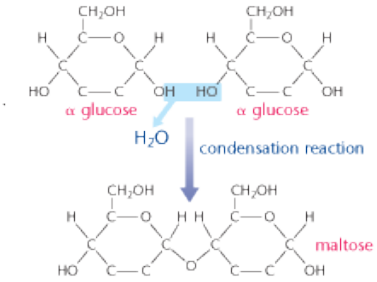
Getting a head start in AS Level Biology



This booklet will provide you with a brief account of the content covered at GCSE and how it crosses over into AS and A2 level. Content will include mostly GCSE content, with extension text relating to the A level.

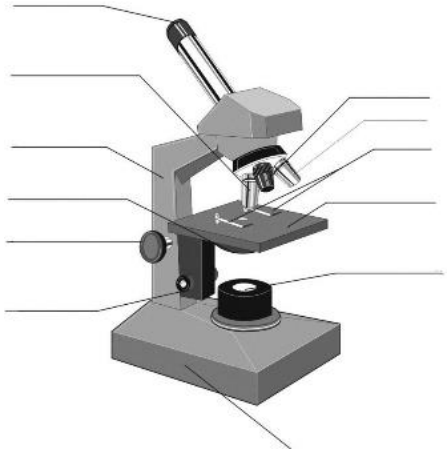
Please use the booklet effectively to ensure you are fully prepared for A-Level Biology.

Best of luck!

Microscopes;

The Light microscope allows you to view animal cells. It can magnify up to 1500 times. Some organelles such as mitochondria, chloroplasts, vacuoles, cell walls, cell membranes and nuclei are visible. Staining makes these organelles visible.

Label and annotate the diagram

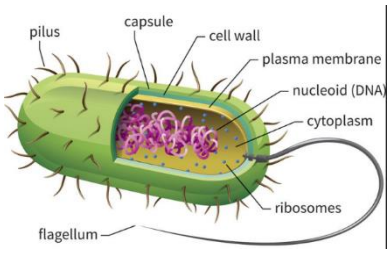


The electron microscope; invented in 1950s it allows a much higher magnification (500 000x) and better resolution, allowing greater detail to be seen. Electron microscopes allowed detailed ultrastructure of the cell to be seen, such as ribosomes and the inside of mitochondria and chloroplasts. The image is called an ELECTRON MICROGRAPH.

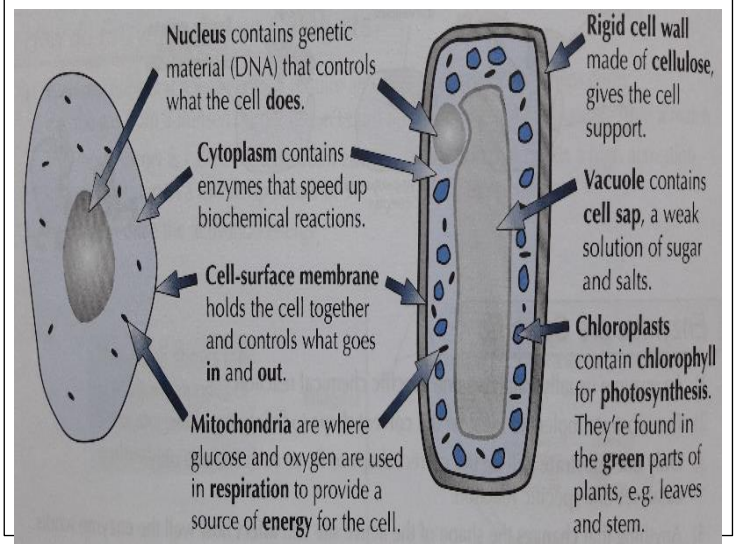
Eukaryotes and prokaryotes;

Prokaryotes are singled celled organisms such as bacteria.

Usually much smaller than eukaryotic cells (1/10th the size), do not contain a nucleus, chloroplasts or mitochondria, DNA can be found floating free in the cytoplasm or in loops called Plasmids, some have flagellum for movement.



Eukaryotic cells are more complex and can be single cellular or multi cellular organisms.



Questions;

Name 3 things visible with a light microscope in both animal and plant cells._____

_____

Name 4 organelles that both plant and an animal cell have. _____

_____

What is the calculation used to calculate the magnification of an object? _____

_____

What is the function of the mitochondria? _____

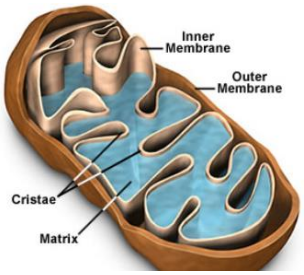
Cell structure;

Nuclei: controls the cell function, containing the DNA which is the coded information for the production of proteins.

During cell division the chromosomes become shorter and thicker and can be seen with a light microscope. The chromosomes will then make a copy of themselves, one copy for each cell produced during cytokinesis.

Nuclei have a double membrane called the nuclear envelope.

Mitochondria: can be seen with a light microscope, however, greater internal detail can be seen using an electron microscope. The mitochondria's function is to carry out aerobic respiration.



The energy released is used to form molecules of ATP.

ATP is used in the cells to provide energy for muscular contractions, active transport as well as anabolic and catabolic reactions.

Cell wall: the plant cell wall is made up of cellulose Molecules laid side by side to form microfibrils.

These provides rigidity and support for the cell.

Questions;

Name 2 molecules that make up the cell membrane.

_____

Describe the membranes of the mitochondria.

_____

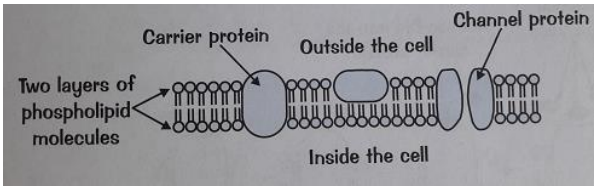
What is the name of the molecule that provide energy to the cell? _____

What term is used to describe water concentration?

_____

Cell structure;

Cell surface membrane: Found around every cell, it allows the movement of substances into and out of the cell. It is a partially permeable membrane and will prevent certain substances from entering.



It is made up of a double layer called the PHOSPHOLIPID BILAYER. These are molecules closely packed together in a mosaic pattern. Within the bilayer are large proteins which are also responsible for transport and for cell recognition.

Transport into and out of cells

There are 4 modes of transport you need to be aware of;

Diffusion; can be gas or liquid particles. They move from an area of high concentration to an area of low concentration down a concentration gradient. Small molecules such as oxygen, water and carbon dioxide can pass through the phospholipid bilayer.

Osmosis; occurs only with water. The water particles move from an area of high water concentration to an area of low water concentration, down a concentration gradient, across a partially permeable membrane. NO ENERGY IS REQUIRED. You will be required to refer to water potential in AS level not water concentration.

Facilitated diffusion; Some particles are too large to fit through the phospholipid bilayer and therefore require a carrier protein to assist. The protein carriers are within the bilayer and they change shape when they come into contact with a specific molecule (i.e. Glucose). NO ENERGY IS REQUIRED.

Active transport; This moves substances for an area of low concentration to an area of high concentration against a concentration gradient. ENERGY IS NEEDED for this to occur. Specific carrier proteins are also required these can be called 'pumps'.

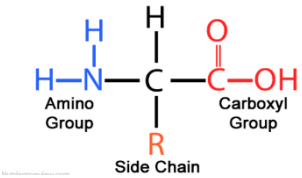
Proteins;

Proteins are made of long chains of amino acids, up to several hundred long. There are only 20 different amino acids and the combination of these 20 produce a wide range of complex proteins. Protein structures are held together with strong bonds called PEPTIDE bonds. The order of the amino acids determines the structure and how it works.

