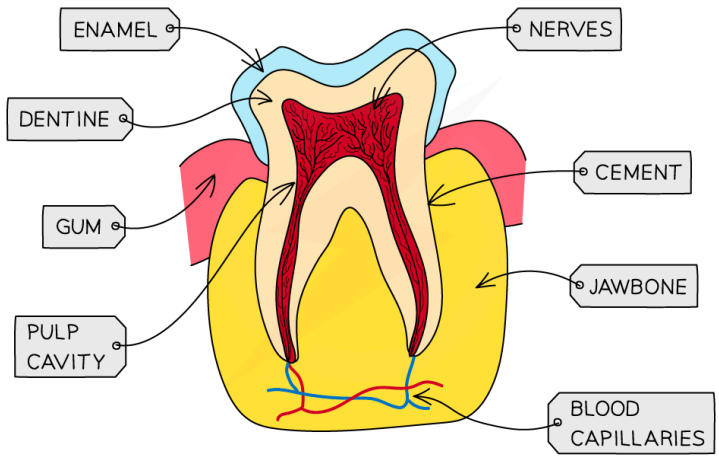
Small intestine	First section is called the **Duodenum** and is where the food coming out of the stomach finishes being digested by enzymes produced here and also secreted from the pancreas. Small intestine = pH 8-9 Second Section is called the **Ileum,** where absorption of digested food molecules takes place, the **ileum** is long and lined with villi to increase surface area over which absorption takes place
Large Intestine	**Water is absorbed** from remaining material in the colon to produce faeces. Faeces is stored in the **rectum** and removed through the anus
Pancreas	Produces three enzymes that secrete into the small intestine: amylase, protease and lipase
Liver	Produces Bile to Emulsify fats (mechanical digestion) and amino acids not used are converted to urea (deamination)
Gallbladder	**Store Bile** to release into duodenum as required

Diarrhoea causes & Treatment

- **Diarrhoea** is the loss of watery faeces
- If it is severe and continuous for a long time, it **can lead to death**
- Severe diarrhoea can cause the **loss of water and ions**
- Treatment is **oral rehydration therapy**
    - Drink that contains salt and sugar dissolved in it
- There are many causes of diarrhoea, one of which is infection with **Vibrio cholerae bacteria,** which causes the diseases **cholera**
    - Ingested via food or water
- How Does Vibrio Cholerae Cause Diarrhoea?
    - Bacteria attach to the wall of small intestine
    - Start producing a toxin
    - The toxin stimulates the cells lining the intestine to release chloride ions from inside the cells into the lumen of the intestine
    - The chloride ions accumulate in the lumen of the small intestine and **lower the water potential** there
    - Once the water potential is lower than that of the cells lining the intestine, water starts to move out of the cells into the intestine, water starts to move out of the cells into the intestine
    - Large quantities of water are lost from the body in **watery faeces**
    - The blood contains **too little chloride ions and water**

Mechanical Digestion

- Carried out by the chewing action of the teeth, the churning action of the stomach and emulsification by bile in the duodenum
- Teeth
    - They are used for increasing the surface area of the food so that it can be exposed to saliva (amylase) and other digestive juices and broken down more quickly
- Types of teeth structures
    - Incisors
        - chisel -shaped for biting and cutting
    - Canines
        - Pointed for tearing, holding and biting
    - Premolars and molars
        - Large and flat surfaces with ridges at the edges for chewing and grinding up food



- Dental Decay
    - Tooth decay and gum disease are both caused by bacteria
    - Many bacteria live in the moth and most are harmless, however some form a sticky film with saliva called **plaque,** which coats teeth and the areas where they attach to gums
        - It is easy to remove by brushing, however if it hardens and forms tartar
    - Tartar around the edges of teeth and gums can allow bacteria to work their way into roots, causing **gum disease** and loss of teeth
    - If sugar is left in the mouth after eating, bacteria in plaque will feed on it
        - They use it in respiration and turn in into **acids**
    - The acids dissolve the enamel coating of the teeth, working its way into the **dentine**
    - Dentine is softer than enamel and so **dissolves more easily** and quickly
    - **This is tooth decay** and if not dealt with, can cause painful infections and loss of teeth

- Dental Health
    - **Reducing the amount of sugar** eaten can be prevent tooth decay
    - **Brushing teeth regularly** remove the buildup of plaque that can cause gum disease and removes the sugars in the mouth
    - Toothpaste should contain **fluoride** as this helps to strengthen enamel and reduce damage from acids
    - **Regular visits to a dentis**t ensures that any signs of gum disease or tooth decay can be dealt with promptly

Chemical Digestion

- Food is partially digested mechanically and to increase the surface area of the large molecules
- Chemical digestion is controlled by **enzymes** which are produced in different areas of the digestive system
- Carbohydrases
    - Amylase are produced in the mouth and pancreas (secreted into the duodenum)
    - Amylase is secreted into the alimentary canal in the mouth and the duodenum (from the pancreas) and digests starch to maltose (a disaccharide)
    - Maltose is digested by maltase into glucose on the membranes of the epithelium lining the small intestine.
- Proteases
    - Proteases are a **group of enzymes** that break down **proteins into amino acids** in the **stomach** and **small intestine**
    - Protein digestion takes place in the stomach and duodenum with two main enzymes produced:
        - Pepsin is produced in the stomach
        - Trypsin is produced in the pancreas and secreted into the duodenum
- Lipases
    - Produced in the pancreas, secreted into the duodenum
    - Digest lipids into fatty acids and glycerol

Role of HCl

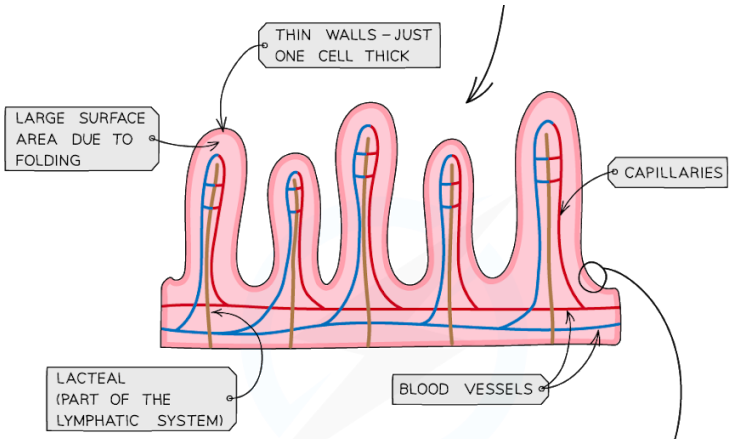
- Stomach produces several fluids which together are known as **gastric juice**
- One of the fluids produced is **hydrochloric acid**
- This kills bacteria in food and gives an **acid pH for enzymes** to work in the stomach

- Low pH Helpful in the Stomach
    - Helps kill bacteria in food
    - Pepsin has optimum pH of 2

- The Role of Bile
  - Cells in the liver produce **bile** which is then stored in the **gallbladder**
  - Two main roles:
    - Alkaline to neutralise the hydrochloric acid which comes from the stomach
    - It breaks down large drops of fat into smaller ones known as **emulsification**
    - The larger surface area allows **lipase to chemically break down the lipids into glycerol and fatty acids faster**

- Absorption of Food and water
  - Water is absorbed in both the small intestine and the colon, most absorption occurs in the small intestine
  - Absorption takes place in the second section of the small intestine, the **ileum**
    - The ileum is very long and has a highly folded surface with millions of **villi**
      - Increase the surface area of the ileum
      - Allowing absorption to take place faster and more efficiently

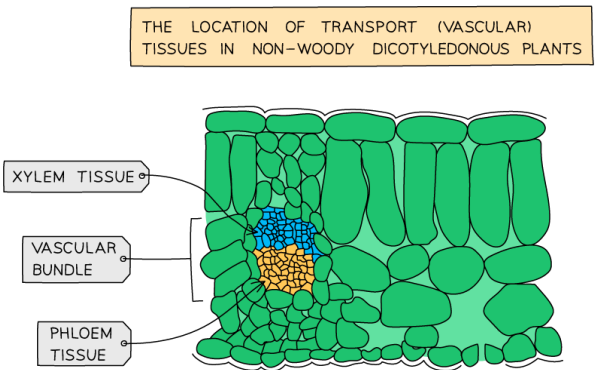
  - Structure & adaptations of a villus
    - Microvilli on the surface of the villus further increase surface area for faster absorption of nutrients
    - Wall of villus is one cell thick
      - Only short distance for diffusion and active transport
    - Well supplied with a network of blood capillaries that transport glucose and amino acids away from the small intestine and into the blood
    - **Lacteal** runs through the centre of the villus to transport fatty acids and glycerol away from the small intestine in the lymph

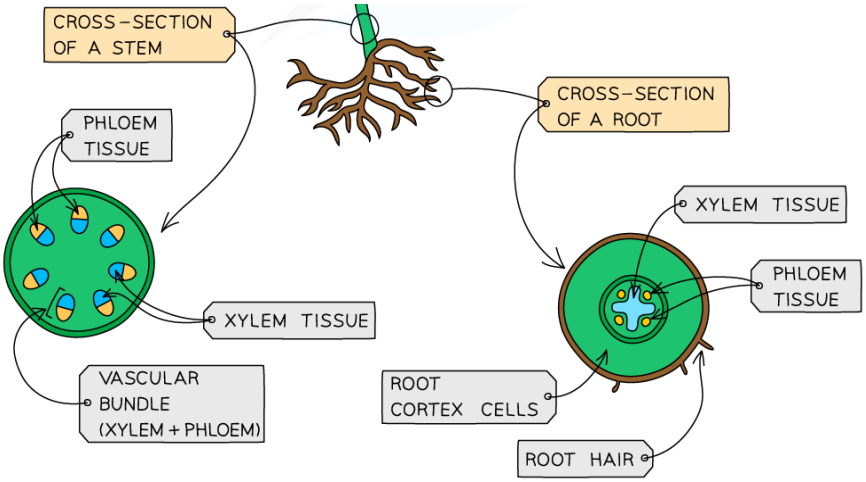


Transport in Plants

- Functions of Xylem & Phloem
- Plants contain two types of transport vessel:
    - **Xylem vessels** - transport water and minerals from the roots to the stem and leaves
    - **Phloem vessels** - transport food materials (mainly sucrose and amino acids) made by plant from photosynthesizing leaves to non-photosynthesising regions in the roots and stem

- These vessels are arranged throughout the root,stem and leaves in groups called **vascular bundles**





- Water Uptake
    - Root Hair Cells
        - Single celled extension of epidermis cells in the root
        - They grow between soil particles and absorb water and minerals from the soil
        - Water enters the root by **osmosis**
            - Due to soil having a higher water potential than the cytoplasm of the root hair cell
        - Increases surface area is important as **it increases the rate of absorption of water by osmosis and mineral ions by active transport**
    - Pathway of Water through Roof to Leaf
        - Root hair cell => root cortex cells => xylem => leaf mesophyll cells
    - Investigating pathway of water
        - The pathway can be investigated by placing a plant in a beaker of water that has has a stain added to it
        - After a few hours the color of the celery will turn the same as the stain in the water
        - If a cross section of the celery is cut, only **certain areas of the stak is stained the colour of the water, showing that the water is being carried in specific vessels through the stem - these are the xylem vessels**

- Transpiration
    - Water travels up xylem from the roots into the leaves of the plant to replace the water that has been lost due to transpiration
    - Transpiration is defined as the **loss of water vapour from plant leaves by evaporation of water at the surfaces of the mesophyll cells followed by diffusion of water vapour through the stomata.**
    - Functions of transpiration in plants
        - Transporting **mineral ions**
        - Providing **water to keep cells turgid**
        - Providing water for photosynthesis
        - Keeping the **leaves cool (**Uses up heat to convert water into water vapour)

    - Evaporation takes place from the surface of spongy mesophyll cells
    - The manly interconnecting air spaces between these cells and the stomata creates a **large surface area**
        - This allows evaporation to take place rapidly when the stomata are open
    - If more water evaporates from the leaves of plant than is available in the soil to move into the root by osmosis, then **wilting will occur**
        - Wilting will cause the cells to lose water so they cannot support the plant

- How is the transpiration stream created?
    - Water molecules are attracted to each other by **cohesion** - creating a continuous column of water up the plant
    - Water moves through the xylem vessels in a continuous **transpiration stream** from roots to leaves via the stem.
    - Transpiration produces a **tension** or “Pull” on the water in the xylem vessels by the leaves
    - As water molecules are held together by **cohesive forces**, so water is pulled up through the plant
    - If the rate of transpiration from the leaves increases, water molecules are pulled up the xylem vessels **quicker**

- Investigating factors that affect transpiration
        - Cut a shoot underwater to prevent air entering through the xylem and place in a potometer
        - Dry the leaves of the shoot
        - Remove the capillary tube from the beaker of water to allow a single **air bubble** to form and place the tube back into water
        - Set up the environmental factor (if temperature, then increase or decrease the temperature of the room)
        - Allow the plant to adapt to environment for 5 minutes
        - Record the starting location of the air bubble
        - Leave for a set period of time

        - Record the location of bubble
        - Subtract both the values to get the distance moved

- Temperature and humidity on transpiration rate
    - Rate of transpiration increases with temperature
    - Rate of transpiration increases with decreasing humidity

Translocation

- Movement of sucrose and amino acids in phloem from regions of production (source) to regions of storage (sink) or to regions where they are used in respiration
- The soluble products of photosynthesis are **sugars and amino acids**
- Transported via the phloem
- Transportation of sugars and amino acids is not always from source to sink
    - During winter: when many plants shave no leaves, the phloem tubes may transport dissolved sucrose and amino acids from storage organs to other parts of the plant so that respiration can go on
    - During a Growth period: storage organs would be the source and the growing areas of the plant will be the sink
    - After the plant has grown: the leaves are the source and the storage organs are the sink

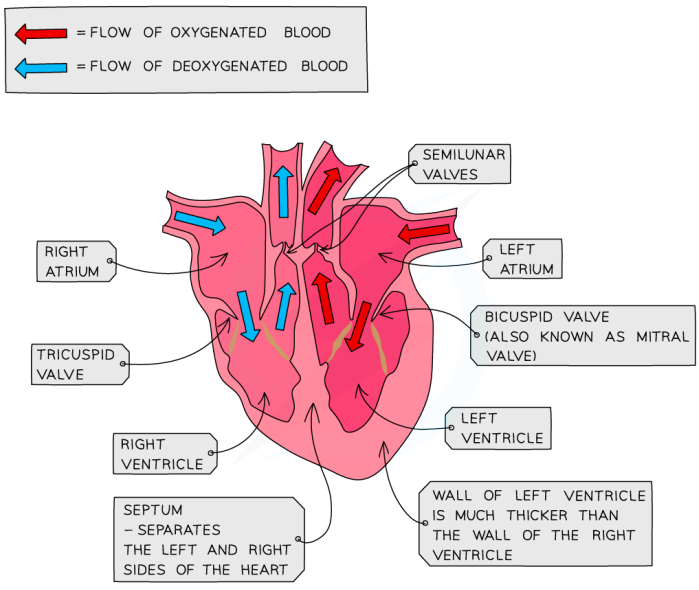
Transport in Animals

- ### Circulation
    - Circulatory system is a system of blood vessels with a pump and valves to ensure one-way flow of blood
    - Fish have a two-chambered heart and a **single circulation**
        - For every one circuit of the body, the blood passes through the heart **once**
    - Mammals have a four-chambered heart and a **double circulation**
        - For every one circuit of the body, the blood pases through the heart **twice**
        - The right side of the heart receives deoxygenated blood and pumps it to the lungs
            - Pulmonary circulation
        - The left side of the heart receives oxygenated blood from the lungs and pumps it to the body
        - Advantages of a double circulation
            - Blood travelling through the small capillaries in the lungs **loses a lot of pressure** that was given to it by the pumping of the heart, meaning it cannot travel as fast

        - By returning the blood to the heart after going through the lungs its **pressure can be raised** again before sending it to the body, meaning cells can be supplied with oxygen and glucose they need for respiration **faster and more frequently**

- Heart
    - Structure
        - Split into two main parts **ventricles** and **atria** (singular: atrium)
            - Ventricles have thicker walls as they are pumping blood out of the heart and so need to generate a **higher pressure**
        - The **left ventricle has a thicker muscle wall** than the right ventricle as it has to pump blood at high pressure around the entire body, whereas the right ventricle is pumping blood at lower pressure to the lungs.
        - The **septum** separates the two sides of the heart and so **prevents** mixing of oxygenated and deoxygenated blood
        - The heart is made of muscle tissue which are supplied with blood by the **coronary arteries**
    - Valves
        - Basic function is to prevent blood flowing backwards
        - Tricuspid valve and Bicuspid valve
            - The tricuspid valve is on the **right** side of the heart
            - The bicuspid valve is on the **left** side of the heart
            - when the atria contracts, the valves open
            - When the ventricles contract, they are pushed shut to prevent blood flowing back into the atria
        - Semilunar valves
            - Found in two blood arteries that come out of the top of the heart
            - They are unusual in that they are the **only two arteries in the body that contain valves**
            - These valves **open when the ventricles contract** so blood squeezes past them out of the heart, but then shut to avoid blood flowing into the heart

- Pathway of Blood through the Heart
    - Deoxygenated blood coming from the body flows into the **right atrium** via the vena cana
    - Once the right atrium is filled with blood the heart gives a little beat and the blood is pushed through the **tricuspid valve** into the **right ventricle**
    - the walls of the ventricle **contract** and the blood is pushed into the **pulmonary artery** through the **semilunar valve** which prevents blood flowing backwards into the heart.