All amino acids have the same structure with one variation on the R group.

Contains; Hydrogen, oxygen,

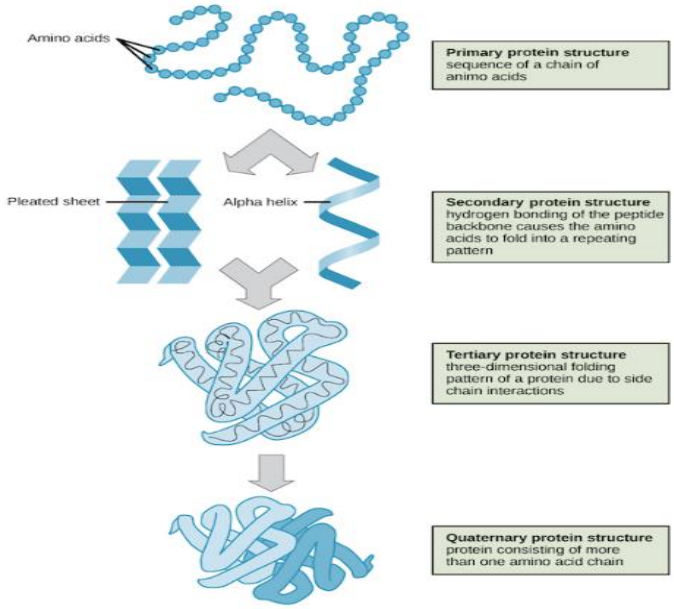
Nitrogen and carbon.



Proteins structure;

The order of the amino acids forms the PRIMARY STRUCTURE. The protein chain can then **coil** or **fold** into **pleats** which are held together by weak hydrogen bonds to for the SECONDARY STRUCTURE.

Enzymes have a further folding held together with stronger disulphide bonds. This is the TERTIARY STRUCTURE. If the structure is almost spherical it is called a **globular protein**.



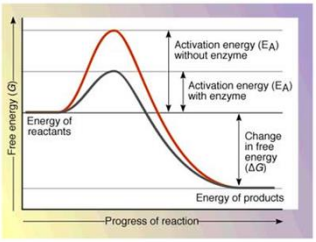
Enzymes; Help to speed up biochemical reactions.

Metabolism is the sum of all the biochemical reactions that occur per second and a single chain of these reactions is called a metabolic pathway.

Enzymes are biological catalysts and increase the rate of reactions.

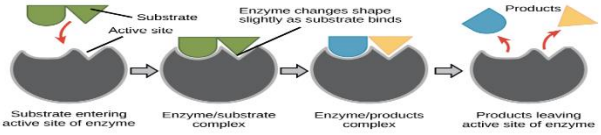
Reactions that release energy need an input energy to start.

The input energy is called the ACTIVATION ENERGY. Enzymes reduce the activation energy.



Enzymes are proteins; enzymes are globular proteins with a specific order of amino acids that determines what the enzyme does.

Enzymes can be catabolic (break substrates down) or anabolic (build substrates up). Enzymes have a specific site into which the substrates can attach itself, this attachment site is called the **active site.** The active site is **complementary** to the shape of the substrate. Once they attach together they form the **enzyme substrate complex**. The substrate then breaks bonds or makes bonds (depending on the type of enzyme) and the product leaves the active site. The active site is now able to accept another substrate.



Denaturing enzymes; Enzymes have a specific tertiary shape held in place by weak hydrogen bonds and stronger disulphide bonds. These bonds can be broken by an increase in temperature (kinetic energy) or a change in pH (H^+ in acid or OH^- in alkali disrupt the bonds).

Useful enzymes; Digestive enzymes are catabolic, breaking down food into smaller molecules. Enzymes are also needed in DNA replication, building up molecules (DNA polymerase).

Questions;

What types of bond hold together the secondary structure? _____ The tertiary structure? _____

How many amino acids are there and what elements are found in them? _____

Explain why denatured enzymes will not function. _____

_____

What is activation energy? _____

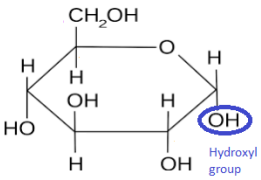
Carbohydrates;

Three elements make up the carbohydrate molecule – carbon, hydrogen and oxygen.

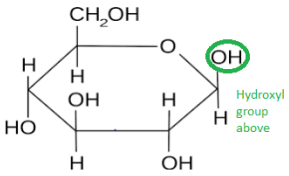
There are several types of carbohydrates;

Sugars; Small, sweet, water soluble molecules. Can be **monosaccharides** or **disaccharides**. Monosaccharides are single units from which disaccharides are built. **Glucose** and **Fructose** are monosaccharides and join together to form the disaccharide sucrose. The joining together of 2 monosaccharides occurs to release a molecule of **water** this is called a **condensation reaction.**

Glucose occurs in 2 forms alpha (α) glucose and beta (β) glucose.



Alpha glucose

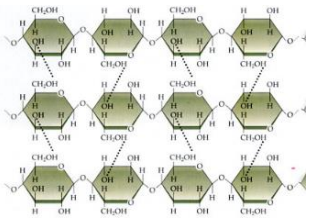


Beta glucose

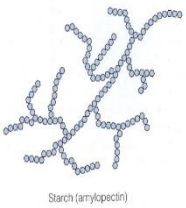
Starch; A **POLYSACCHARIDE** (a large molecule –polymer, made up of monomers). Two different polysaccharides of glucose are used to make starch- **amylose** and **amylopectin**. Starch is insoluble so it is a good storage molecule in plants.

Cellulose; a polymer of glucose. Bonding is different in cellulose, molecules are bonded in a long straight line with **hydrogen** bonds between the strands. It forms **microfibrils** to provide strength to plant cell walls.

Cellulose



Amylopectin



Amylose

Questions;

Describe the difference between a triglyceride and a phospholipid. _____

_____

Describe the difference between Starch and cellulose.

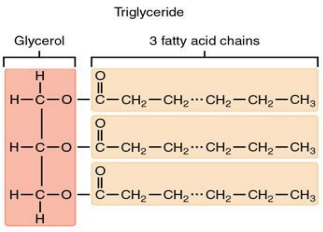
_____

_____

What bonds hold Cellulose microfibrils together? _____

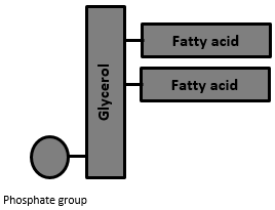
Lipids;

Three elements make up the lipid molecule – carbon, hydrogen and oxygen. Lipids are fats and oils, predominantly made up of a group of lipids called **triglycerides**. These contain a molecule of **GLYCEROL** with 3 **fatty acids**.



The fatty acid is a long chain of carbon atoms with an acid (-COOH) group. Hydrogen atoms are attached to the carbons by single bond. A single bond forms a **saturated** lipid. If there is a double bond then the lipid is **unsaturated**, many double bonds forms a **polyunsaturated** lipid.

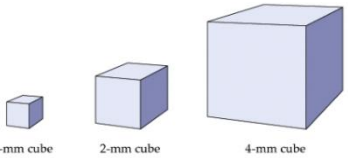
Cell membranes are formed from phospholipid. They do not have 3 fatty acid chains but 2 fatty acid chains and a phosphate group.



Exchange surfaces;

All good exchange surfaces require adaptations to make the exchange efficient. The smaller the object the quicker exchange is able to occur due to it having a large surface area to volume ration, however larger, more complex organisms have a much smaller surface area to volume ratio.

The larger the object the lower the surface area to volume ratio.



Surface area	6 sides × 1^2 = 6 mm^2	6 sides × 2^2 = 24 mm^2	6 sides × 4^2 = 96 mm^2
Volume	1^3 = 1 mm^3	2^3 = 8 mm^3	4^3 = 64 mm^3
Surface area-to-volume ratio	6/1	3/1	1.5/1

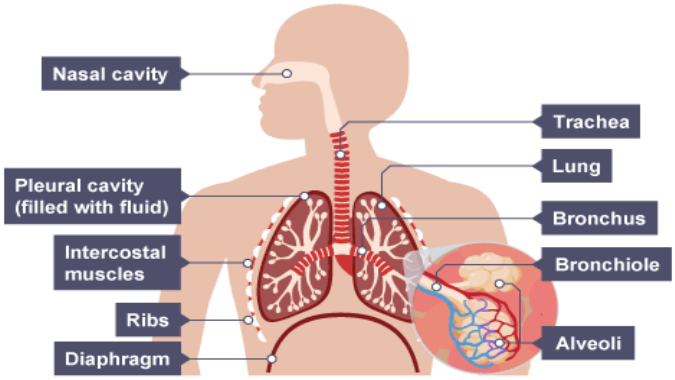
To overcome this, multicellular organisms have highly adapted exchange organs. Adaptations include;

- Folded to increase the surface area to volume ratio for a faster exchange.
- A good blood supply to maintain the concentration gradient.
- One cell thick (thin) to reduce diffusion distance.

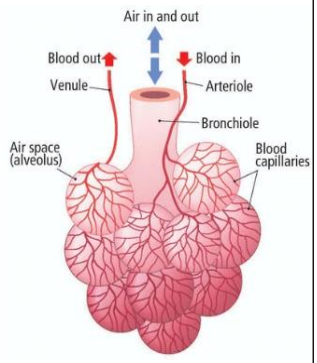
Materials that need to be exchanged between the cell and he environment include; heat, oxygen, water, carbon dioxide, nutrients and other waste products such as urea. The adaptations allow MORE substances to be

Gas exchange in animals;

Lungs; Multi cellular organisms have evolved a **complex blood supply system** and a large gas exchange system (**lungs**). The lungs contain millions of tiny air sacs called ALVEOLI which are then folded to further increase the surface area of the lung.

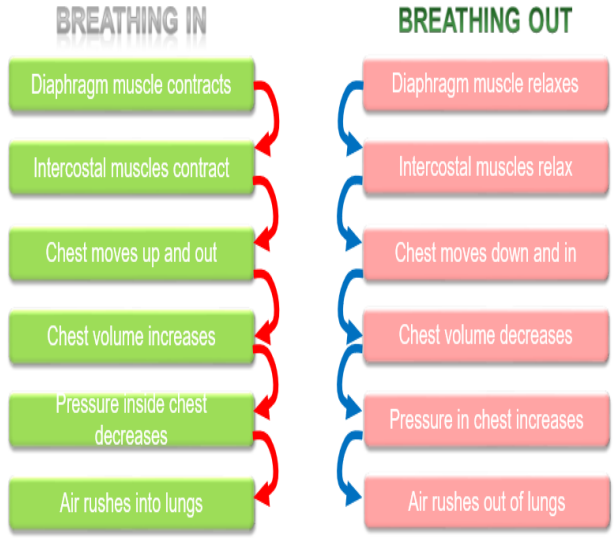


The alveoli are further adapted by having a single flattened layer of **epithelial squamous cells** which reduces the diffusion distance increasing the speed of diffusion. Alveoli have a dense network of capillaries to move the blood away quickly, maintaining a steep diffusion gradient. The walls of the alveoli are fully permeable to dissolved oxygen and carbon dioxide.

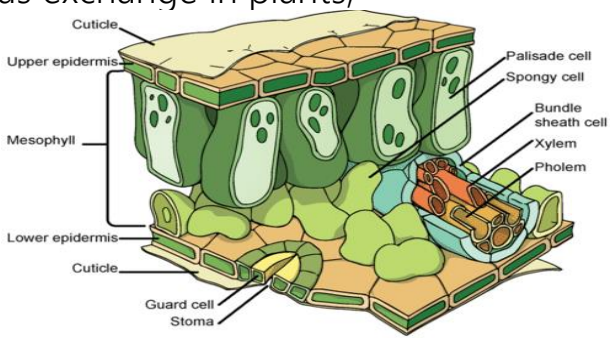


Breathing/ventilation; The process of maintaining a high concentration of oxygen inside the lungs and getting rid of the waste product carbon dioxide. Ventilation increases he rate of diffusion.

Lungs are suspended in the airtight Thorax and any change in volume will affect the pressure in the thorax.



Gas exchange in plants;



Plants also have adaptations to allow gas exchange. The leaf is an organ that is adapted to allow the movement of water from the leaf and the diffusion of carbon dioxide into the leaf. The upper mesophyll layer contains Palisade cells which are packed with chloroplasts to absorb as much energy from the sun as possible for photosynthesis. The lower part of the mesophyll layer is the spongy mesophyll which contains air spaces to facilitated the diffusion of gases into the cells and out of the cells.

The upper epidermis is covered by a waxy cuticle to prevent water loss. The lower epidermis has a specialised pair of cells called the **GUARD CELLS**. The guard cells have an uneven thickening in the cell wall which causes the cell to bend and open up a hole in the lower epidermis called the **STOMA**. The stoma allows the water vapour to move out of the leaf into the environment (**transpiration**) and carbon dioxide to move into the leaf.

Transpiration; The movement of water from the root and out of the leaf is called the transpiration stream. Water passes into the root by osmosis and then moves through the root by 3 different processes;

- The symplast pathway; water moves from root cell to root cell through the cytoplasm.
- The apoplast pathway; water moves through the cell wall, not passing over the cell membrane, carrying minerals with it through a process called **MASS FLOW**.
- The vacuolar pathway; water moves from root cell to root cell via the cytoplasm and the vacuole.

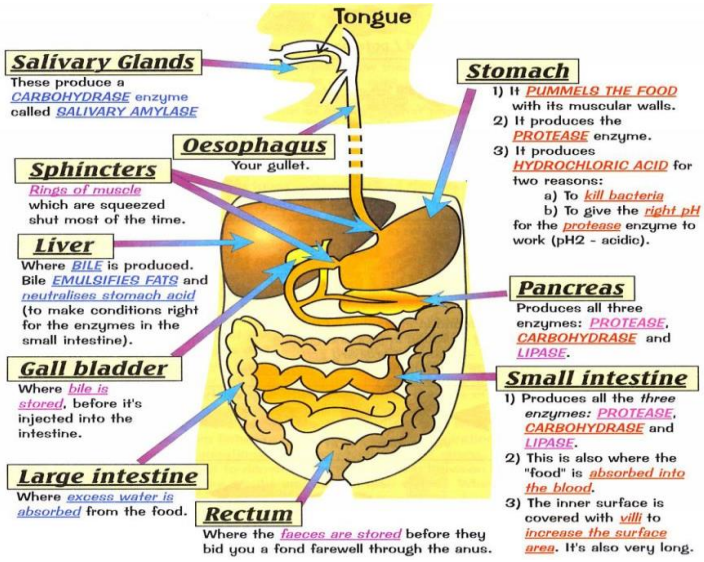
Water moves out of the leaf by diffusion into the environment. The water moves from root to leaf through a specialised tube called the **xylem**. Water is pulled up the xylem due to an attraction force between the water particles causing a tension in the xylem (**Cohesion tension**) and the attraction between the water particles and the sides of the xylem vessel (**adhesion**).