- The blood travels to the lungs and moves through the capillaries past the alveoli where gas exchange takes place
- The oxygenated blood returns to the left atrium via the **pulmonary vein**
- It passes through the bicuspid valve (or mitral valve) into the **left** ventricle
- The thicker muscle walls of the ventricle contract strongly to push the blood forcefully into the **aorta** and all the way around the body
- The **semilunar valve** in the aorta prevents the blood flowing back down into the heart

- Exercise & heart rate
  - Heart activity can be monitored using an ECG, measuring pulse rate or listening to the sounds of valves closing using a stethoscope
  - Unit is bpm (beats per minute)
  - Exercising increases heart rate
    - The body starts to respire anaerobically during exercise to gain the energy required and this builds up an oxygen debt
      - This has to be ‘’repaid’
      - Lactic acid is formed during anaerobic respiration during exercise and oxygen is required to break down the lactic acid that had built up
        - This is also the reason that your heart rate does not go down as soon as you stop working out
- Coronary heart disease
  - Occurs when there are fatty deposits called ‘plaques’ on the coronary artery (blood supply for heat)
    - Partial blockage can cause chest pains called an **angina**
    - Complete blockage causes a heart attack
  - Caused by
    - Poor diet (high amounts of saturated fat)
    - Stress (increase blood pressure)
    - Smoking (nicotine increases blood pressure)
    - Genetic predisposition
    - Age (risk of developing increases as you get older)
    - Gender (Males are more likely to develop)
  - Prevention
    - Quit smoking
    - Exercise regularly

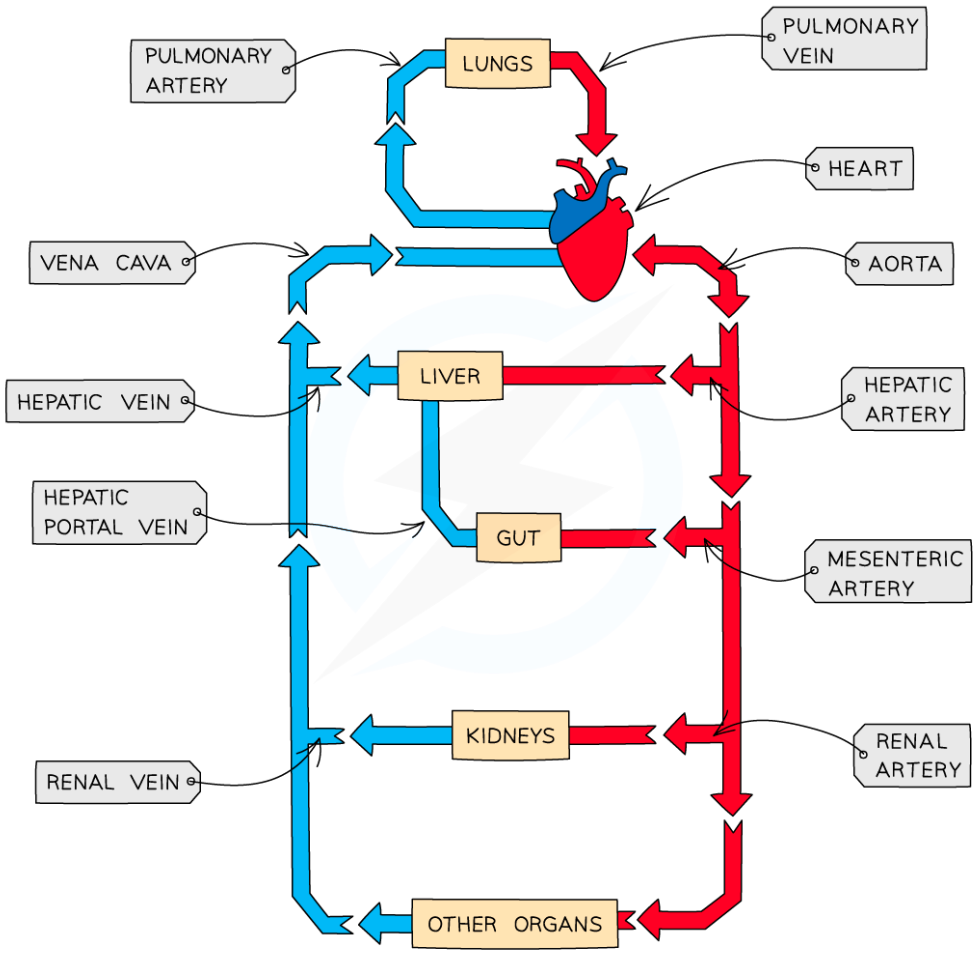
  - Treatments
    - Aspirin can reduce the risk of blood clots
    - Angioplasty
      - A narrow catheter is threaded through the grain up to the blocked vessel
      - A tiny balloon inserted into the catheter is pushed up to the blocked vessel and inflated
        - Flattens the plaques
      - A stent is inserted to push against the wall of the artery

        - Coronary bypass surgery
            - A piece of blood vessel is taken from the patient's leg, arm or chest and used to **create a new passage for the flow of blood** to the cardiac muscle. Bypassing the blocked area

- Blood & Lymphatic vessels
    - Blood vessels
        - Arteries
            - Carry blood at **high pressure away from the heart**
            - Carry oxygenated blood (except pulmonary artery)
            - Have a **thick** muscular wall containing elastic fibres
                - To withstand high pressure of blood and maintain the blood pressure as it recoils after the blood has passed through
            - Have a **narrow** lumen
                - To maintain high pressure
            - Speed of flow is fast
        - Veins
            - Carry blood at **low pressure towards the heart**
            - Carry deoxygenated blood (except pulmonary vein)
            - Have **thin** walls
            - Have a **large** lumen
                - As pressure is low
            - Contain valves
                - To prevent backflow
            - Speed of flow is **slow**

        - Capillaries
            - Carry blood at low pressure within tissues
                - Oxygenated and deoxygenated
            - Have walls that are **one cell thick**
                - So that substances can easily diffuse in and out of them
            - Have 'leaky' walls
                - So that blood plasma can leak out and form tissue surrounding cells
            - Speed of low is slow
        - Vessels that connect arteries to capillaries are called **arterioles**
            - Made by arteries branching out more and more the further they get away from the heart
        - Vessels that connect capillaries to veins are called **venules**
            - Made by veins branching out more and more the further they get away from the heart

        - Shunt vessels
            - The body might have to use more blood on a specific muscle or organ that is requiring than something that is not being used, so shunt vessels in the body are used to redirect blood to organs, that require it
                - For example
                    - During exercise: more of it goes to the working muscles and less of it goes to other body organs such as the digestive system
                    - When we are hot, more blood flows through the surface of the skin and when we are cold less blood flows through the surface of the skin
    - Circulation



- The lymphatic system
    - The walls of the capillaries are so thin that water, dissolved solutes and dissolved gases easily leak out of the walls from the plasma into the **tissue fluid** surrounding the cells.
    - Cells **exchange materials** across the cell membrane with the tissue surrounding them by diffusion, osmosis or active transport
    - More fluid leaks out of the capillaries than is returned to them and this excess fluid passes into the lymphatic system and becomes **lymph fluid**

- Lymph Vessels & Nodes
    - The lymphatic system is formed from a **series of tubes which flow from tissues back to the heart**
    - It connects with blood system near to the heart, where lymph fluid is returned to the blood plasma
    - **Lymph nodes** are small cluster of lymphatic tissue found throughout the lymphatic system
        - Especially in neck and armpits
    - Large number of **lymphocytes** are found in lymph nodes
    - Tissues associated with the lymphatic system, such as bone marrow, produce these **lymphocytes**
    - Lymphocytes are important for the immune system
- Blood
    - Red blood cells
        - Biconcave disc with no nucleus, only haemoglobin
    - White blood cells
        - Large cells containing a big nucleus, different types have a slightly different structures and functions
        - Two types of white blood cells
            - Phagocytes
                - Carry out phagocytosis by engulfing and digesting pathogens
                - They are able to detect chemicals given off by pathogens to find the pathogen
                    - Release digestive enzymes to digest it
                - Recognized by their **Multi-labeled nucleus** and their **granular cytoplasm**
            - Lymphocytes
                - Produce antibodies to destroy pathogenic cells and antitoxins to neutralise toxins released by pathogens
                - Recognized by their large round nucleus and are clear and non-granular cytoplasm

      Platelets
        - Fragments of cells
        - Involved in blood clotting
    - Plasma
        - Straw coloured liquid
        - Transport of **carbon dioxide, digested food, urea, minerals, etc**

- Blood Clotting
    - Platelets form the scabs where the skin has been cut or punctured
        - Prevents entry of microorganisms that could cause an infection
    - The scab will be present until new skin has grown underneath
    - When the skin is broken
        - Platelets arrive to stop the bleeding

        - Then an enzyme called thrombin converts soluble fibrinogen proteins to convert into insoluble fibrin and form a insoluble mesh across trapping red blood cells and therefore forming a clot
            - Develops into a scab to protect the wound

Diseases and Immunity

- A pathogen is a **disease-causing** organism
- A transmissible-disease is a disease in which the pathogen can be passed from one host to another through multiple methods
    - Contact
        - People or insect that transfers pathogens to a surface or another person are called **vectors**
    - Blood
    - Contaminated surfaces
    - Droplets in air
    - Insect bites
- Defence against pathogens
    - Mechanical barriers
        - Skin
            - Covers most parts of the body do deny entry of pathogens, if cut or grazed, heals quickly by forming a scab
        - Hairs in the nose
            - Makes it difficult for pathogens to enter
    - Chemical barriers
        - Mucus
            - Secreted in various parts in the body that trap pathogens and cough or sneeze them up
        - Stomach acid
            - Contains hydrochloric acid strong enough to kill almost any pathogen
    - Immune system
        - Consists of multiple types of cells which work together to kill a pathogen.
        - By phagocytosis:
            - Done by phagocytes which engulf the pathogen and then digest the pathogenic cells
        - By producing antibodies
            - Done by lymphocytes
                - “Read” and an antigen and produce the antibodies. Very slow process
            - Antibodies lock on to antigens (chemical on the surface of a pathogen)
                - Every pathogen has a different antigen and so each virus requires a new antibody
            - leading to the direct destruction of the cell or marking for phagocytes
                - They are complementary to the shape of the antigens
            - Antibodies attach to other and cause agglutination (clumping of cells)

- And release chemicals to signal antigens
- Lymphocytes usually produce antibodies and a good number of **memory cells**
    - Memory cells are cells that remember how to produce the antibody and recognise the antigen of a virus
        - This is **active immunity**
            - This is long lasting and slow acting
            - defence against a pathogen by antibody production in the body

- The body can accidentally recognise one of its own cells as a pathogen and start attacking them, this is called as an **auto-immune** disease
    - Type 1 diabetes is a common example
        - Causes inability to produce insulin
        - Body starts to destroy pancreatic cells which are responsible for insulin production

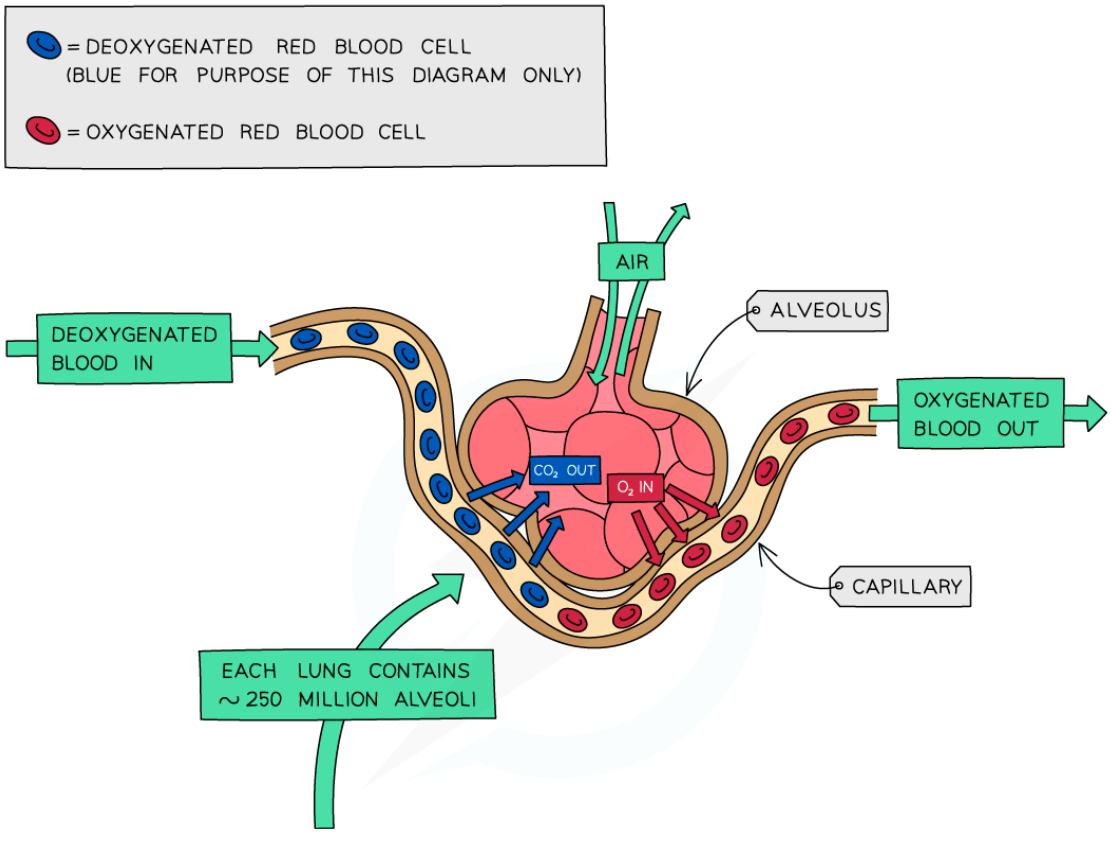
- Vaccine
    - Gives protection against diseases and boost body's immune system
    - Vaccines are a dead or altered (harmless)
    - Entered into the body and triggers the immune system and the body starts to produce antibodies
    - And then the body produces memory cells which gives long lasting immunity
    - So this is also **active immunity**
    - How this affects population
        - If the majority of the population vaccinated this reduces the number of breeding grounds of the pathogen thus helping the population not vaccinated
        - Prevents epidemics and pandemics

- Injection of antibodies
    - Many methods most common are an injection or through mother's breast milk to a baby
        - These are an example of **passive immunity**
            - Short-term defence against a pathogen by antibodies acquired from another source
            - Memory cells are not produced in this type of immunity
            - These are fast acting
            - From mother to infant via breast milk – this is important as it helps the very young to fight off infections until they are older and stronger and their immune system is more responsive
            - Used for diseases like rabies and tetanus

- Controlling spread of diseases
  - Sanitation
    - Remove waste on roads and other public resources as they may have pathogens on their surface
  - Waste disposal
    - Waste attracts flies
  - Personal hygiene
    - Washing and using soaps kills or washes off bacteria
  - Hygienic food preparation
    - Food cold to slow growth of bacteria
    - Cover food to avoid flies
    - Cook food well

Gas Exchange In Humans

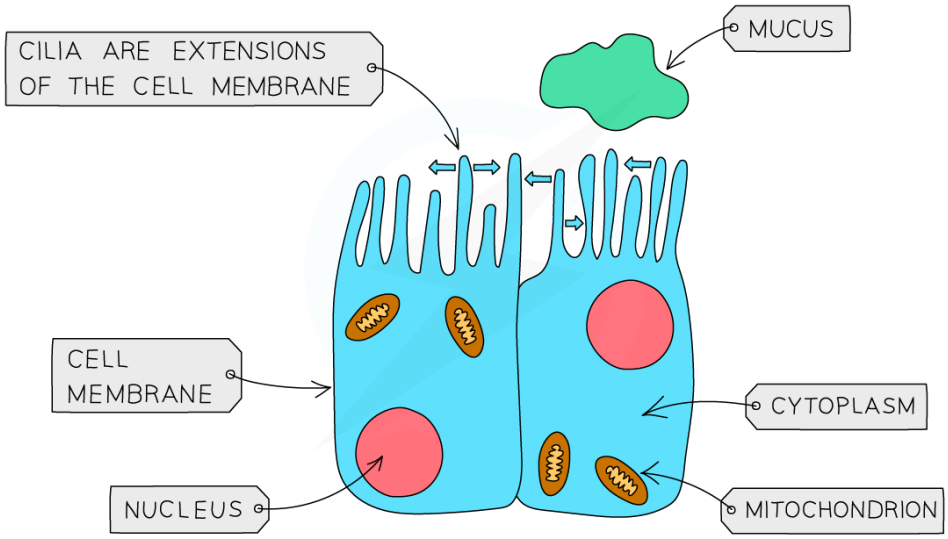
- Features of gas exchange surface
  - Large surface area:
    - Allow faster diffusion
  - Thin walls
    - to ensure to diffusion distances remain short
  - Good ventilation with air
    - Maintain diffusion gradient
  - Good blood supply
    - Maintain a high concentration so diffusion occurs faster

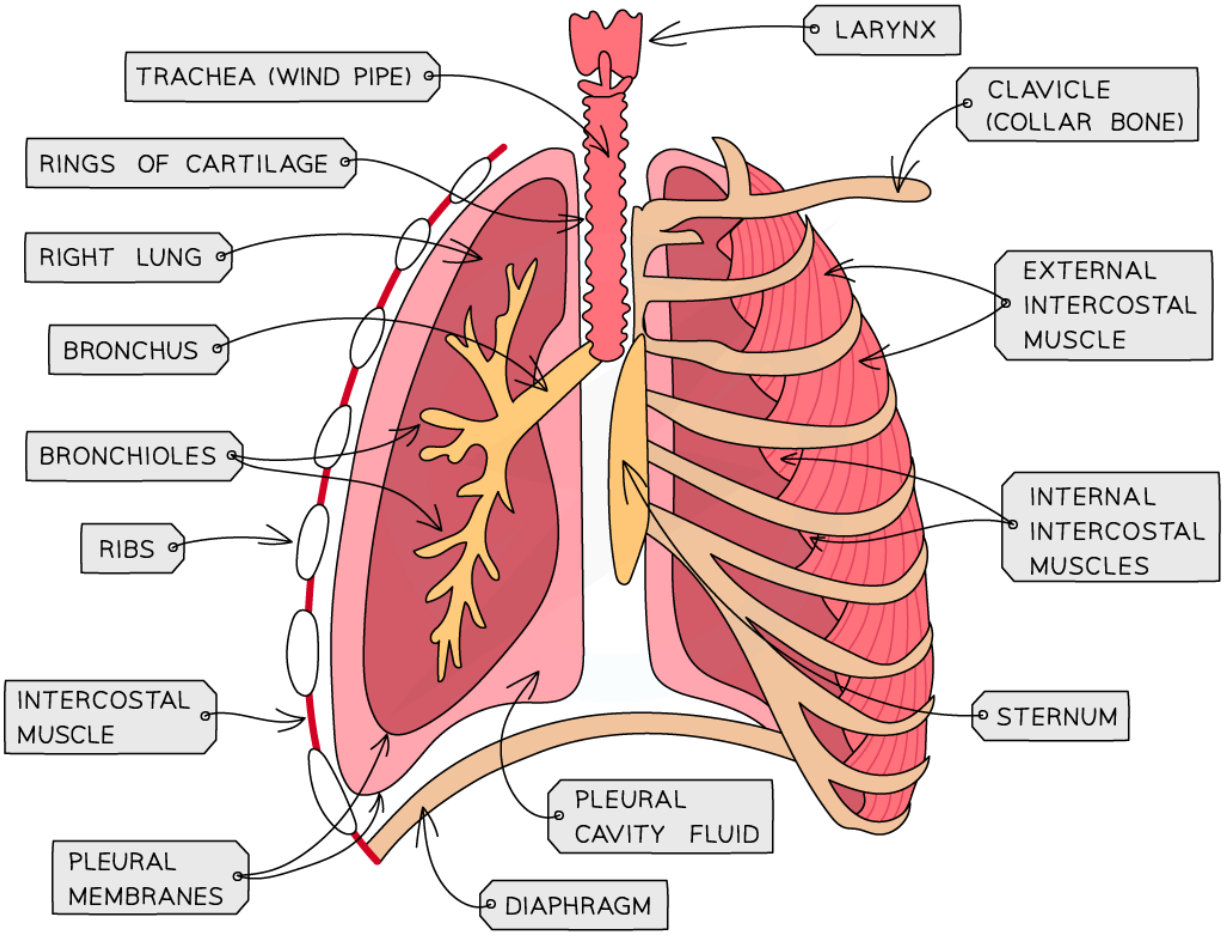


- Structure of the Breathing System
    -

Structure	Description
Ribs	Bone Structure that protects internal organs such as the lungs
Intercostal muscles	Muscles between the ribs which control their movement causing inhalation and exhalation
Diaphragm	Sheet of connective tissue and muscle at the bottom of the thorax that helps change the volume of the thorax to allow inhalation and exhalation
Trachea	Windpipe that connected the mouth and nose to the lungs. ● Rings of cartilage surround the trachea (and bronchi) ● The function of the cartilage is to support the airways and keep them open during breathing ● If they were not present then the sides could collapse inwards when the air pressure inside the tubes drop.
Larynx	Also known as the voice box, when air passes across here, sound is produced
Bronchi (singular:Bronchus)	Large tubes branching off the trachea with one bronchus
Bronchioles	Bronchi split to from smaller tubes called bronchioles in the lungs connected to alveoli
Alveoli	Tiny air sacs where gas exchange takes place

- The intercostal muscles
    - Muscles are only able to pull on bones, not push on them
    - There are two sets
        - Internal Intercostal muscles
        - External intercostal muscles
- Function of cilia & Mucus
    - The passages down to the lungs are lined with **ciliated epithelial cells**
    - Cilla help to push mucus up the passages towards the nose and throat where it can be removed
        - Mucus is secreted by **goblet cells**
    - The mucus traps particles, pathogens and dust to prevent them getting into the lungs


CILIA ARE EXTENSIONS OF THE CELL MEMBRANE
MUCUS
CELL MEMBRANE
CYTOPLASM
NUCLEUS
MITOCHONDRION


LARYNX
TRACHEA (WIND PIPE)
CLAVICLE (COLLAR BONE)
RINGS OF CARTILAGE
RIGHT LUNG
EXTERNAL INTERCOSTAL MUSCLE
BRONCHUS
BRONCHIOLES
INTERNAL INTERCOSTAL MUSCLES
RIBS
INTERCOSTAL MUSCLE
STERNUM
PLEURAL CAVITY FLUID
PLEURAL MEMBRANES
DIAPHRAGM

- Ventilation of the lungs
    - The diaphragm is a thin sheet of muscle that separates the chest cavity from the abdomen; it is ultimately responsible for controlling ventilation in the lungs
        - When the diaphragm **contracts** it flattens and this increases the volume of the chest cavity (thorax) which leads to a **decrease in air pressure**

        - When the diaphragm **relaxes** it moves upwards, and this decreases the volume of the chest cavity, which consequently leads to an **increase in air pressure** inside the lungs relative to outside the body, **forcing air out**

    - The external and internal intercostal muscles work as antagonistic pairs
        - During Inhalation the external set of intercostal muscles contract to pull the ribs up and out:
            - Increases the volume of the thorax
            - Decreases air pressure
            - These cause air to get drawn in

        - During Exhalation, the external set of intercostal relax so the ribs drop down and in:
            - Decreases the volume of the thorax
            - Increases the air pressure
            - Causes air to move out
    - Inhalation
        - External intercostal muscles contract
        - Rib Cage moves up and out
        - Diaphragm contracts and flattens
        - Volume of thorax increases
        - Pressure inside thorax decreases
        - Air is drawn in

    - Exhalation
        - External intercostal muscles relax
        - Rib cage move down and in
        - Diaphragm relaxes (dome shape)
        - Volume of thorax decreases
        - Pressure inside thorax increases
        - Air is forced out

- Composition of air

Gas	Inspired air	Expired Air	Reason for difference
Oxygen	21%	16%	Oxygen is used up by the body so the blood returning to the lungs have low oxygen and high carbon dioxide
Carbon dioxide	0.04%	4%	Carbon dioxide is produced by the body as a product of respiration and it is transported to the lungs to be excreted out
Water vapour	Lower	HIgher	Water evaporated from the moist lining of the alveoli into the expired air as a result of the warmth of the body
Nitrogen	78%	78%	Nitrogen gas is very stable and so cannot be used by the body, for this reason its concentration does not change.

- Effect of exercise on breathing
    - Exercise increases the frequency and depth of breathing
        - More oxygen to be delivered to organs to keep up with energy demand
        - If it cannot me energy demands the body will start to respire **anaerobically,** producing **lactic acid**
        - After exercise the lactic acid needs to be removed so that it doesn't affect the body
            - This can be done by combining it with oxygen
        - Only after this lactic acid has been fully removed does the breathing rate go back to normal
- Carbon dioxide concentration & The brain
    - Carbon dioxide is acidic in nature
    - It has to be removed quickly before it causes any problems
    - As blood flows through the brain, increase in carbon dioxide concentration stimulates receptor cells
    - These cause pulses to be sent to the respiratory organs causing them to contract more often and with increased strength
    - This causes the frequency and depth of breathing to increase until carbon dioxide concentration has been lowered sufficiently.

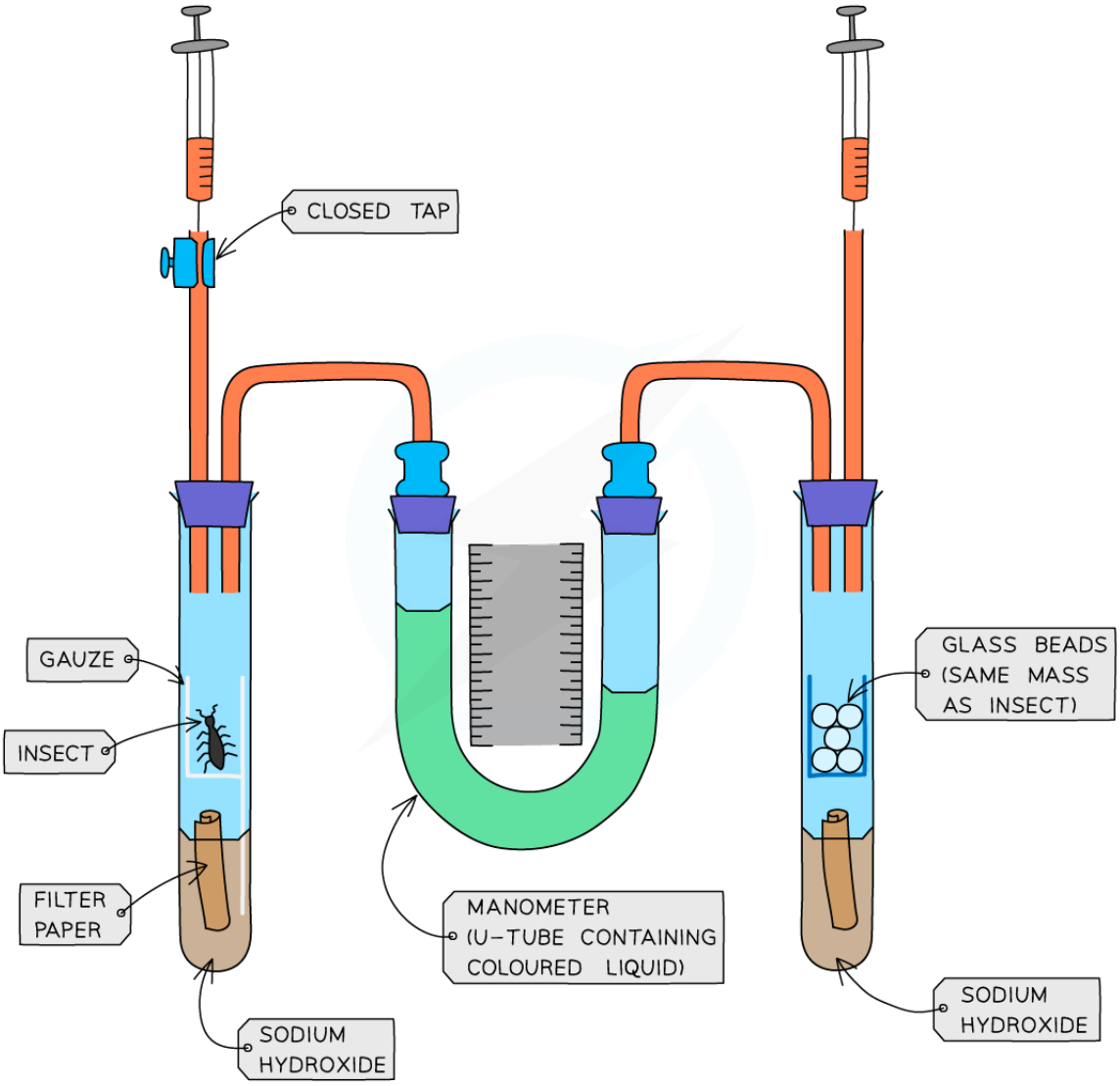
Respiration

- Basics
  - Uses of energy in the body
    - Maintenance of a constant body temperature
    - Passage of nerve impulses
    - Cell division and growth
    - Muscle contractions
    - Protein synthesis
    - Active transport

  - Energy is produced by respiration
    - Respiration is a series of reactions that are controlled by enzymes.
    - Can take place without or without oxygen

- Aerobic respiration
  - Aerobic respiration requires oxygen and is defined as **the chemical reaction in cells that use oxygen to break down nutrient molecules to release energy**
  - It is the complete breakdown of glucose to release **large amount of energy** for use in cell processes
  - It produces **carbon dioxide and water** as well as releasing useful cellular energy
  - : $\mathbf{C_6H_{12}O_6 + 6O \rightarrow 6CO_2 + 6H_2O}$
  - Glucose + Oxygen => carbon dioxide + water

- Investigating uptake of oxygen by respiring organisms
  - We can investigate aerobic respiration in living organisms by measuring the amount of oxygen that they take from the air
    - Done by finding the change in volume
    - Carbon dioxide has to be removed at the as it is being produced by the respiring organism
      - Done by adding soda lime or sodium hydroxide
  - We use a respirometer to do this (image on next page)
    - Two tubes, one with an organism and another with beads of same mass as the organism as control
    - The movement of the colored liquid towards the insect will give a measure of the volume of oxygen taken up by the insect for respiration
    - The reduction of volume in the tube increases pressure causing the coloured liquid to move
    - The distance moved by the liquid will provide the volume of oxygen in by the insect per minute



- To investigate the effect of temperature on seeds
    - Heat the side containing the seed at different temperatures and measure the distance moved
    - The seeds should be kept in the water bath for 15 minutes before the start off the experiment to ensure they have **acclimated to the temperature**
    - respiration is an enzymes controlled reaction.
        - So the enzyme will denature after 40 ℃

- Anaerobic Respiration
    - Does not require oxygen
    - Defined as **the chemical reactions in cells that break down molecules to release energy without using oxygen**
    - **Less energy produced per glucose molecule than in aerobic respiration**
    - It produces different breakdown products depending on the type of organism it is taking place in .
        - Respiration in Yeast
            - Glucose => Alcohol + carbon dioxide
            - $C_6H_{12}O_6 => 2C_2H_5OH + 2CO_2$
    - Respiration In animals
        - Glucose => Lactic acid
        - Anaerobic respiration takes place in muscle cells during vigorous exercise
            - **Lactic acid builds up in muscles and blood during vigorous exercise causing an oxygen debt**
        - Recovery of Oxygen debt
            - Aerobic respiration of lactic acid in the liver
                - This causes a fast heart rate even after exercise is over
            - Transports lactic in blood from muscles to the liver
            - Deeper breathing, supplying oxygen for aerobic respiration of lactic acid

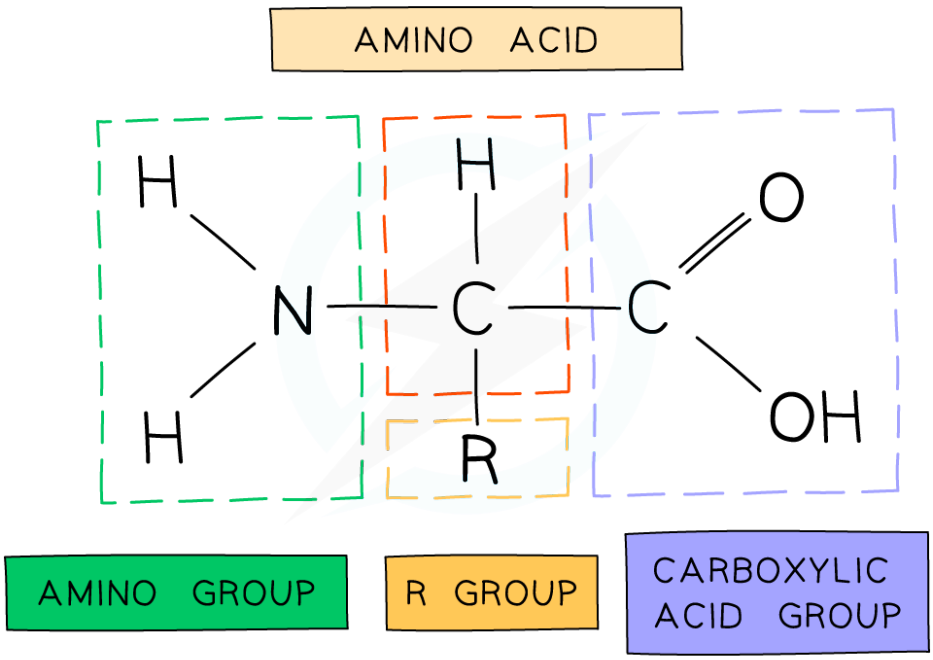
The Excretory System

Excretory Products

- Urea, formed in the liver from excess amino acids
- Carbon dioxide, excreted through the lungs due to aerobic respiration
- The kidneys excrete urea and excess water and salts
- The volume and concentration of urine (formed in the kidneys) is affected by water intake, temperature and exercise
    - Kidneys excrete excess water, excess salts and urea. If the temperature increases or the person is exercising or the water intake is low, the water is used by the body or goes out as sweat (due to exercise or temperature increase)
        - This causes the colour of urine to change if urea concentrated - yellow, and the urine becomes clearer with the more water in it.