The second vessel in the plant is the **phloem** and this is responsible for **translocation**, the mass flow of substances from the leaf to the rest of the plant

Other exchange surfaces;

Digestion; The human digestive system has 3 main functions;

- Mechanical breakdown of food
- Chemical breakdown of food
- Absorption of digested food particles into the blood stream.



The digestive system contains 3 types of enzyme;

- **Carbohydrase** enzymes for breaking down complex carbohydrates into simple sugars. These are found in the mouth (amylase enzyme), the pancreas and the small intestine.
- **Protease** enzymes break down proteins into amino acids. These are found in the stomach (protease enzyme requires a pH 2 which is provided by the **hydrochloric acid**), the pancreas and the small intestine.
- **Lipase** enzymes breaks down lipids into fatty acids and glycerol. These are found in the pancreas and the small intestine.

Bile is an important chemical in digestion. Bile is made in the liver and stored in the gall bladder. It has 2 roles;

1) Makes the digested food, leaving the stomach, slightly alkali for enzymes to work in.
2) It emulsifies the lipids, breaking them up into small droplets to increase the surface area for lipase to digest.

Questions;

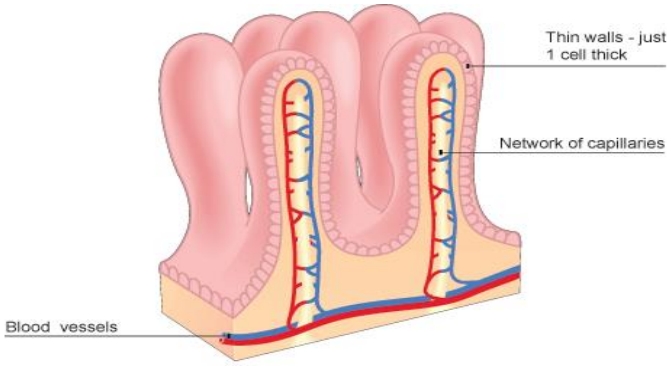
What are the features that makes a surface better adapted for exchange? _____

What is transpiration? _____

What is translocation? _____

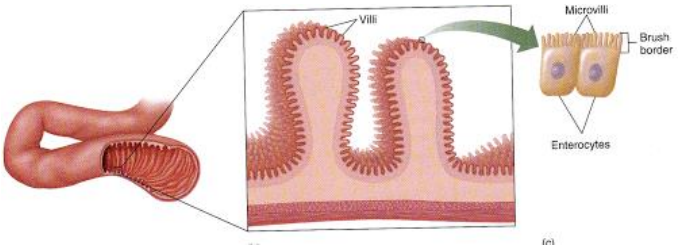
Other exchange surfaces:

All of the digested food is now small enough to pass through the wall of the small intestine into the blood stream.



As an exchange surface it displays the same characteristic adaptations as the lung; Large surface area to volume ratio, good blood supply and one cell thick.

Microvilli; the walls of the small intestine are highly folded into villi, to increase the SA:Vol. ratio. However, this can be increase further by each individual cell having further folds called microvilli.



Questions;

What are the 3 ways water moved through the root? _____

_____

_____

What are the 3 digestive enzymes, what do they break down and where are they found?

Enzyme	Breaks down (chemical)	Into (chemicals)	Where found

What is the role of Bile? _____

_____

How is the small intestine adapted to increase the rate of diffusion of digested food products? _____

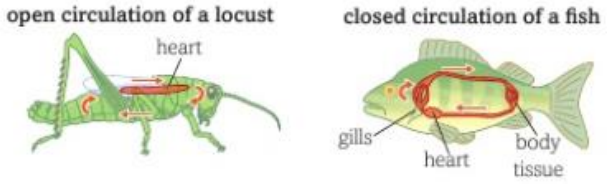
_____

_____

The circulatory system and blood vessels;

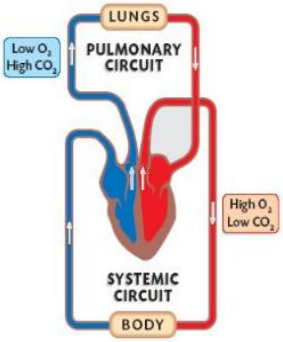
Large multicellular organisms have a small surface area to volume ratio and have evolved a complex circulatory system to transport chemicals around the body, this is called the **CIRCULATORY SYSTEM**.

Some organisms such as flat worms can diffuse oxygen and glucose across their surface. Less active organisms such as insects may have a much more simplified circulatory system.



Fish have a more complex system were by the blood enters the heart once before being transported to the **systemic** system this is called a **single circulatory system**. Mammals have evolved a **double circulatory** system with a **pulmonary** and a **systemic** circuit.

The heart pumps the deoxygenated blood to the lungs **(pulmonary system**) to pick up oxygen and removes carbon dioxide. The oxygenated blood is then returned to the heart to be pumped out to the organs (**systemic system**).

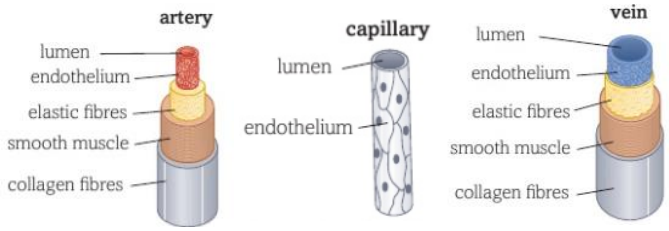


The blood travels through 3 main types of blood vessels;

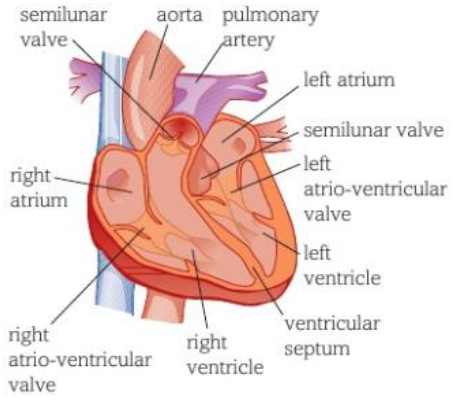
1) **<u>The Arteries</u>**; carry blood **away** from the heart. They have a thick layer of **elastic tissue** and **smooth muscle**. The elastic walls **stretch** when the heart contracts and the elastic tissue **recoils** to maintain the pressure.

2) **<u>Capillaries</u>;** These consist of a single layer of **endothelial cells**. The arteries subdivide **arterioles** which further divide into thousands of capillaries. The capillaries come into close contact with body cells providing a huge surface area to volume ratio and a short diffusion distance for the exchange of oxygen, glucose, carbon dioxide, urea and other substances.

3) **<u>Veins</u>**; The capillaries start to come back together forming **venules** and then veins. Veins carry blood back towards the heart. Blood is at a lower pressure and therefore do not need such a thick layer of elastic tissue or smooth muscle. The veins contain **valves** to prevent the blood flowing backwards.