The Role of the liver

- The Role of Liver
    - Many food molecules absorbed into the blood intestine are carried to the liver for **assimilation** (conversion of food molecules to other molecules that the body needs)
        - Such as fibrinogen, a protein found in the blood plasma that is important for blood clotting
    - Excess amino acids are absorbed into the blood that is not needed to make proteins.
        - But they can't be stored, they are broken down in a process called **deamination**
            - **Deamination** is the removal of the nitrogen-containing part of amino acids to form urea.
            - Enzymes in the liver split up the amino acid molecules
            - The part of the molecule which contains carbon is turned into glycogen and stored
            - The other part containing nitrogen is turned to urea
            - The urea dissolves in the blood and is taken to the **kidney**
                - A small amount is excreted in sweat

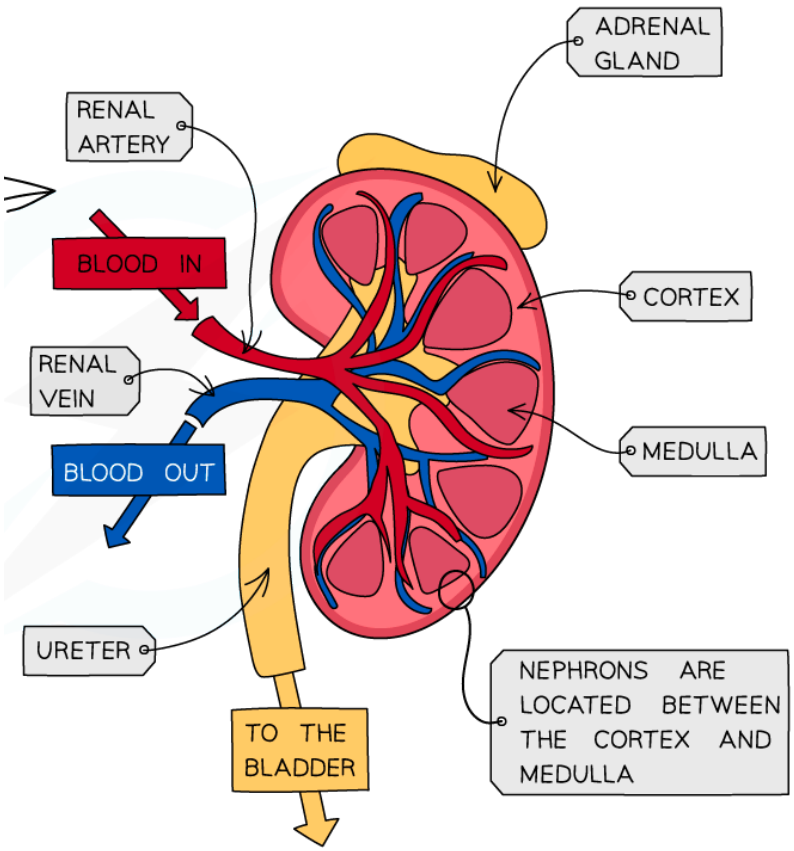


The urinary system

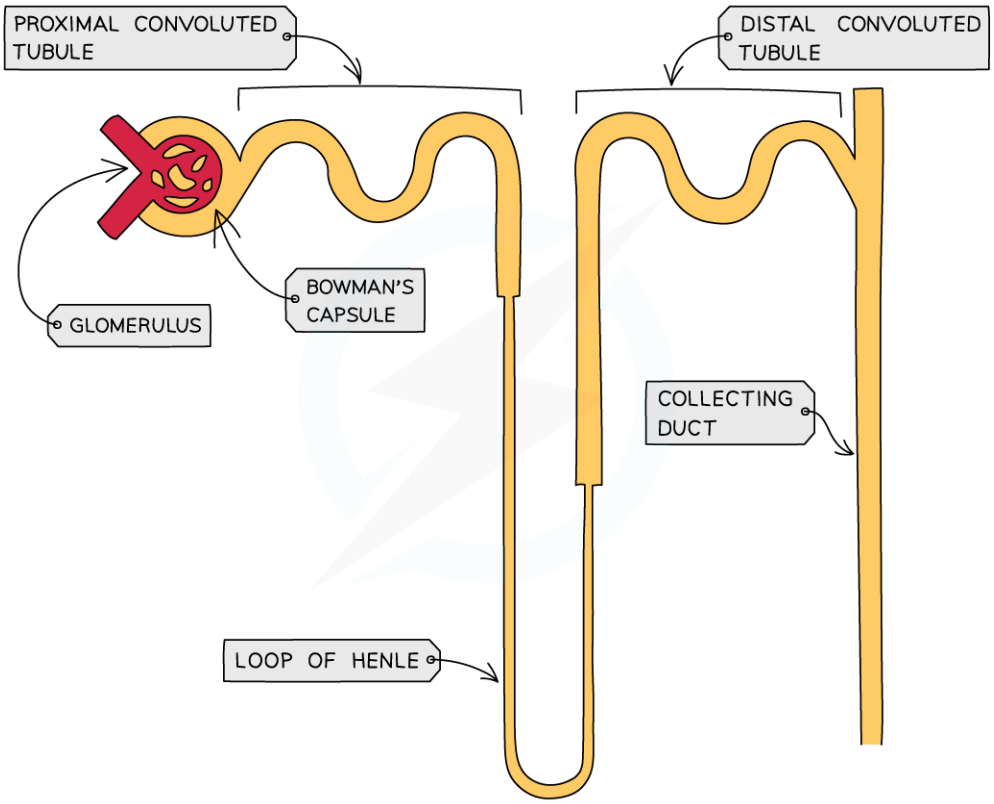
- Main Structures involved and their function

Structure	Explanation
Kidney	Two-Bean shaped organs that filter blood
Ureter	The tube connecting the kidney to the bladder
Bladder	The organ that stores urine as it is produced by the kidney
Urethra	The tube that connects the bladder to the exterior; where urine is released

- The kidney
    - Located in the back of the abdomen
    - They regulate the water content of the blood
    - They excrete the toxic waste of products of metabolism and substances present in excess
    - Each kidney contain a million tiny structures called nephrons



- The nephrons in the cortex of the kidney, loop down into the medulla and back up to the cortex
- The contents of the nephrons drain into the innermost part of the kidney and the **urine collects** there before it flows into the ureter and it flows into the ureter to be carried to the bladder for storage of urine



- Processes in the nephron
    - Ultrafiltration
        - Arterioles branch off the renal artery and lead to each nephron, where they form a knot of capillaries sitting inside the cup-shaped Bowman's capsule
        - The capillaries get narrower as they get further into the glomerulus which increases the pressure (already at high pressure)
        - This eventually causes smaller molecules being carried in the blood to be forced out of the capillaries and into the Bowman's capsule, where they form what is known as the filtrate
        - The substances forced out are: **glucose, water, urea, salts**
        - Some of these are useful and will be reabsorbed back into the blood further down the nephron.

- Reabsorption of Glucose
  - After the glomerular filtrate enters the Bowman's capsule.
    - Glucose is the first to be reabsorbed at the proximal convoluted tubule
  - This takes place by **active transport**
    - Nephrons have many mitochondria for this process
  - Reabsorption of glucose cannot take place anywhere else in the nephron.

- Reabsorption of Water & Salts
  - As the filtrate drips through the **Loop of Henle** necessary salts are reabsorbed back into the blood by **diffusion**
  - As salts are reabsorbed back into the blood, water follows by **osmosis**
  - Water is also reabsorbed from the collecting duct in different amounts depending on how much water the body needs at that time

Kidney Failure

- Humans can survive with one functioning kidney, but if both are damaged them there will quickly be a build-up of toxic wastes in the body which will be fatal if not removed
- Treatment options
  - Kidney transplant
  - Dialysis
- Kidney Dialysis
  - The usual treatment for someone with kidney failure is dialysis
  - This is an artificial method of filtering the blood to remove **toxins and excess substances**
  - Patients are connected to a dialysis machine which acts an artificial kidney to remove most of the urea and restore the water and salt balance of the blood.
  - Unfiltered blood is taken from an artery in the arm, pumped into the dialysis machine and then returned to a vein in the arm
  - Inside the machine, the blood and dialysis fluid are separated by a partially permeable membrane, the blood flows in the opposite direction to dialysis fluid.
    - Allowing exchange to occur between the two, as a concentration gradient exists.
  - Dialysis fluid contains
    - A glucose concentration similar to a normal level in the blood
    - A concentration of salts similar to a normal level in the blood
    - No urea
  - As the dialysis fluid has no urea in it, there is a **large concentration gradient**
  - The urea is diffused as there is a **large concentration gradient**
  - As the salt concentration similar to the ideal blood concentration, movement of salts will only occur if the body has too much (into the dialysis fluid) or too little (out of the dialysis fluids)
  - Things required to do for dialysis to work properly
    - The fluid is continually refreshed so that concentration gradients remain the same
    - Dialysis takes up to 3-4 hours to complete and needs to be done several times a week to prevent damage to the body from a buildup of toxic substances.
    - An anticoagulant is added to the blood before it runs through the machine to prevent the blood from clotting and slowing the flow

- Kidney Transplants vs Dialysis

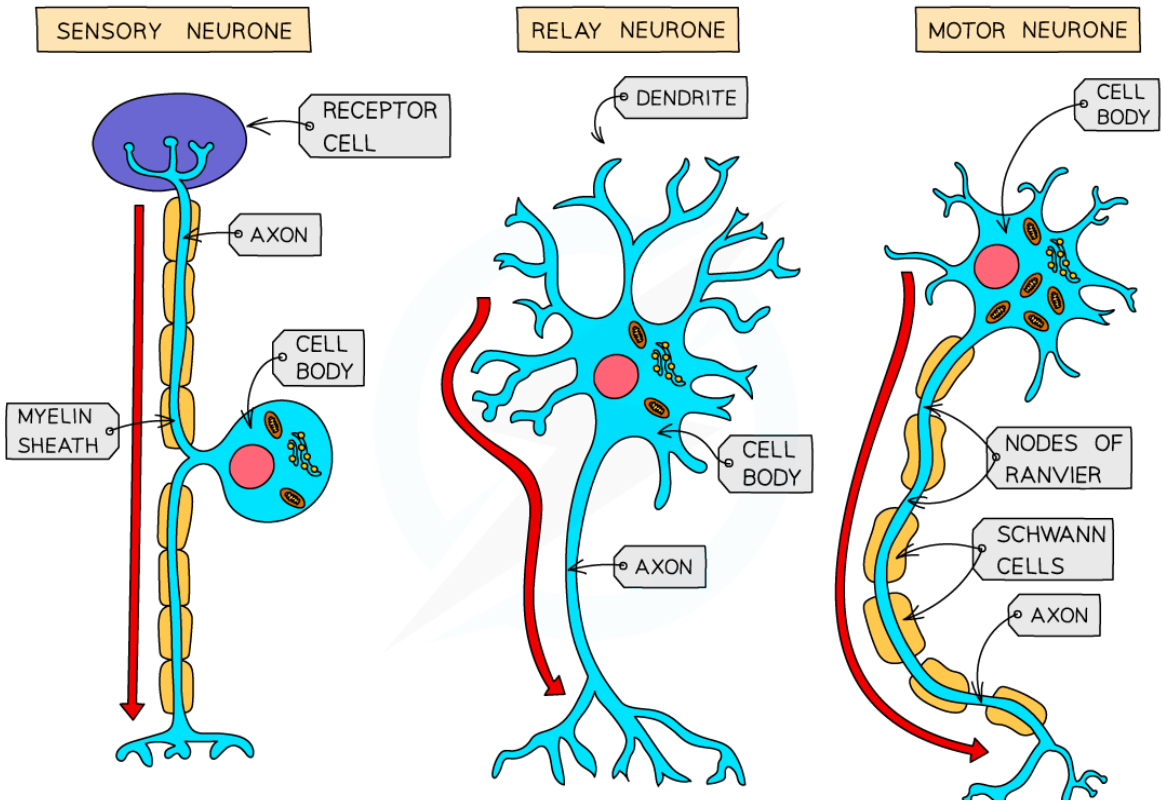
Kidney transplant	Dialysis
Donors won't have the same antigens on cell surfaces so the immune system might view the new kidney as a threat and as a result, the patients has to use immunosuppressants which could compromise the patient's health	Less expensive
Not enough donors to cope with demands	Dialysis only work for a limited time
Much more freedom	Have to go hospital often
Less strict diet	Strict diet
Very expensive	-

Coordination and Response

- Nervous control in humans
    - A **nerve impulse** is an electrical signal that passes along nerve cells called **neurons**
        - A bundle of neurons is known as a nerve
    - Human nervous system consists of:
        - The Central nervous system (CNS)
        - The peripheral nervous system
    - The Human nervous system allows for coordination and regulation of body functions
    - The Human nervous system has two types of actions/responses
        - Voluntary
            - Type of action is one where you make a **conscious** decision to carry out a particular action therefore it starts with the **brain**
        - Involuntary
            - Does not involve the brain and you are not aware of it until you have completed it
                - Such as your hand being burnt, knee-jerk reaction

        - Occurs due to sensation
        - Very fast, automatic and protective
    - There are three types of neurons
        - Sensory
            - Carries an impulse from sense organs to the CNS
        - Relay
            - Found inside the CNS
        - Motor
            - Carries impulses from CNS to effectors (muscles or glands)

- Neurones have a long fibre called an **axon**
    - Less time is wasted to transfer impulses
- The axon is insulated by a fatty sheath with uninsulated sections along it called nodes
- Their cell body may contain **dendrites**
    - They connect to many other neurons and receive impulses from them

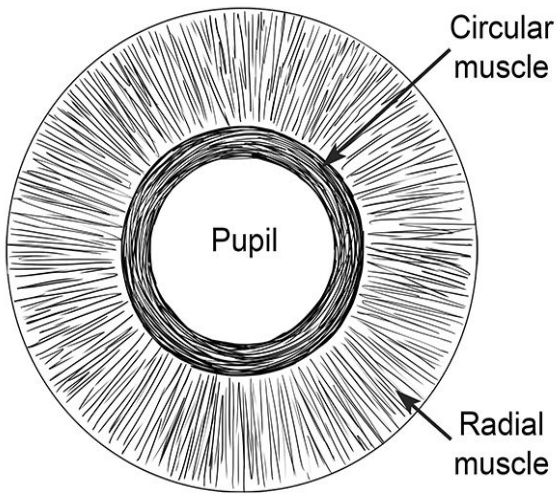


- How neurons work together
    - Neurons have to transfer the impulse but they are unable to since there is a tiny gap in between them
        - Neurons never touch

- The junctions or gaps between neurons is called a **synapses**
- The electrical impulse is carried along the first axon
  - The membrane of this neuron is called the **pre synaptic membrane**
- This impulse triggers the release of chemicals called **neurotransmitters** from vesicles
- This diffuses into the gap (the gap is called **synaptic cleft**)
- There are receptors on the end of the other neuron, the neurotransmitters bind with the receptor molecules on the membrane of the other neuron
  - The membrane of this neuron is called the **postsynaptic membrane**
- This stimulates the second neuron to generate an electrical impulse
- The neurotransmitters are destroyed to prevent continuous stimulation
- Synapses ensure impulses travel in one direction
- Drugs such as Heroin, Alcohol act upon the synapses to create impulses

Sense Organs

- Sense organs are groups of **receptor** cells responding to specific stimuli
  - stimuli: light, sound, touch, temperature and chemicals
- Eye is a sense organ sensitive to light
- Structures of the eye
  - Pupil
    - Allows light in
  - Cornea
    - Refracts light
  - Iris
    - Controls how much light enters pupil
  - Lens
    - Focuses light onto retina
  - Retina
    - Contains light receptors, some sensitive to light of different colours
  - Optic nerve
    - Carries impulses to the brain
- The Pupil reflex
  - Protects retina from damage
  - In Dim light the pupil **dilates** in order to allow more light in
    - Photoreceptors detect change in environment (dark)
    - Radial muscles contract
    - Circular muscles relax
    - Pupil dilates (diameter increases)
  - In Bright light the pupil **constricts** in order to prevent too much light entering the eye and damaging the retina
    - Photoreceptors detect change in environment (light)



            - Radial muscles relax
            - Circular muscles contract
            - Pupil constricts (diameter decreases)
    - Accommodation viewing near & distant objects
        - The way lens bring about find focusing is called **accommodation**
        - The lens is elastic and its shape can be changed when the **suspensory ligaments**
        - Changes are brought by ciliary muscles
        - When an object is close
            - Ciliary muscles contract
            - Suspensory ligaments slacken
            - lens become fatter
                - Light is refracted more

        - When an object is far
            - Ciliary muscles relax
            - Pulled tight
            - Lens become thinner
                - Light is refracted less

    - Rods & Cones
        - Rods are sensitive to dim light
        - Cones distinguish between different colours of light
            - There are 3 types, each sensitive to different types of light (RGB)
        - The **fovea** is an area on the retina, where **almost all of the cone cells are found**
        - **Rod cells** are found all over the **retina,** other than the area where the optic nerve attaches to the retina
            - There are no light-sensitive cells at all in this area, and so it is known as the **blind spot**

- Hormones in humans
    - A **hormone** is a **chemical substance** produced by **glands** and carried by the blood, which alters the activity of one or more specific target organs
        - The glands are collectively known as the **endocrine system**

Glands	Secretions
Adrenal glands	Adrenaline
Pancreas	insulin
testes	testosterone
ovaries	oestrogen

- Adrenaline is the hormone secreted in ‘fight or flight’ situations and its effects,
    - Increases breathing
    - Pulse rate
    - Dilates pupils
        - Increase information can be sent to the brain
    - Increases blood glucose concentration
        - For increased respiration in muscle cells
    - Diverts blood flow towards muscles and away from non-essential parts
- Hormone take a very long time to transmit and the length of the effect is longer than that of the nervous system

- Homeostasis
    - Homeostasis is the maintenance of a constant internal environment
        - Control of internal conditions within set limits (such as temperature, blood, pressure, water concentration)
        - When one of these conditions deviate far away from the normal the body will not function properly and can cause death without medical treatment
            - Diabetes
                - Need to control glucose intake as the boyd is unable to regulate them
                - **Type 1 diabetes** is a condition where the blood glucose levels are not able to be regulated as the **insulin-secreting cells in the pancreas are not able to produce insulin**
                    - Often blood glucose levels are often far too high
                - It can be treated by **injecting insulin**
                - Symptoms of diabetes: thirst, weakness or tiredness, blurred vision, weight loss and loss of consciousness in extreme cases
    - Most homeostatic mechanisms in the body are controlled by a process known as **negative feedback**
    - **Negative Feedback**
        - Negative feedback occurs when conditions change from ideal or set point and returns conditions to a set point
        - If the level of something rises, control systems are switched on to reduce it again
        - If the level of something falls, control systems are switched on to raise it again
- Negative feedback mechanisms are usually a continuous cycle of bringing levels down and then bringing them back up so that overall, they stay within a narrow range.
- Blood glucose levels are controlled by a negative feedback mechanism involving the production of two hormones **insulin** and **glucagon**
- **Insulin** is produced when blood glucose **rises** and **stimulates** liver and **muscle cells to convert glucose into glycogen to be released into the blood**
- **Glucagon** is produced when blood glucose **falls** and **stimulates liver and muscle cells to convert Stored glycogen into glucose to be released into the blood.**

- Control of body temperature is a **homeostatic** mechanism
- The human body need to maintain a temperature of 37°C for enzymes to work best
    - If it increases too much enzymes might denature
- Regulation is controlled by the brain which contains receptors sensitive to the temperature of the blood
- The skin also temperature receptors and sends nervous impulses to the brain
- Fatty tissue under the dermis (in skin) acts as a layer of insulation to prevent too much boyd heat being lost through the skin

- If the body is hot
    - Sweat is secreted by sweat glands
        - Cools skin by evaporation
            - Heat energy from the body is lost as liquid water in sweat becomes water vapour
        - Hairs lie flat against skin, allowing air to freely circulate
            - Increases transfer of heat to environment by radiation
        - Vasodilation
            - Skin capillaries get wider
                - This cools the body as blood carries heat and is flowing at a faster rate through the skin's surface and so more heat is lost by radiation
- If the body is cool
    - Skeletal muscles contract rapidly and we shiver
    - These involuntary muscle contractions need **energy from** respiration and some of this **released as heat.**
    - Erect hairs trap a layer of air around the skin which acts an an insulation
    - Vasoconstriction
        - Skin capillaries get narrower
        - This reduces the amount of heat lost from blood by radiation
- Tropic responses
    - Plants can respond to changes in environment for survival
    - These responses are called **tropisms**
        - These are chemical controls of plant growth
    - Two Types
        - Gravitropism
            - Where the stimulus is gravity
            - Growth towards or away from gravity
            - Positive response: Growth towards gravity (roots)
            - Negative response: Growth away from gravity (shoots)

        - Phototropism
            - Where the stimulus is light
            - Growth towards or away from the direction of light
            - Positive response: Growth towards light (shoots)
            - Negative response: Growth away from light (roots)

- The role of Auxin
  - Plants respond to stimuli by producing a **growth hormone called auxin** which controls the direction of growth of roots or stems
    - Therefore we day plants control their growth **chemically**
  - Auxin is mostly made in the **shoot tips** and can diffuse to other parts of the stems or roots; spreading from a high concentration in the shoot tips down the shoot to an area of low concentration
  - Auxin elongates the tip
  - Auxin is unequally distributed in response to light and gravity
  - Auxin stimulates cell elongation

- Use of plant hormone and 2, 4-D as weedkillers
  - These are **synthetic hormones** (auxin, 2,4-D)
  - They are **selective** so they are sprayed onto the area such as a lawn or form crops and the synthetic auxin **affects the weeds but not the grass/ crop plants**
  - The weeds respond by **growing very fast and then die off**

Drugs

- What is a Drug?
  - A drug is any substance taken into the body that modifies or affects chemical reactions in the body
  - Some drug are medicinal drugs that are used to treat the symptoms or causes of disease (antibiotics, etc)

- Antibiotics
  - Antibiotics are chemical substance made by certain fungi or bacteria that affect the working of bacterial cells, either by **disrupting their structure or function** or by **preventing them from reproducing**
  - **Antibiotics kill bacteria but do not affect viruses**
  - Antibiotics when in contact with a bacterial cell can rupture the cells and then the bacterial cell will die when it tries to grow
  - Some bacteria are resistant to antibiotics which reduces the effectiveness of antibiotics

- Why antibiotics don't affect viruses?
  - Viruses cannot be treated with antibiotics
  - Disrupting cell functions such as respiration, or breaking down the structure
  - Since viruses do not carry out any cell functions and do not have cell walls, they cannot be affected

- Antibiotic resistance
    - Antibiotics are **widely overused**
    - Commonly prescribed antibiotics are becoming less effective due to these reasons:
        - Overuse and being prescribed when not necessary
        - Patients failing to complete the fully described course by the doctor
        - Large scale use of antibiotics in farming to prevent diseases
    - If a bacteria becomes resistant to all known antibiotics we call that bacteria a superbug and the most common bacteria is **MRSA**

    - Prevention methods
        - Only taking antibiotics when essential
        - Ensure the entire course is completed

Misused Drugs

- Alcohol
    - Wine, beer and spirits contain an alcohol called ethanol
    - It is a depressant drug - it slows down signals in the nerves and brain
    - Alcohol increases reaction times (slowing the body)
    - Effects of alcohol
        - Vomiting (alcohol toxicity)
        - Impaired judgement and violent behaviour
        - Impaired balance and muscle control
        - Sleepiness and in excess can cause unconsciousness
        - Damages the brain causing memory loss and confusion (long term)
        - Heavy alcohol abuse over a long period of time damages the liver, causing cirrhosis
        - The liver is the site of breakdown of alcohol and other toxins
    - It is an addictive drug

- Heroin
    - Depressant drug
    - Slows down reaction time
    - Require higher dosage over time
        - Overdose can cause death
    - May result in committing crimes to get the drug
    - Withdrawal symptoms
        - Nause
        - Muscle cramps
        - Sweating
        - Anxiety
        - Difficulty sleeping
    - Syringes are required to inject drug needles could be **affected by HIV**

- Heroin effect on the nervous system
    - The heroine is metabolised to morphine in the body
    - Morphine molecules **fit into some fo the endorphin receptors** (reduce sensation) and this is why taking heroin makes users feel so good
    - Taking heroin can reduce the production of natural endorphins thus requiring more of the substance to get the same feeling

- Tobacco & Gas exchange system
    - Smoking causes various lung cancers and coronary heart disease
    - Cigarettes contain:
    - **Tar** - a carcinogen (a substance that causes cancer)
        - Tar increases the chance of cancerous cells developing in the lungs
        - Also Contributes to **COPD**
        - Chronic bronchitis is caused by tar which stimulates goblet cells and mucus glands to enlarge, producing more mucus
        - It destroys **cilia**, inhibiting the cleaning of the airways and mucus builds up blocking the smallest bronchioles
        - **Emphysema** develops as a result of **frequent infection**, meaning phagocytes are attracted to the lungs where they release elastase - an enzyme that breaks down the elastin in the alveoli walls to enable them to reach the surface where the bacteria are.
            - Without elastin, the alveoli will burst, making it harder for the smoker to breathe

    - **Nicotine** - an addictive substance which also narrows blood vessels
        - Nicotine narrows blood vessels so i'll put more strain on the circulatory system and increase blood pressure
        - Narrow blood vessels get clogged up easier, this causes coronary heart disease
        - The heart muscles are not receiving enough oxygen and so less aerobic respiration takes place
        - To compensate, the cells respire anaerobically, producing **lactic acid** which cannot be removed
        - This creates a **low pH** environment in the cells causing **enzymes to denature** and eventually **heart muscle cells will die**
            - If enough die this can cause a heart attack
    - **Carbon monoxide** - reduces the oxygen-carrying capacity of the blood
        - **Carbon monoxide** binds irreversibly to haemoglobin, reducing the capacity of blood to carry oxygen
        - Puts strain on the breathing system
        - Increases risk of Coronary heart disease

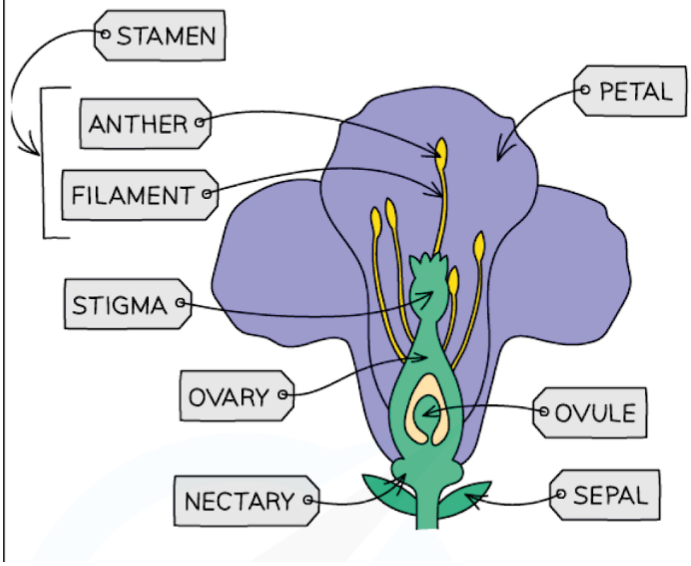
- Drugs in sport
    - Hormones produced in the body help to control the way it develops and responds to changes
        - Drugs are used to increase these effects
    - Drugs
        - Testosterone
            - Hormone produce in testes affects the development of male secondary sexual characteristics
            - More proteins to be made in muscles so that muscles become larger and stronger
        - Steroid
            - Group of hormones which stimulate anabolic reactions to occur in the body (synthesis of large molecules from smaller ones), so it is known as an anabolic steroid
            - increases muscle mass, helps athletes train harder and for longer periods of time, and can increase aggression which can give an edge when competing
    - Side effects
        - Increase the risk of heart disease
        - Increases risk of liver damage
        - Increases risk of kidney damage
        - Affect the menstrual cycle in women
        - Increase immunity of the body

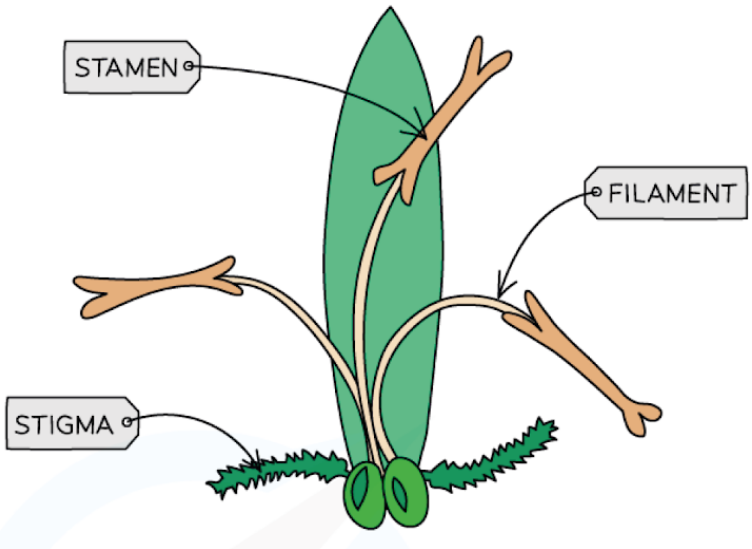
Reproduction

- Asexual reproduction
    - Process resulting in the production of genetically identical offspring from one parent
    - Examples are binary fission, budding(using bulbs, tubers and runners)
    - Advantages
        - Population can be increased rapidly
        - Can exploit suitable environments quickly
        - More time and energy efficient
    - Disadvantages
        - Limited genetic variation in population
        - Population is vulnerable to changes in conditions and may only be suited for one habita
        - Disease is likely to affect the whole population as there is no genetic variation

- Sexual reproduction
    - Sexual reproduction as a **process involving the fusion of the nuclei of two gametes to form a zygote and the production of offspring that are genetically different from each other**
    - Fertilisation is the **fusion of gamete nuclei**
    - Nuclei of gametes are **haploid**
    - The nucleus of a zygote is **diploid**
    - Advantages
        - Increases genetic variation
        - The species can adapt to new environments due to variation, giving them a survival advantage
        - Disease is less likely to affect population
    - Disadvantage
        - Takes time and energy to find mates
        - Difficult for isolated members of the species to reproduce

- Sexual reproduction in plants
    - Flowers are the reproductive organ of the plant
    - They usually contain both male and female reproductive parts
    - Plants produce which contains a nucleus inside that is the **male gamete**
    - Unlike the male gamete in humans, pollen is **not capable of locomotion**
        - So plants have mechanisms to transfer pollen
    - Transfer of pollen is known as **pollination**
        - **Transferred by insects (left)**
        - **Transferred by wind (right)**