The heart;



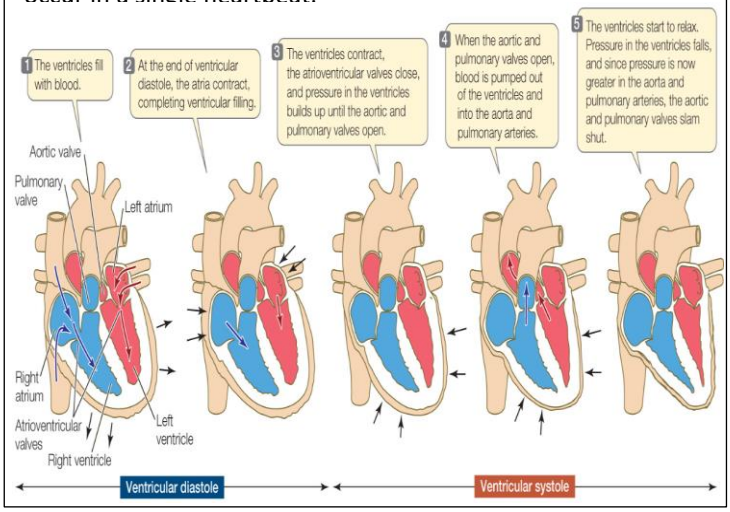
The heart has two separate pumps. The right side of the heart pumps blood to the lungs and the left side pumps blood to the body. Valves within the heart keep the blood flowing in the correct direction. Valves open and close in response to the changes of pressure inside the chambers.

The heart is made up of 4 chambers; the right **atria**, the right **ventricle**, the left **atria** and the left **ventricle**. The left side of the heart has a **thicker muscular wall** to create enough pressure to force the blood around the whole body.

The hearts contractions are initiated by a cluster of specialised cells called the **SINO-ATRIAL NODE** or the **PACEMAKER**. These cells send out electrical impulses at regular intervals.

The coronary arteries supply the muscle in the heart with blood.

The cardiac cycle; This is the sequence of events that occur in a single heartbeat.



Questions;

What is the name of the system that sends blood to body organs? _____

Which blood vessels contain valves? _____

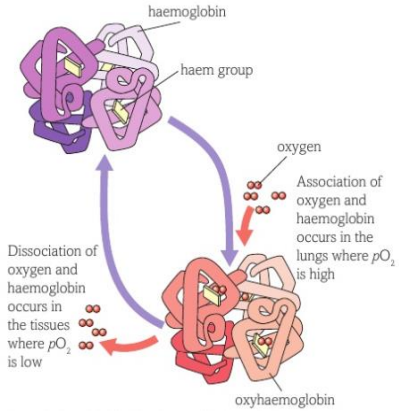
Which blood vessel has the thickest smooth muscle and what is its function? _____

Which Valves close when the ventricles contract? _____

Which side of the heart is the thickest and why? _____

The blood;

Blood is made up of 4 different components;
1) **Plasma**; the liquid part of blood that transports the cells, dissolved substances and thermal energy.
2) **Platelets**; cell fragments responsible for clotting of the blood.
3) **White blood cells**; there are many different white blood cells all responsible for protecting the body from pathogens.
4) **Red blood cells** AKA **erythrocytes**; these are responsible for transporting oxygen to body cells. Erythrocytes contain a complex protein called **HAEMOGLOBIN**. Haemoglobin contains four iron ions each will bind to one oxygen.
One haemoglobin can carry 4 molecules of oxygen (100% saturated) and becomes **OXYHAEMOGLOBIN**.
Due to the low availability of oxygen in the tissue and the high concentration of carbon dioxide, the oxygen will dissociate from the haemoglobin. The carbon dioxide from the respiring tissues makes the haemoglobin less able to 'hold on' to the oxygen so increases the rate at which the oxygen **dissociates**.

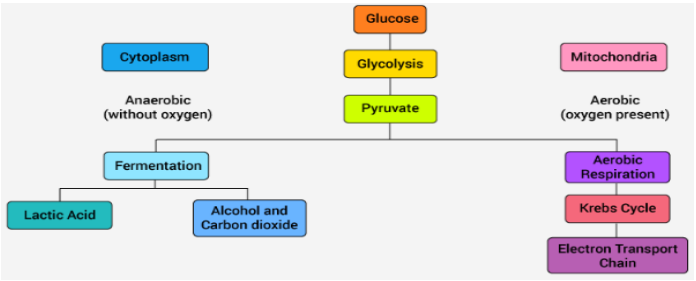


Questions;

1)What substance is picked up by the blood in the lungs?
_____
2) What is the name of the protein found in the erythrocyte?
_____
3) What metal ion is present in the protein? _____
4) What does it mean if the blood is said to be 'fully saturated'?
_____
_____
5) Which gas affects the oxygen binding properties of haemoglobin? _____
6) What is the term used to describe oxygen leaving the haemoglobin protein? _____
7) What is the name of the stage of respiration that is common to aerobic and anaerobic respiration? _____
8) What are the products of the first stage of respiration?
_____
9) Name the remaining 3 stages of aerobic respiration.
_____
_____
10) Name the molecule that is produced and will supply energy to other parts of the body. _____

Respiration;

Aerobic respiration; This occurs in the mitochondria of cells. It requires a number of small stages to break down **glucose** ($C_6H_{12}O_6$) to release a large amount of energy; **adenosine triphosphate** (ATP). The first stage is a stage called **GLYCOLYSIS**, this occurs in the cytoplasm and converts glucose into two 3 carbon molecules called **PYRUVATE**. Pyruvate is formed in both aerobic and anaerobic respiration, however in aerobic respiration the pyruvate passes into the matrix of the Mitochondria. Pyruvate then goes into the **link reaction** to form **acetyl CoA** which then passes into to the **Kreb cycle** with the oxidise products passing into **oxidative phosphorylation** to form **ATP** and waste products **carbon dioxide** and **water**.



Anaerobic respiration; Respiration without oxygen.
This form of respiration occurs **without oxygen**. Glucose is converted into pyruvate, through the process of **GLYCOLYSIS**, in the cytoplasm and is unable to pass into the mitochondria. The process of glycolysis releases small amounts of energy and over a short period of time it can keep the muscles working.

Anaerobic respiration in plants and yeast forms **carbon dioxide** and **alcohol**. Anaerobic respiration in animals forms **lactic acid**. The build-up of lactic acid in muscles must be broken down as the formation of the acid alters the pH and affects enzymes in the cells, slowing down reactions. As the lactate ions build up in the muscles this causes pain called **fatigue**. The oxygen required to convert the lactate ions back to pyruvate is called the **oxygen debt**.

Questions continued….

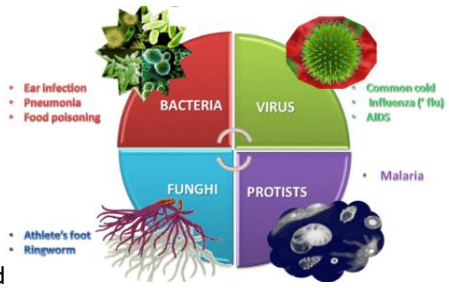
11) Define the term anaerobic respiration _____
_____
12) Write a word equation for;
a) anaerobic respiration in plants and yeast
_____
b) anaerobic respiration in mammals
_____
13) What is the oxygen debt? _____
_____
14) Why can a person not anaerobically respire for a long time?
_____
_____

Disease;

Disease can be **communicable** and **non-communicable**.