- Pollen
    - Insect pollinated flowers produce smaller amounts of larger, heavier pollen grains that often contain spines or hooks on the outside so that they are able to stick better
    - Wind pollinated produce large amount of small, lightweight pollen grains that are usually smooth
- Self & Cross-Pollination
    - **Cross-Pollination** occurs when the **pollen from one plant is transferred to the stigma of another plant of the same species**
        - This is the way most plants carry out pollination as it **improves genetic variation**
        - Bees are common pollinators

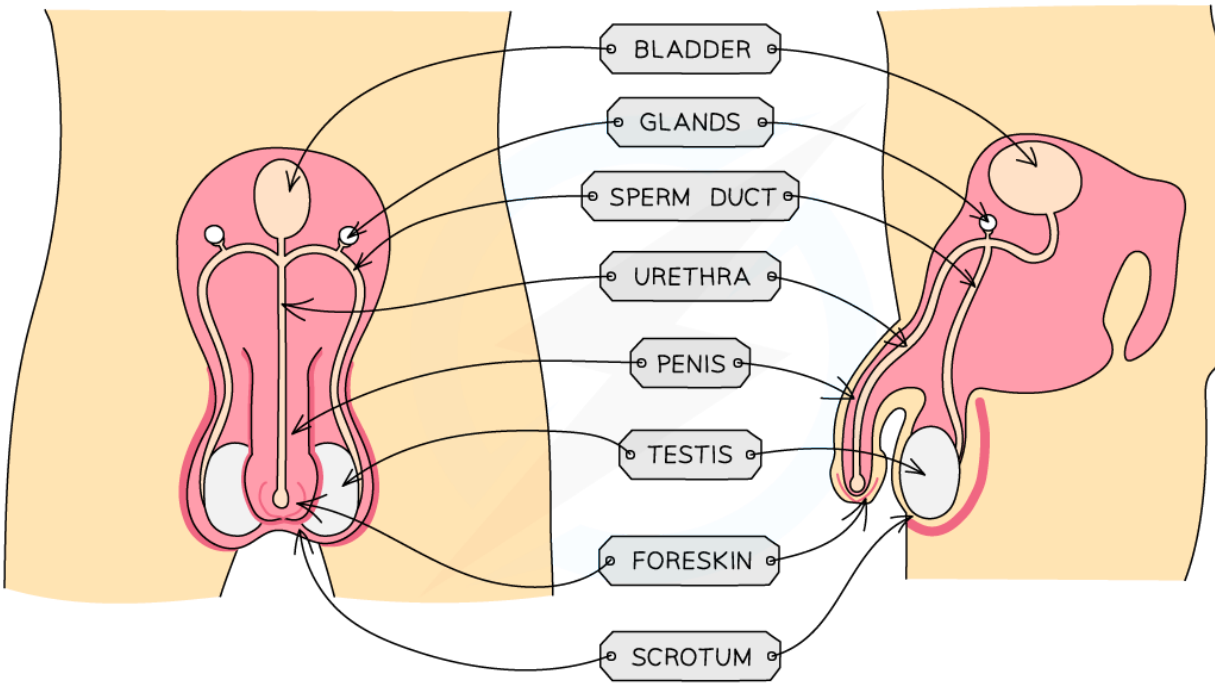
    - **Self pollination** is the transfer of pollen grains from the anther of a flower to the stigma of a flower on a different plant of the same species
        - Reduce genetic variance

STRUCTURE	DESCRIPTION
SEPAL	PROTECTS UNOPENED FLOWER
PETALS	BRIGHTLY COLOURED IN INSECT–POLLINATED FLOWERS TO ATTRACT INSECTS
ANTHER	PRODUCES AND RELEASES THE MALE SEX CELL (POLLEN GRAIN)
STIGMA	TOP OF THE FEMALE PART OF THE FLOWER WHICH COLLECTS POLLEN GRAINS
OVARY	PRODUCES THE FEMALE SEX CELL (OVUM)
OVULE	CONTAINS THE FEMALE SEX CELLS (FOUND INSIDE THE OVARY)

- Fertilisation
    - Occurs when a pollen nucleus fuses with a nucleus in an ovule
    - As the pollen have to grow a **pollen tube**
        - Only happens if the pollen grain has landed on the same species as the flower
    - The nucleus inside the pollen grain slips down the tube as it grows down the style towards the ovary
    - The ovary contains one or more **ovules** which each contain an ovum with a female nucleus that a malle pollen nucleus fuses with
    - As soon as the ovule is fertilized an zygote (diploid) is formed

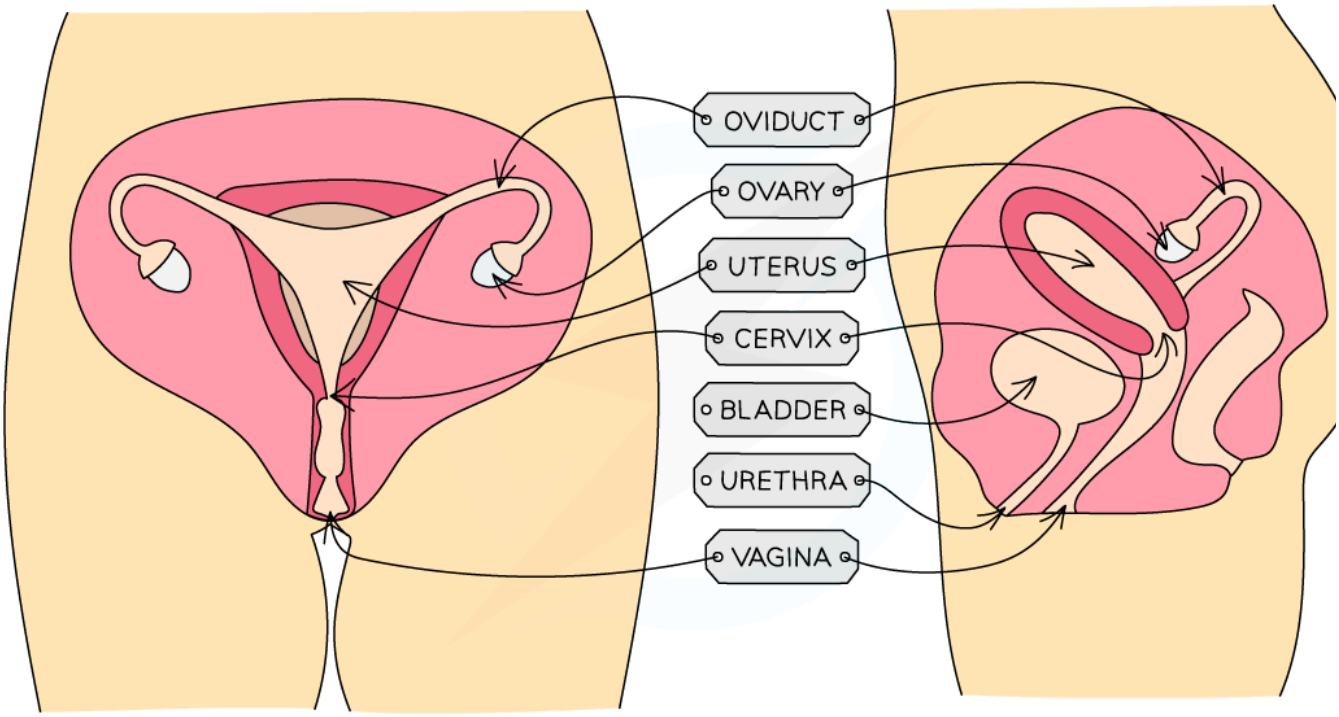
    - The zygote will start to divide and eventually form a seed within the ovule
        - Fruits develop from the ovary, seeds are in the fruit
- Germination
    - Start of the growth in the seedc
    - Factors that affect germination
        - **Water** - Allows the seed to swell up and the enzymes in the embryo to start working so that growth can occur
        - **Oxygen** - So that energy can be released for germination
        - **Warmth** - Germination improves as temperature rises as the reactions which take place are controlled by enzymes

Sexual reproduction in Humans



- Prostate gland
    - Produces fluid called semen that provide sperm cells with nutrients
- Sperm duct
    - Sperm passes through the sperm duct to be mixed with fluids produced by the glands before being passed into the urethra for ejaculation
- Urethra
    - Tube running down the centre of the penis that can carry out urine or semem, a ring of muscle in the urethra prevents the urine and semen from mixing
- Testis
    - Produces sperm the male gamete and testosterone

- Scrotum
    - Sac supporting the testes outside the body to ensure sperm are kept at temperature slightly lower than body temperature
- Penis
    - Passes urine out of the body from the bladder and allows semen to pass into the vagina of a woman during sexual intercourse

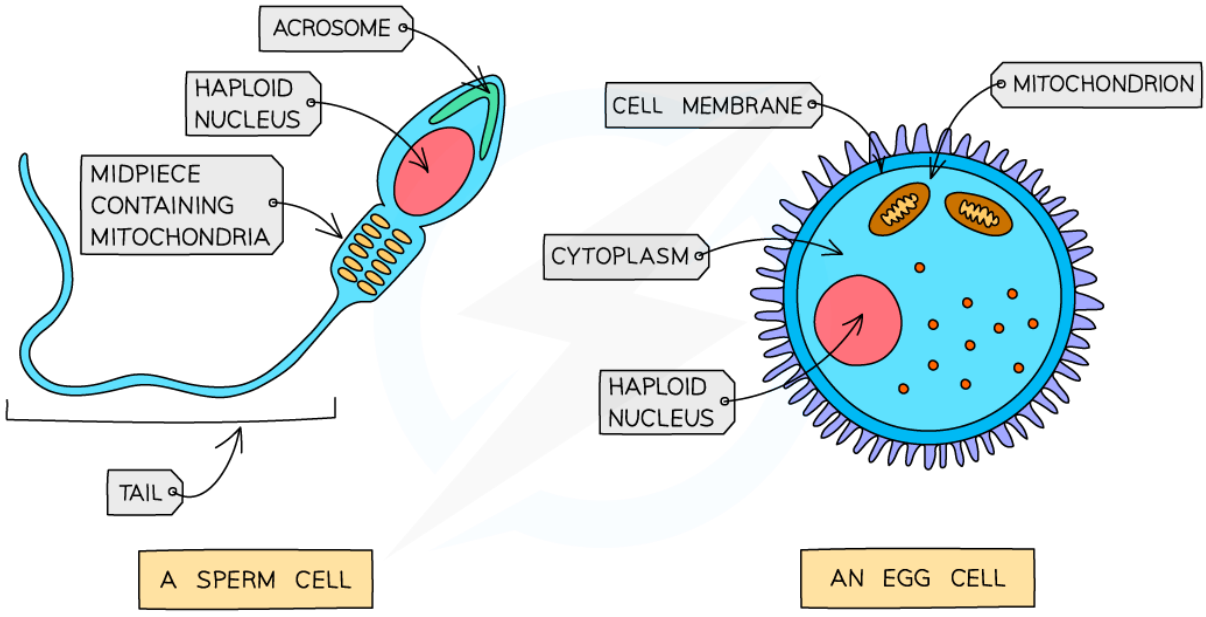


- Oviduct
    - Connects the ovary to the uterus
- Ovary
    - Contains ova which will mature and develop when hormones are released
- Uterus
    - Muscular bag with a soft lining where the fertilised egg will be implanted to develop into a foetus
- Cervix
    - Ring of muscle at the lower end of the uterus to keep the developing foetus in place during pregnancy
- Vagina
    - Muscular tube that leads to the inside of the woman's body, where the male's penis will enter during sexual intercouse and sperm are deposited

- Fertilisation
    - Fusion of the nuclei from a male gamete and a female gamete
    - Occurs in the oviduct
    - Gametes have **adaptations** to increase the chances of fertilisation and successful development of an embryo

- Sperm cells (45 μm)
  - Produced every day in huge numbers
  - Has a flagellum (tail for swimming)
  - Contains enzymes in the head region (acrosome)
    - To digest the outer coating of the egg cell
  - Contain many mitochondria
    - Provide respiration so that the flagellum can move back and forth for locomotion

- Egg cell (0.2mm)
  - Thousands of immature eggs in each ovary, but only one released each month
  - Cytoplasm containing a store of energy
    - Provides energy for dividing zygote after fertilisation
    - Jelly like coating that changes after fertilisation
      - Forms an impenetrable barrier after fertilisation to prevent other sperm nuclei entering the egg cell



- Pregnancy & Birth
  - After fertilisation in the oviduct, the zygote travels towards the uterus
    - Takes about 3 days
    - During this time, the cells divide several times to form a ball of cells known as a **embryo**

- In the uterus, the embryo embeds itself in the thick lining (implantation) and continues to grow and develop
- Gestation period for humans is 9 months
- Major organs develop in the first 12 weeks
  - The placenta forms about now
- The embryo is not called a fetus
- The fetus is surrounded by an amniotic sac which contains amniotic fluid
  - Protects fetus by cushioning it
- The **umbilical cord joins** the fetus's blood supply to the placenta for exchange of nutrients and removal of waste products

- Placenta
  - During the gestation period the fetus develops and grows gaining the **glucose, amino acids, fats,water and oxygen**
  - The bloods run opposite each other, never mixing, in the **placenta**
  - The mother's blood absorbs the waste from the fetus's blood in the placenta
  - Movement of all molecules across the placenta occurs by diffusion
    - Placenta is adapted by having a large a surface area and a thin walls
  - The placenta also acts as a barrier to prevent toxins and pathogens getting into the fetus's blood
    - Not all toxin molecules and pathogenic organisms are stopped
      - Rubella
      - Nicotine (should not smoke during pregnancy)
  - The placenta detaches from the uterus wall and is pushed out due to contractions in the muscular wall of the uterus - known as the **afterbirth**

- Stages of Birth
  - Amniotic sac brakes
  - Muscles in the uterus wall contract
  - Cervix dilates
  - Baby passes out through the vagina
  - Umbilical cord is tied and cut
  - Afterbirth

- Antenatal care (before birth care)
  - Diet should consist of folic acid to prevent developmental issues with fetus and the importance of a **balanced diet**
  - Exercise to stay fit
  - Health precautions such as avoiding infections, **tobacco, alcohol** and other **drugs**

- Breastfeeding
    - Mammary glands enlarge and become prepared to secrete milk
    - Shortly after birth, the mother will be stimulated to release milk due to the sucking action of the baby at the breast
        - Free
        - Helps develop bond between mother and baby
        - Contains antibodies which help prevent infections in babies
        - Contains the exact amounts of nutrients required by the baby at different stages
        - Can cause postnatal depression as it does not come easily to mothers
    - Some mothers use formula milk in a bottle instead
        - Risk of infection increases
        - Expensive
        - Allows more more freedom
        - Allows father to bond with baby

Sex hormones in humans

- Secondary sexual characteristics
    - Changes that occur in puberty
        - Controlled by testosterone (in boys) and oestrogen (in girls)
        - Examples body hair growth (occur in both)
    - Male sexual characteristics
        - Growth of penis & testes
        - Growth of facial & body hair
        - Muscles develop
        - Voice breaks
        - Testes start to produce sperm

    - Female sexual characteristics
        - Breasts develop
        - Body hair grows
        - Menstrual cycle begins
        - HIps get wider

- Menstrual cycle
    - Starts at around age 12 controlled by hormones
    - Average menstrual cycle is 28 days longs
    - **Ovulation** (the release of an egg) occurs about halfway through the cycle (day 14) and the egg travels down the oviduct to the uterus
    - Failure to fertilise the egg causes menstruation to occur
        - Causes breakdown of thickened lining of the uterus
        - Menstruation lasts around 5-7 days and signals the beginning of the next cycle
    - After menstruation finishes, the lining of the uterus starts to thicken again

- Hormonal control of the menstrual cycle
    - Controlled by hormones released from ovary and pituitary gland in the brain
    - Oestrogen levels rise on day 1 to peak just before day 14 (before ovulation)
        - Stimulates the uterus to develop a lining
        - Inhibits FSH and IH production post ovulation

    - Progesterone starts to rise after ovulation has occurred
        - Maintains and thickens lining of the uterus
        - Inhibits FSH and LH production
        - If fertilisation does not occur, the levels drop and menstruation occurs

    - FSH (follicle stimulating hormone) causes an egg to start to mature in the ovary
        - Produced in the pituitary gland
        - Stays about the same throughout the menstrual cycle

    - LH (Luteinizing hormone)
        - Causes ovulation to occur and stimulates ovary to produce progesterone

- How all 4 hormones work together
    - The FSH stimulates the development of a follicle in the ovary
    - An egg develops inside the follicle and the follicle produces the hormone **oestrogen**
    - Oestrogen causes **growth and repair of the lining of the uterus wall** and inhibits the production of FSH
    - When oestrogen rises to a high enough level it stimulates the release of **LH** from the pituitary gland which causes ovulation
    - The follicle becomes the **corpus luteum** and starts producing **progesterone**
    - If the ovum is not fertilised, the corpus luteum breaks down and stops producing progesterone
    - This is where menstruation begins, the uterus lining breaks down and is removed through the vagina
    - If the ovum is fertilised the corpus luteum keeps producing progesterone until the placenta has developed
        - Placenta takes over the secretion of progesterone

- Birth controls
    - Important to limit increase in human population
    - Prevent STI (Sexually transmitted infections) and STD
        - Unprotectyed sexual intercouse can lead to the transfer of pathogens via exchange of body fluids
        - Infections passed on in this way are known as STIs
            - HIV (Human immunodeficiency virus), the virus that usually leads to the development of AIDS (acquired immunodeficiency virus)
                - HIV can also spread via sharing needles with an infected person

        - From mother to fetus through placenta or breastfeeding
    - Controlled by limiting the number of sexual partners
        - Not having unprotected sex
        - Getting tested
        - Raising awareness
- How HIV works
    - Immediately after infection people suffer from flu-like symptoms
    - These symptoms pass and for a period of time infected people might not know they are infected
    - The viruses affects lymphocytes
        - They are cells of the immune system
    - HIV avoids being recognised and destroyed by lymphocytes by repeatedly **changing its protein coat**
    - Uses the lymphocytes to increase in number
        - Reduces the number of lymphocytes and number of antibodies
    - Making the body **immuno-compromised**

- Natural Birth control
    - Abstinence
        - avoding of sexual intercouse
    - Rhythm
        - Avoiding sexual intercouse during fertile period
- Chemical
    - IUD.IUS
        - Intrauterine device or intrauterine system is a small device fitted inside the uterus by a doctor or nurse
        - Release hormones to thicken the mucus produced in the cervix making it difficult for sperm to swim into the uterus

    - Contraceptive pill, injection or implant
        - May contain a mixture of progesterone and oestrogen
        - Mimic hormone level during pregnancy, the uterus lining is maintained and development of anther egg cell is prevented
    - Spermicide
        - Cream that kills sperm

- Barrier
    - Prevent sperm from reaching egg
    - Condom
        - Latex sheat worn over the eggs
        - Prevents sperm entering the vagina as ejaculate remains in condoms
        - Also protects against STIs

        - Femidom
            - Latex sheath inserted into the vagina
            - Prevents entry of sperm into the vagina
        - Diaphragm
            - Rubber caps that fit over the entrance to the cervix
    - Surgical
        - Vasectomy
            - Sperm ducts are cut so no sperm present in semen
            - Very effective difficult to reverse
        - Female sterilisation
            - The oviducts are cut or tied off
            - Difficult to reverse
    - Fertility treatments
        - Treatments for people finding it difficult to conceive
        - Artificial insemination
            - If the male is not producing healthy sperm, donor sperm can be used
            - The sperm are placed into the female's vagina at the fertile poin in her menstrual cycle

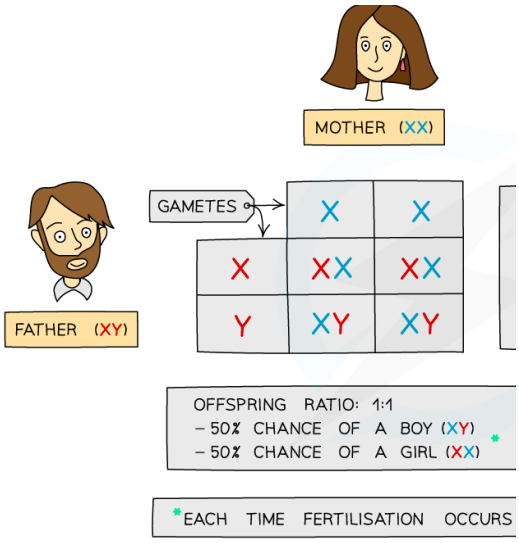
        - Fertility drugs
            - Used when female is not producing enough eggs
            - Hormones are given to stimulate egg production
        - In vitro Fertilisation
            - If the female cannot conceive naturally even after taking fertility drugs or if there are issues with both male and female fertility in a couple, IVF is used
            - The eggs are inseminated in a petri dish and once embryos have formed, they are placed back into the uterus of the female
            - Several embryos are implanted to increase the chance of one developing further

Inheritance & Cell Division

- Inheritance is the **transmission of genetic information from generation to generation**
- **Chromosomes** are located in the nucleus of cells
- They are **thread-like structures of DNA, carrying genetic information in the form of genes**
- **A gene** is a short length of DNA found on a chromosome that **codes for a specific protein**
- This could be a structural protein such as a collagen found in skin cells, an enzyme or a hormone
- Genes control our characteristics as they code for proteins that play important roles what our cells do
- **Alleles** are **different versions of a particular gene**
    - Examples: I^A, I^B
- Humans have **23 different** chromosomes in each cell
- In most body cells(expect gamete cells), we have 2 copies of each chromosomes (mother and father), leading to a total of **46 chromosomes**
- Gametes cells have 23 chromosomes
- Nuclei with one set of unpaired chromosomes are known as **haploid nuclei**

- XX & XY chromosomes
    - Sex is determind by an entire pair of chromsome pair
    - Females have Chromosomes XY
    - Males have Chromosomes XX
    - Only the father can pass on the Y chromosome

- Inheritance can be shown using a genetic diagram



- Protein synthesis
    a. DNA unwinds
        - Proteins are made by ribosomes with the sequence of amino acids controlled by the sequence of bases contained within DNA
    b. Gene is copied into mRNA
        - As DNA cannot travel out the nucleus
        - Base code of each gene is transcribed onto an RNA molecule called mRNA or messenger RNA
    c. mRNA moves out of the nucleus into cytoplasm
    d. mRNA passes through ribosome
        - Attaches to the ribosomes
    e. The ribosome assembles amino acids into a particular order to make a protein
        - The ribosome ‘reads’ the code in triplets
            - Each triplet is a amino acid
            - Order is determined by the sequence of the bases in the mRNA
        - This make up a sequence of amino acids and when it is released from the final structure of the protein

- Mitosis
    - Nuclear division giving rise to genetically identical cells

    - Most body cells have two copies of each chromosome (diploid)
    - Required for:
        - Growth
        - Repair of tissues
        - Replacement of cells
        - Asexual reproduction
    - Exact duplication of chromosomes occurs before mitosis
    - During mitosis, the copies of chromosomes separate, maintaining the chromosome number

- Stem cells
    - Unspecialised cells that divide by mitosis to produce daughter cells that can become specialised for specific functions

- Meiosis
    - Reduction division in which the chromosome number is halved from diploid to haploid resulting in genetically different cells
    - Meiosis is involved in the production of gametes
    - Meiosis produces **4 haploid cells**
    - **Process**
        - Each chromosome make identical copies of itself
            - Forming an x shaped chromosomes
        - Chromosomes pair up along the centre of the cell, recombination occurs and then cell fibres will pull them apart, each new cell will have one of each recombinant chromosome pair (first division)
        - Chromosomes will line up along the centre of the cell, cell fibers will pull them apart (second division)
        - A total of four haploid daughter cells are produced
    - Allows variation to occur

- Monohybrid inheritance
    - Genotype is the genetic make-up of an organism in terms of the alleles present
    - Phenotypes is the observable features of an organism
    - Homozygous is having two identical alleles of a particular gene
    - Two identical homozygous individuals that breed together will be pure-breeding
    - Heterozygous individual will not be pure-breeding
    - Dominant is an allele that is expressed if it is present
    - Recessive is an allele that is only expressed when there is no dominant allele of the gene

- Codominance
    - is a type of inheritance where both the alleles are expressed
    - I^A and I^B are codominant

        - I is the gene, A and B are the alleles
        - These are genes that determine blood group
        - I^A produces the antigen A in the blood
            - Same for the others

- Sex-Linked characteristics
    - Characteristic in which the gene responsible is located on a sex chromosome and that this makes it more common in one sex than in other
    - Colour blindness is a common example
    - Genetic diagrams are used to predict the results

Variation & selection

- Variation
    - Differences between individuals of the same species
    - Types of variation
        - Phenotypic variation
            - Cause an observable variation in the species
            - Caused by **genetic** and **environmental** factors
        - Genetic variation

- Continuous variation
    - Results in a range of phenotypes between two extremes
        - Example: height, weight
- Discontinuous variation
    - Results in a limited number of phenotypes with no intermediates
        - Example: tongue rolling
    - Mostly caused by genes alone
        - Blood groups are an example
- Mutation
    - Change in the base sequence of DNA
    - Way in which new alleles are formed
    - Ionising radiation and some chemicals increase the rate of mutation

- Sickle cell anaemia
    - Symptoms
        - Breathlessness

            - Due to the cells blocking of the capillaries as they are not flexible (sickle cell crisis)
        - Dizziness
        - Fatigue
    - A change in the base sequence of the gene for haemoglobin results in abnormal haemoglobin and sickle-shaped red blood cells and **sickle**-shaped red blood cells
    - People who are **heterozygous** for the sickle-cell allele (Hb^s) have a **resistance to malaria**
        - Hb^s Hb^A

- Malaria and anaemia
    - Malaria is very common in places like Africa
    - In Africa and other countries with high rates of malaria, people with sickle cell anemia live longer as the malaria virus is unable to reproduce in the cells

- Adaptive features
    - Inherited functional features of an organism that increase its fitness
    - Fitness is the probability of an organism

- Hydrophytes
    - Plants that are adapted to live in extremely wet conditions
    - **Large air species in their leaves** to keep them close to the surface of the water where there is more light for photosynthesis
    - **Small roots** as they can also extract nutrients from the surrounding water
    - Stomata **usually** open all the time and **found on the upper epidermis** of the lead where they can exchange gases much more easily with the air

- Xerophytes
    - **Thick waxy cuticle,** cuts down on water loss
    - **Sunken stomata**, traps more air, lengthens the diffusion pathway, reduces evaporation rate
    - **Leaf rolled and inner surface covered in hair,** traps moist air and prevents air movement across stomata which reduce transpiration
    - **Small leaves**, reduce surface area, reducing transpiration area
    - **Extensive shallow roots** allowing for the quick absorption of large quantities of water when it rains
    - **Thickened leaves or stems,** contain cells that store water

- Selection
    - Individuals that have the best adaptive features are the ones most likely to survive and reproduce
    - Results in **natural selection**

    - **Individuals in a species show a range of variation** caused by differences in genes
    - Organisms **reproduce more offspring** than the environment is able to support
    - This leads to competition for food and other resources which results in a '**struggle for survival**' individuals with characteristics **most suited to the environment**
    - They then pass these alleles to the next generation

- Selective breeding/ Artificial selection
    - Selection by humans of individuals with desirable features
    - Crossing these individuals to produce the next generation
    - Selection of offspring showing desirable
    - Selectively breeding plants
        - Plants are breed for
            - Disease resistance
            - Increase yield, etc
            - Hardiness to weather conditions
            - Better tasting fruits
            - Large or unusual flowers

- Evolution
    - The change in adaptive features of a population over time as the result of natural selection
- Process of adaptation
    - The process resulting from natural selection, by which populations from natural selection, by which populations become more suited to their environment overy many generations

- Antibiotic resistance in Bacteria
    - An **antibiotic** is a chemical that can kill or inhibit the growth and reproduction of bacteria
    - They are extremely useful to humans as some bacteria are **pathogenic** and can cause life-threatening disease
    - Bacteria reproduce, on average, every 20 minutes and therefore **evolution occurs in a much shorter time span**
    - Like all other organisms, **within a population there will be variation** caused by mutation
        - Mutation might cause a population there will be variation
        - Resistant bacteria do not die and continue to reproduce
        - Over time the bacteria becomes antibiotic-resistant
    - Overuse of antibiotics can cause resistance bateria, examples:
        - For treatment for non-serious infections
        - Routine treatment to animals in agriculture
        - Failure to finish prescribed course of antibiotics
    - A common example is MRSA
    - If more and more bacteria become antibiotic-resistant
        - It will be very hard to find antibiotics to treat it

Organisms & their environment

- Energy flow
    - Sun is the principal source of energy input to biological systems
- Producers
    - Organisms that produce their own organic nutrients usually energy from sunlight.
    - Plants are producers as they carry out photosynthesis to make glucose

- **Herbivore** - An animal that get its energy by eating plants
- **Carnivore** - An animal that get its energy by eating other animals
- **Primary consumers** - Organisms that feed on producers
- **Secondary consumers** - Predators that consume on primary consumers
- **Tertiary consumers** - Predators that consume on secondary consumers
- **Decomposers** - Bacteria and fungi that get their energy from feeding off dead and decaying organisms and undigested waste by secreting enzymes to break them down
- **Food chain** is showing the transfer of energy from an organism to the next, beginning with a producer
- Energy is transferred **between organisms in a food chain by ingestion**
- **Food web** is a network of interconnected food chains
- **Trophic level** is the position of an organism in the food chain, food web, pyramid of numbers or pyramid of biomass
    - Producers convert light energy into chemical energy and it flows in this form from one consumer to the next
    - Eventually all energy is transferred to the environment
        - Some being used by each and lost at each stage
- Food webs are more realistic way of showing connections between organisms within an ecosystem as **animals rarely exist on just one type of food source**

- Transfer of energy
    - Very inefficient
    - It has to be consumed
    - Not all of the energy grass plants receive goes into making new cells that can be eaten
    - Organisms lose energy through
        - Making waste products
        - As movement
        - As heat
        - As undigested waste
    - Food chains are rarely more than 5 organisms long

- A **pyramid of numbers** shows how many organisms we are talking about at each level of a food chain
    - **Width of the box** indicates the number of organisms

- **A pyramid of biomass** shows how much mass the creatures at each level would have without including all the water that is in the organisms

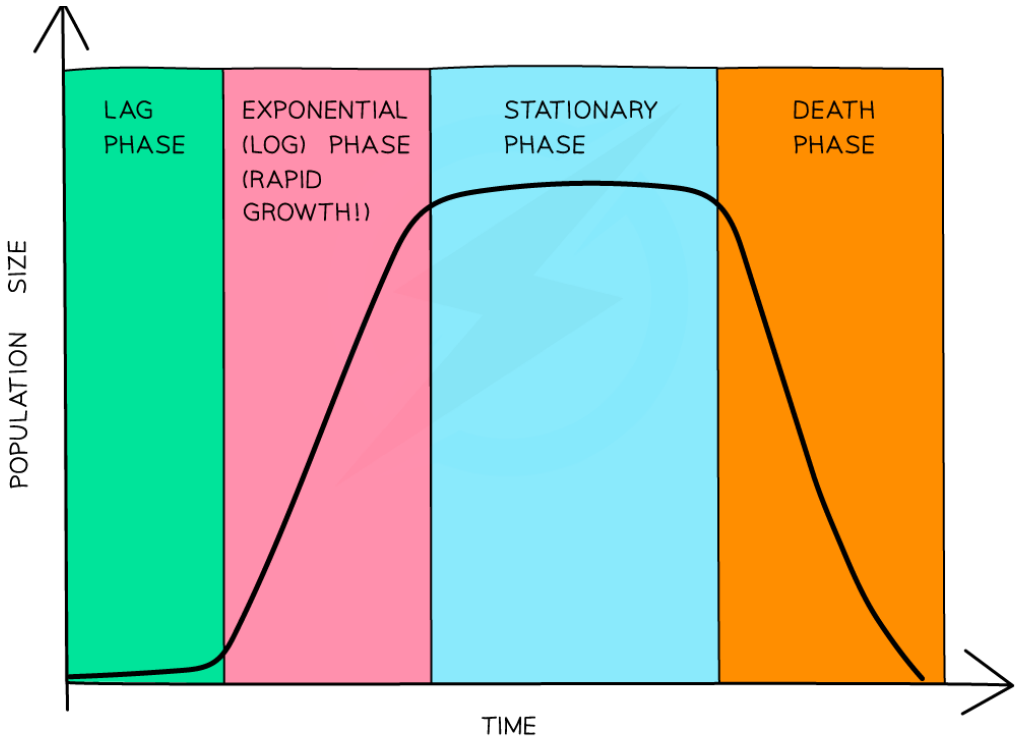
- Carbon cycles
    - Carbon is taken out of the atmosphere in the form of carbon dioxide by plants to be used for photosynthesis
    - It is passed on to animals by feeding
    - It is returned to the atmosphere in the form of carbon dioxide by plants, animals and microorganisms as a result of respiration
    - If animals and plants die in conditions where decomposing microorganisms are not present the carbon in their bodies can be converted into fossil fuels
    - **Increased use of fossil fuels** is contributing to an increase in the carbon dioxide content of the atmosphere
    - Mass deforestation is **reducing the amount of producers** available to take carbon dioxide out of the atmosphere by photosynthesis