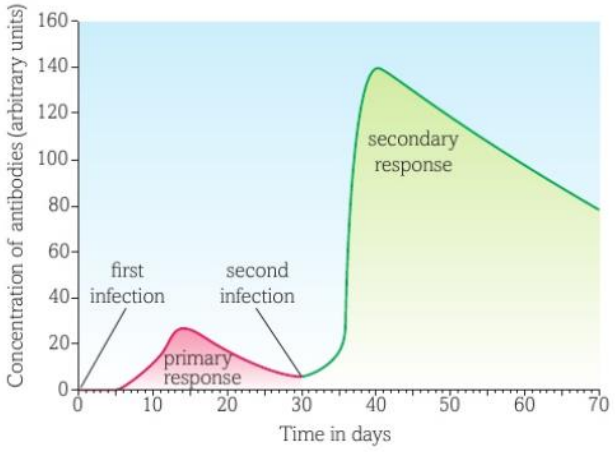
♦ Non-communicable disease are disease's which cannot be directly passed for person to person. These include cancer, heart disease, diabetes and Alzheimer's.

♦ Communicable disease are disease which can be transmitted from organism to organism. These are caused by **PATHOGENS** such as **VIRUSES**, **BACTERIA**, **FUNGI** and **PROTISTS**.



Bacteria will produce toxins. Viruses will place their genetic information into a cell and the information replicates and bursts the host cells. Fungi produce **mycelium** and **exocytose** digestive enzymes to digest the tissue it is living on; it then reabsorbs the digestive products. Protists use a host to complete an important part of its life cycle and will damage the hosts cells/organs in the process.

If the first lines of defence do not prevent the pathogen entering the body, then the bodies defence systems will be activated. All cells have a unique protein structure (**ANTIGEN**) identifying it as not self and activating the **immune system**. White blood cells will respond in different ways. First the **MONOCYTES** and **MACROPHAGES** (types of phagocyte) identify the pathogen as 'foreign'. These cells will **engulf** the pathogen and destroy it. Macrophages do not destroy all of the pathogen, it retains the antigen of the pathogen and '**presents**' it on its own surface. This is now an **ANTIGEN PRESENTING CELL** and initiates the next round of specific white blood cells. The **LYMPHOCYTES** now have 3 jobs, track down and destroy the pathogens (**T Lymphocytes**), produce antibodies (**B Lymphocytes**) and make **memory cells** to produce antibodies quickly if the pathogen enters the body again in the future.

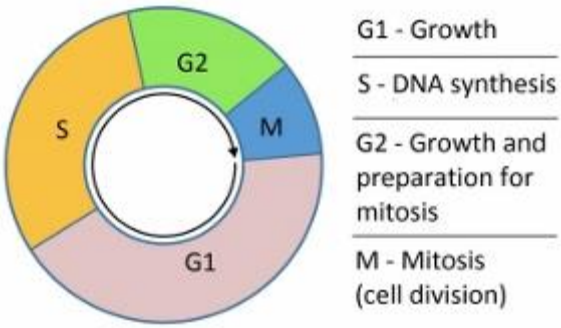


Primary and secondary response to infection.

Risk factors;

A risk factor is something that will **increase the chance** of becoming ill. Risk factors do not always lead to the disease, just increase the risk. Some risk factors are unavoidable such as genetic risk factors; genetic predisposition to producing high quantities of cholesterol, having high blood pressure or carrying the **BRCA** gene which increase the risk of breast cancer.

Other risk factors are avoidable such as; smoking, drinking alcohol, unprotected sex, high fat or high salt diet. Some risk factors (**carcinogens**) can cause DNA to mutate and cause cells to go into uncontrolled cell growth.



Questions;

What is a pathogen? _____

_____

Give 3 examples of non-communicable disease.

_____

_____

How do bacteria make us ill? _____

_____

How do viruses make us ill? _____

_____

What do monocytes do? _____

_____

_____

What do macrophages do? _____

_____

What are the 2 main types of lymphocytes?

_____

What do memory cells do? _____

_____

Look at the graph. Describe the different between the primary and secondary response. _____

_____

_____

_____

_____

DNA and protein synthesis;

DNA is a complex chemical, found in the nucleus of eukaryotes and in the cytoplasm of prokaryotes. DNA is made up of; **pentose sugar**, **phosphate** and **nitrogenous bases** forming a **NUCLEOTIDE**.

There are 4 different nitrogenous bases;

A= Adenine
T= Thymine
C= Cytosine
G= Guanine

Complementary pair;

A pairs with T
C pairs with G

The bases pair up in the formation stated above. They are held together by **hydrogen bonds**. The two strands run in opposite directions causing the molecule to spiral forming a **DOUBLE HELIX**.

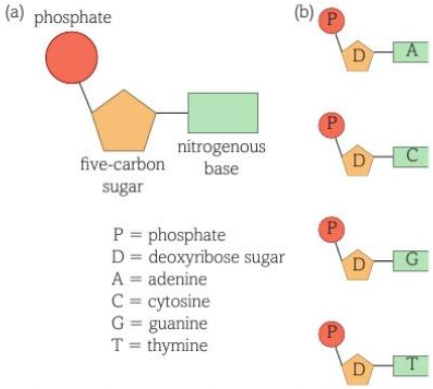
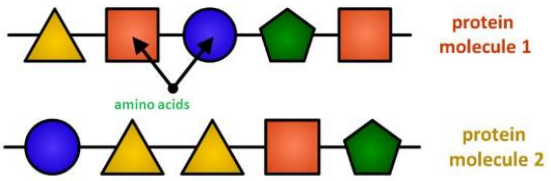


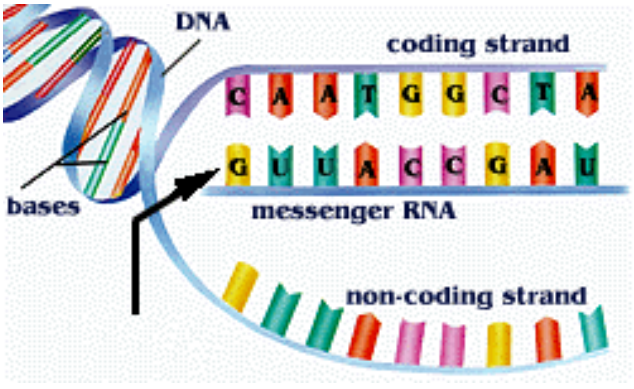
Figure 1 (a) General structure of a single nucleotide. (b) The four DNA nucleotides.

DNA controls the production of proteins. A section of DNA that codes for a protein is called a **gene**. Proteins are made up of a string of **amino acids**, each protein has a different number and order of amino acids. The proteins also have different bonds which holds the molecule in a unique shape which means all proteins have a different function.

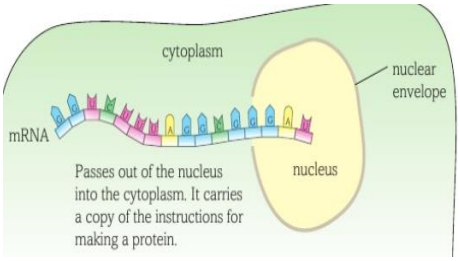


Different combinations of amino acids make different proteins.

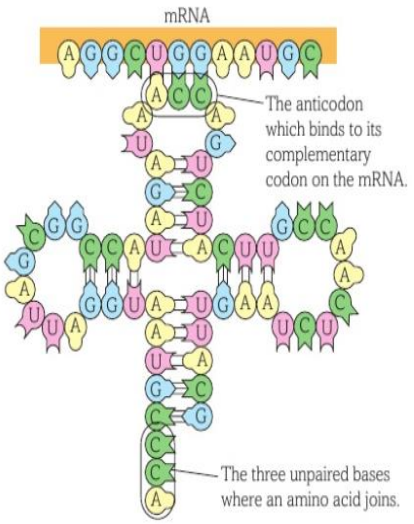
Protein synthesis; Protein synthesis occurs in the cytoplasm, carried out by **RIBOSOMES**. When a protein is required then the gene has to be copied producing a molecule called **messengerRNA (mRNA)**. mRNA is small enough to pass out of the nucleus into the cytoplasm. mRNA is a template, containing nucleotides and bases. The nucleotide on the mRNA will line up with the **complementary base**. However, on RNA there is no Thymine, RNA will have the base **URACIL** (**U**).

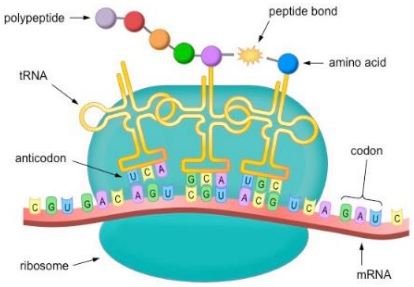


The mRNA passes out of the nucleus carrying the code for a protein. Once in the cytoplasm the mRNA binds to a ribosome.



Within the cytoplasm there is another molecule called transferRNA (tRNA). At one end, the **anticodon** is complementary to the mRNA. At the opposite end there are three **unpaired bases** which code for an **amino acid**. The amino acid is brought in to form a **peptide bond** with the amino acids brought in by the previous tRNA. This forms a **polypeptide** chain which will form hydrogen and **disulfide bonds** to form the unique protein.





Mutations: Mutations change the order of bases in the DNA. Some bases may change to a different base (**substitution**), some bases may be deleted and some bases may be added. Mutations can cause the following;

- Incorrect protein to be produces
- No change in protein being made
- Causes a harmful proteins/ no protein to be made

Questions;

What are the components of a nucleotide. _____

_____

What are the names of the 4 nitrogenous bases?

_____

What type of bonds hold the 2 strands together? _____

What is the name of a section of DNA that codes for a protein? _____

What are proteins made from? _____

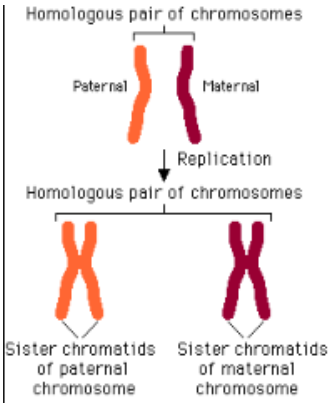
DNA is too big to leave the nucleus, what is the copy of the gene called that enters the cytoplasm? _____

What organelle will this molecule attach to? _____

Which molecule has a complementary anticodon and brings in the correct amino acid? _____

Genetics and cell division;

The DNA molecule contains thousands of genes along its length. The DNA molecule is wound up into a chromosome. Each body cell in a human contains **23 pairs of chromosomes (diploid number)**, one from mother and one from father. These pair up forming a **homologous pair**, both the **same size** and containing the **same genes** (these genes can be different **alleles**). A chromosome is often seen as an X shaped molecule. The X shape is actually one chromosome attached to an exact copy of itself (2 **CHROMATIDS**). They are joined together by an attachment called a **centromere.** In preparation for **cell division** the chromosome will make a copy of itself. All damaged tissue and cells are replaced by a process of cell division called **MITOSIS**. Mitosis is also seen in **asexual reproduction,** the offspring are **genetically identical** to the parent.



Mitosis cell division;

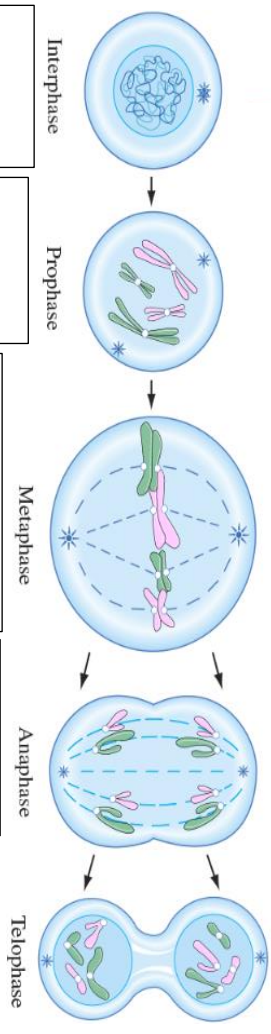
Interphase; DNA molecules are indistinct in the nucleus. They replicate their DNA, attaching at the centromeres.

Prophase; The DNA becomes **supercoiled** and **compact** and can now be seen under a light microscope. It has the X shape.

Metaphase; the nuclear membrane breaks down, the chromosomes line up along the **equator** of the cell and **spindle fibres**, produced by the **centrioles**, attach to the chromosomes.

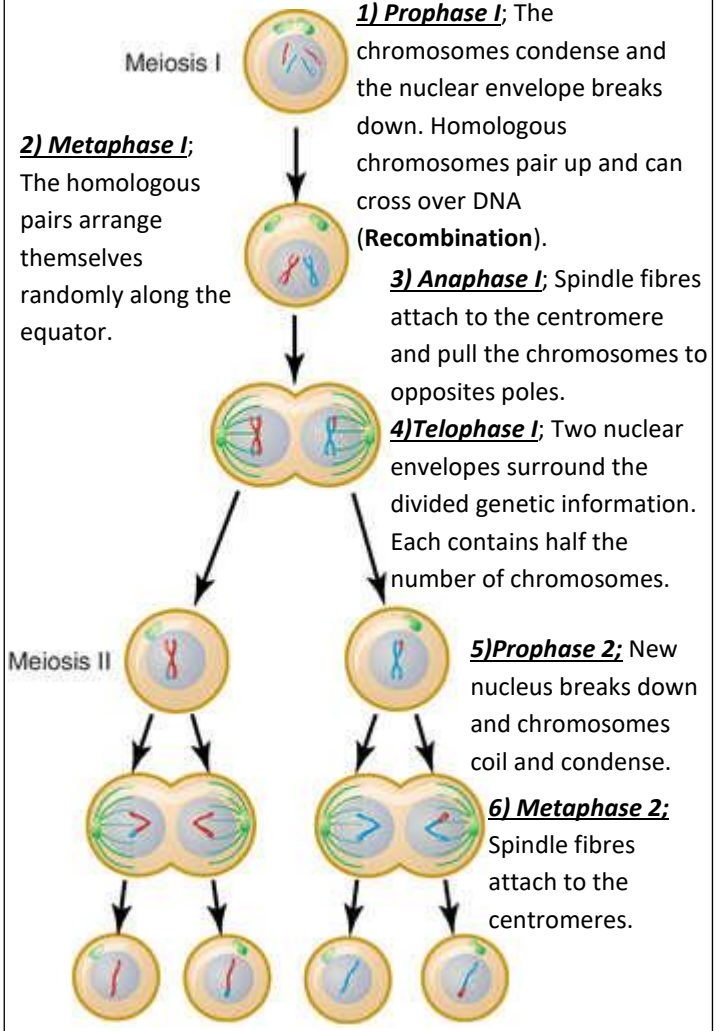
Anaphase; The **spindle fibres** pull the **centromere** apart and the **chromatids** separate and are dragged to the poles of the cell.