- Water cycles
    - Water enters the atmosphere as water vapour by
        - Energy from the sun heats the Earth's surface and water evaporates from oceans, rivers and lakes
        - **Transpiration** from plants release water vapour into the air
    - The moist air cools down as it rises
    - Water vapour condenses back into liquid water, forming **clouds**
    - As the water droplets in the cloud get bigger and heavier, they begin to fall as **rain,snow and sleet**
    - This is called **precipitation**

- Nitrogen cycle
    - Plants nor animals absorb nitrogen from the air
    - There are two ways it can be taken out of the air and converted into something easier to absorb:
        - Nitrogen fixing bacteria
        - Lighting can 'fix' N_2 gas
    - Plants absorb nitrates they find in the soil and use the nitrogen to make proteins
    - Animals eat the plants and get the nitrogen they need from the proteins in the plant or animal
    - **Waste** from animals sends nitrogen back into the soil as ammonium compounds
    - When the animals and plants die, they **decay** and all the proteins inside them are broken down into ammonium compounds and put back into the soil by decomposers
    - The plants can't absorb ammonium compounds though, so then **nitrifying bacteria**
    - Convert the ammonium compounds to nitrites and then to nitrates, which can then be absorbed by plants
    - The third bacteria called **denitrifying bacteria** found in poorly aerated soil
        - Take nitrates out of the soil and convert them into N_2 gas
- Population is the group of organisms of one species, living in the same area, at the same time
- Community is all of the populations of different species in an ecosystem

- Ecosystem is a unit containing the community of an organisms and their environment interacting together
- Human population has exponentially increased in the last 150 years
    - There are many reasons for this exponential growth
    - Improved technology leading to an abundance of food = rapid increase in birth rate
    - Improved medicine, hygiene and health care = decrease in death rate

- Growth and death graph



Biotechnology & genetics

- Bacteria are useful in biotechnology and genetic engineering due to their rapid reproduction and their ability to make complex molecules
- Bacteria are useful in biotech due to:
    - Lack of ethical concerns over their manipulation and growth
    - Genetic code shared with all other organisms
    - Presence of plasmids

- Biofuels
    - Yeast is a single celled fungus that uses sugar as its food source

    - When it respires, **ethanol and carbon dioxide** are produced
    - $C_6H_{12}O_6 \Rightarrow 2C_2H_5OH + 2CO_2$
    - Yeast can respire anaerobically if it has access to plenty of sugar, even if oxygen is available
        - This is used to make bread
        - The carbon dioxide produced by the yeast during respiration is caught in the dough, causing the bread to rise

- Fruit Juice production
    - Fruit juice is produced by squeezing the fruits to remove the juice
    - Chopping the fruit up before squeezing helps to release a lot more juice, but this does not break open all the cells so a lot of juice is lost
    - Instead we add **pectinase** to the chopped up fruit, so that more juice is released
    - Pectinase works by breaking down a chemical called **pectin** that is found inside plant cell walls
    - Once the pectin is broken, the cell walls break more easily and more juice can be squeezed out of the fruit
    - Adding pectinase to fruits also helps to produce a clearer juice
        - As pectin makes the juice more cloudy

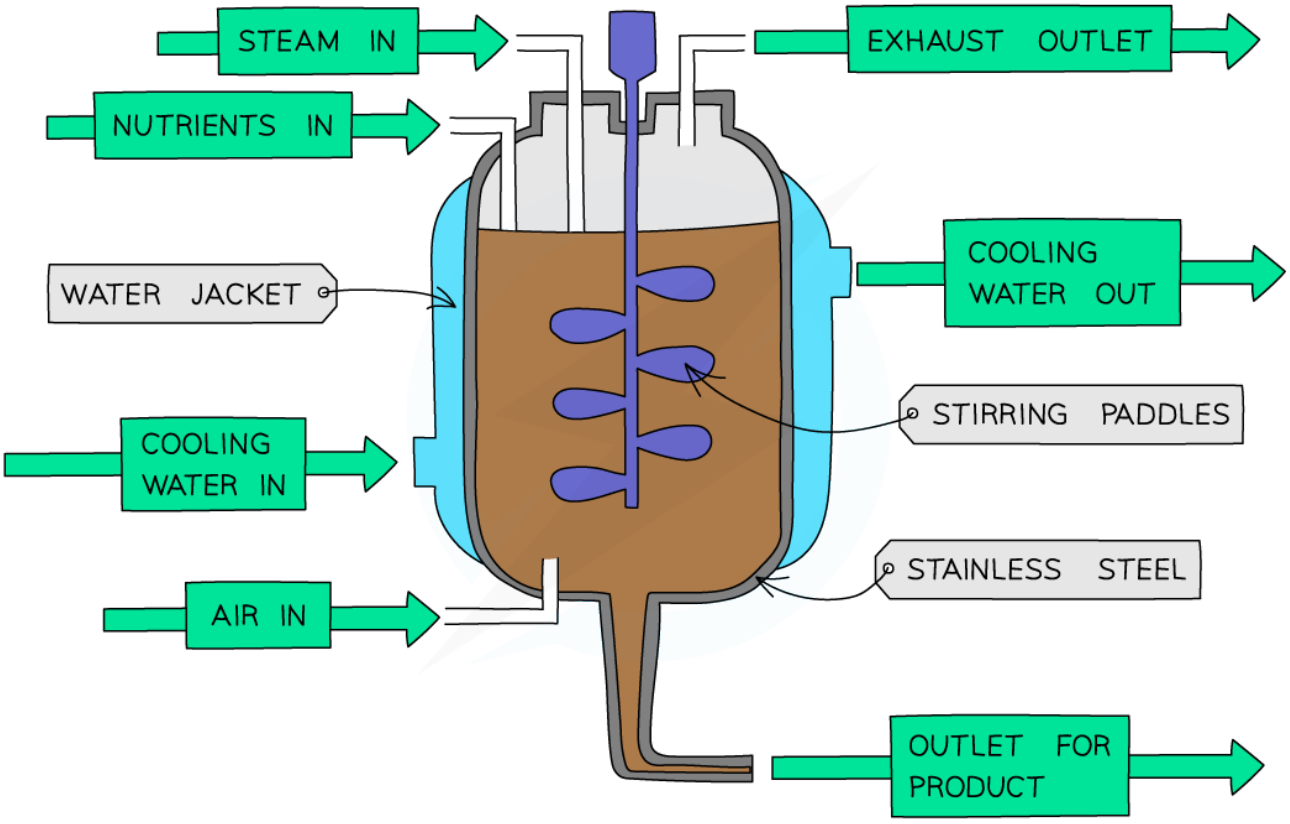
- Biological washing powders
    - Many stains on clothes are organic molecules
        - Oil from sin, fat and protein from food
    - Detergents that only contain soap can remove some these stains when mixed with hot water,
        - This requires a lot of time and very high temperatures
    - Biological washing powders have enzymes similar to the digestive allowing the stains to be broken down
    - The work at low temperatures and require less energy
    - Can be used to clean delicate fabrics

- Lactose-free milk
    - Milk can be made **lactose free** by **adding enzyme lactase to it** and leaving it to stand for a while to allow the enzyme to break down the lactose
        - Used by people who are **lactose-intolerant** (unable to produce lactase to digest milk)
            - Usually older people
            - Can cause diarrhea, nausea and flatulence

- Penicillin production
    - Penicillin was the **first antibiotic** to be discovered
    - mould of the fungus penicillium, was able to kill bacteria
        - Thus called penicillin

- Fermentation production of penicillin

- We had to produce it on a large scale
  - So we used a industrial fermenter
    - Conditions can be controlled to produce large amounts
  - Fermenters are containers used to grow (culture) microorganisms like bacteria and fungi in **large amounts**
  - The fermenter has to be clean, nutrients should present, should have optimum temperature, should have optimum pH, should have oxygen, should be agitated (stirring)
- They are used to produce genetically modified bacteria and penicillium mould that produces penicillin



- Genetic Engineering
    - As changing the genetic material of an organism by removing changing or inserting individual genes
    - Examples of genetic engineering
        - The insertion of human genes into bacteria
        - The insertion of genes into crop plants to confer resistance to herbicides
        - The insertion genes into crop plants to confer resistance to insect pests
        - The insertion of genes into crop plants to provide additional vitamins

    - How genetic engineering using bacterial production of a human protein is done:
        - The DNA making up a human gene is isolated using restriction enzymes, forming sticky ends
        - The cutting of bacterial plasmid DNA with the same restriction enzymes, forming **complementary** ends
        - Insertion of human DNA into bacterial plasmid DNA using **DNA ligase** to form a recombinant plasmid
        - Insertion of plasmid into bacteria
        - Replication of bacteria containing Recombinant plasmids which make human protein as they express the gene

    - Advantages and Disadvantages of genetically modifying crops
        - Advantages
            - Reduced uses of chemicals
            - Better for environment
            - Increase yield from the crops
            - Less time used by farmers
        - Disadvantages
            - Increased costs of seeds
                - Cost more to develop them
                - Poorer farmers cannot compete with larger farms
            - Risk of inserted genes being transferred to wild plants by pollination which could reduce the usefulness of the GM crop
                - If weeds also gain the gene, they will be resistant
            - Reduced biodiversity
                - Fewer plant species when herbicides have been used this can impact insects and insect eating birds

Human influences on ecosystem

- Food supply
    - How modern technology has increased food production:
        - Agricultural machinery to use larger areas of land and improve efficiency
        - Chemical fertilisers to improve yields
        - Insecticides to improve quality and yield
        - Herbicides to reduce competition with weeds
        - Selective breeding to improve production by crop plants and livestock

- Large - scale Monocultures of crop plants
    - Negative impacts on ecosystem
        - Only one type of crop is grown
        - Biodiversity is lower
        - Increase in pest population, if a particular pest feeds upon a crop there will be an abundance of that pest
        - Spraying insecticides leads to:
            - Harmless insects being killed
            - Pollution by pesticides
            - The pests may become resistant to them, reducing their effectiveness

- Intensive livestock farming
    - Large numbers of livestock are often kept in an area that would not normally be able to to support more than a very small number
    - They are often fed high energy foods
    - Given antibiotics
    - Kept in small spaces
    - Ecological issues with intensive farming:
        - Reduction in biodiversity in areas where large amounts of land are used to graze cattle
        - Overgrazing can lead to soil erosion
        - Large numbers of cattle produce large amounts of methane (greenhouse gas)

- Global food supply
    - When people do not receive enough food, **famine** occurs
        - Caused by
            - Natural disasters
            - Drought
            - Flooding
            - Increasing population
            - Poverty
            - Unequal food distribution
            - More land is required to grow crops and animals
            - Global warming

- Habitat destruction
    - Reasons:
        - Increased area for food crop growth, livestock producing and housing
        - Extraction of natural resources
        - Marine pollution
        - deforestation
    - Through altering food webs and food chains, Humans can have a negative impact on habitats
    - Undesirable effects of deforestation on habitat destruction:
        - Extinction
        - Flooding
        - Increase of carbon dioxide in the atmosphere

    - Undesirable effects of deforestation on environment:
        - Extinction/ loss of biodiversity
        - Soil erosion
        - Flooding
        - Increase co2 in atmosphere
            - Plants are unable to remove enough co_2

- Pollution
    - Source and effects of pollution of land and water
        - Insecticides, herbicides, and by nuclear fall-out (effect water bodies)
        - Chemical waste (water)
            - Poison top carnivores
        - Discarded rubbish
            - Can get into food chains way
        - Untreated sewage
            - Causes eutrophication
        - Fertilisers
            - Causes algal bloom

    - Eutrophication
        - Increased availability of nitrate and other ions
        - Increased growth of producers (algae)
        - Increased decomposition after death of producers
        - Increased aerobic respiration by decomposers
        - Reduction in dissolved oxygen
        - Death of organisms requiring dissolved oxygen in water

    - Plastic pollution
        - In marine habitats
            - Animals try to eat plastic, leading to injuries and death
            - As the plastic breaks down it can release toxins these affect marine organisms

        - On land
            - Plastic's toxin can cause soil erosion,
                - Become no good for growing crops or grazing animals

- Female hormones
    - Female contraceptive hormones are excreted from the body in urine and then make their way into the water supply, as they are not filtered out by sewage treatment plants
    - If they reach male aquatic organisms, such as fish and frogs, they are very sensitive to hormone, it can cause feminisation
        - Where males begin to produce eggs and lose the ability to reproduce
        - Lose the ability to reproduce

    - Reduce the sperm count in human males and cause fertility problems

- Acid rain
    - Causes: Sulphur dioxide, oxides of nitrogen
    - Sources: burning of fossil fuels, combustion of petrol in car engines
    - Effects: damage to leaves, killing plants
        - Acidification of lakes, killing animals
        - Increased risk of asthma attacks and bronchitis in humans
        - Corrosion of stonework on buildings
        - Release of aluminium from the soil into lakes that are toxic to fish

- Climate change
    - Greenhouse gas is a gas that absorbs infrared radiation from the sun
        - It remains in the Earth's atmosphere
    - This increases the average temperature of the earth
    - Greenhouse gases
        - Carbon dioxide
        - Water vapour
        - Methane
        - CFCs
    - Consequences
        - Ocean temperatures increases
            - Causing polar ice caps to melt, increasing sea levels
        - Increase temperatures cause extreme weather
        - Can lead to changes in or loss of habitats
        - Decrease in biodiversity
        - Increase in migration
        - Spread of pests and diseases

- Conservation
  - A sustainable resource is one which is produced as rapidly as it is removed from the environment so that it does not run out
  - Some resources such as fossil fuels are non- renewable because they cannot be replaced
  - These resources, once used, cannot be produced anymore and so they need to be conserved by reducing the amount we use and finding other, sustainable resources to replace them
  - Some products like plastics or metals can be reused and recycled to make new things
  - Some resources, such as forests and fish stocks, can be maintained, Enabling us to harvest **them sustainably**
  - Sustainable development
    - Sustainable development is defined as development providing for the needs of an increasing human population without harming the environment
    - When developing the way in which we use resources to manage them sustainably, we have to balance conflicting demands
      - The need for local people to be able to to utilise the resources they have in their immediate environment with the needs of large companies to make money from forests and fishes
      - Need of balancing what current populations need with what future populations might need
    - For development to occur sustainably, people need to corporate at local, national and international levels

  - Sustaining forests
    - Forests are need to produce paper and provide wood for timber
    - Much of the world's paper is now produced from forests which replant similar trees when mature trees are cut, ensuring that there will be adequate supply in the future
    - Using these types of wood has now been made more sustainable due to schemes designed to monitor logging companies and track the wood produced
    - Education helps to ensure logging companies are aware of sustainable practices and consumers are aware of the importance of buying products made from sustainable sources
  - Sustaining fish stocks
    - Methods to manage fish stock sustainably
      - Controlling the number of fish caught each year
      - Controlling the size of fish caught
      - Controlling the time of year that certain fish can be caught depletion of stocks when fish come together in large numbers in certain areas
      - Restocking
      - Educating fishermen on local and international laws

- Sewage treatment
    - Pipes carry sewage water to treatment plants where the organic waste is removed and the water cleaned so it can be returned to natural water sources without causing eutrophication
    - Crude sewage flows through a screen in which large materials like paper and sticks are trapped
    - The sewage is passed slowly through channels where grit and other particles are picked up along the way settle to the bottom - grit is washed and returned to land
    - The channels lead to sedimentation tanks, where the solid material settles on the bottom as sludge and the liquid part, called **effluent**, remains on top
    - Sludge is removed by pumping it into tanks where anaerobic bacteria decompose it
        - The bacteria produce methane which is then used as a energy source
    - The liquid called **effluent** is treated with aerobic bacteria to remove any organic waste in it
    - The liquid is then treated with chlorine to kill the bacteria
    - It can be returned to natural water systems now

- Endangered species
    - Species that at risk of going extinct
    - Causes
        - Not enough genetic variation in the population
            - Inability to adapt
        - Hunting
        - Climate change
        - Pollution
        - Introduction of non-native species
            - Outcompetes native species
    - Solutions
        - Education programmes
        - Captive breeding programmers
        - Monitoring and legal protection
        - Seed banks
            - For plants that are going to be extinct