Telophase; A **nuclear envelope** forms around each set of **chromatids** and the **cytoplasm divides** forming 2 genetically identical cells.



Meiosis; This cell division is responsible for the production of sex cells and introduces **genetic variation**. It results in the formation of gametes containing half the original genetic information (**Haploid number**). This ensures, that during **fertilisation**, the **embryo** obtains two complete sets of genetic information.

In meiosis the cell undergoes 2 cellular divisions.



1) Prophase I; The chromosomes condense and the nuclear envelope breaks down. Homologous chromosomes pair up and can cross over DNA (**Recombination**).

2) Metaphase I; The homologous pairs arrange themselves randomly along the equator.

3) Anaphase I; Spindle fibres attach to the centromere and pull the chromosomes to opposites poles.

4)Telophase I; Two nuclear envelopes surround the divided genetic information. Each contains half the number of chromosomes.

5)Prophase 2; New nucleus breaks down and chromosomes coil and condense.

6) Metaphase 2; Spindle fibres attach to the centromeres.

7) Anaphase 2; The spindle fibres start to drag the chromatids to opposite sides of the cell.

8) Telophase 2; The nuclei's start to reform and the cytoplasm spits to form 4 haploid cells that are genetically different to the parent cells.

Questions;

Which cell division forms haploid cells? _____

What happens during prophase? _____

_____

What do centrioles do? _____

_____

Which organs produce haploid cells? _____

_____

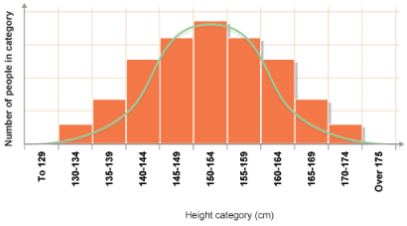
What happens in Telophase? _____

Variation and evolution;

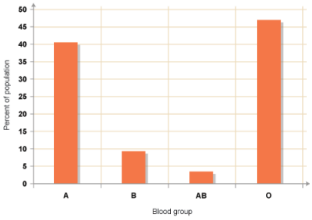
Due to the mechanisms used to produce haploid cells through meiosis, **genetic variation** occurs. Organisms of the same species show some variation due to alleles. There are 2 types of variation;

- **Genetic variation**; passed from parent to child (blood group, eye colour).
- **Environmental variation**; caused by the environment (scars, accents, freckles)

Some variation can be due to a **combination of both** genetic variation and environmental variation (intelligence, height and weight).

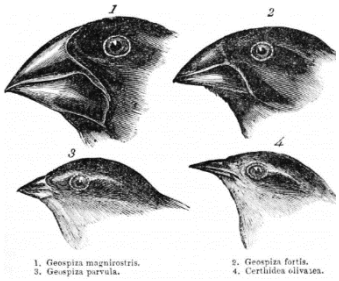


Some **characteristics** fall into the category of **continuous variation** whereby there is a large range in variations (height and weight).



Other characteristics fall into a few distinct categories such as blood type, colour, tongue rolling; this is called **discontinuous variation**.

Sometimes a variation may lead to a characteristic that helps the organism to **survive** and be **better adapted** to its environment. The variation may be that the animal is slightly fast or better camouflaged. This slight difference within the species will allow the individual to **compete** better, **survive**, **breed** and potentially **pass on the genetic variation** to it's offspring. This is called **Natural selection**. **Evolution** can occur through natural selection. **Gradual changes over millions of years** can ultimately lead to the formation of a **new species**.

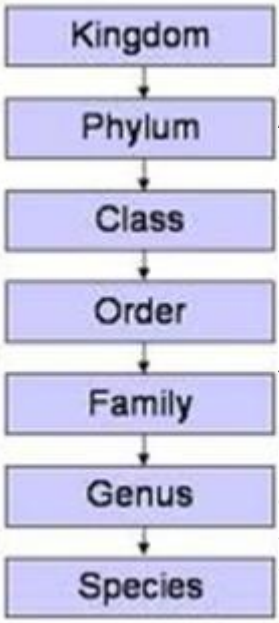


as antibiotic-resistant bacteria. Darwin noticed that the finches - songbirds - on the different islands in the Galápagos were fundamentally similar to each other, but showed wide variations in their size, beaks and claws from island to island. For example, their beaks were different depending on the local food source. Darwin concluded that, because the islands are so distant from the mainland, the finches that had arrived there in the past had changed over time.

Classification;

King Prawn Curry Or Fat Greasy Sausages.

Developed by Carl Linnaeus in the 18th century, it was a method of sorting, grouping and naming different groups of organisms.



Organisms were grouped into divisions based on characteristics they had in common. The five kingdoms are; **Animalia, Plantae, Fungi, Prokaryotes, Protoctists**. The kingdoms then divide into **Phylum**; in Animalia these are; Cnidaria (**invertebrates**), Chordata (**vertebrates)**, Arthropods, Molluscs and Echinoderms.

In animals the vertebrate's phylum further splits into Mammalia (Mammals), Fish, Birds, Amphibians and Reptiles.

Order, Genus and species further classifies the organisms. The Genus and species names are always written in Latin and italics. The genus name has a capital letter and the species is lower case.

A species was classified as a group of organisms that look very similar to each other and can reproduce to form fertile offspring.

Technology has advanced and organisms can now be classified on a genetic level using base sequence, proteins and enzymes in common and growth during embryonic stage.

The Three Domains; Taxonomic ranking was altered in the 1970's with the introduction of the domains before kingdom. It was further clarified in the 1990's with better understanding of cellular structure. **Archaea** are prokaryotic cells, **Bacteria** (even though bacteria are prokaryotic cells just like Archaea, their cell membranes have a different composition) and **Eukarya** (eukaryotes).

Questions;

What type of variation can be displayed as a distribution curve?

_____

What type of variation can be displayed on a bar chart?

_____

Describe Natural selection. _____

_____

_____

_____

_____

What are the 3 domains? _____

What method did Linnaeus use to group organisms? _____

_____

What newer methods are now used? _____

_____

Define species. _____

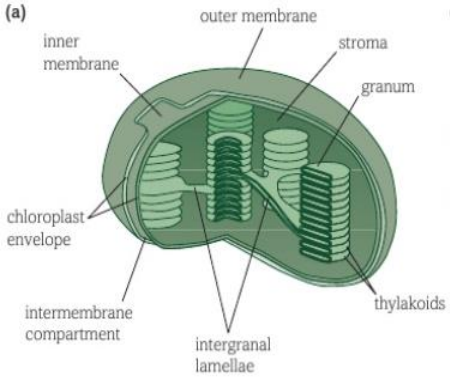
Photosynthesis;

Photoautotrophs are organisms that produce their own food with the use of **solar energy**. They are the source of chemical energy for other organisms within a food chain.

The general equation for photosynthesis is:

$$6CO_2 + 6H_2O + \text{energy from photons} \xrightarrow{\text{chlorophyll}} C_6H_{12}O_6 + 6O_2$$

Photosynthesis is and **endothermic** reaction requiring the energy to initiate it. A special organelle in the plant cell called the **CHLOROPLAST** contains a chemical called **CHLOROPHYLL**. The chloroplast has an inner and outer membrane called the **envelope**. Inside the chloroplast are flattened sacs called **GRANA**. The grana stack up to form **THYLAKOIDS**. The chemical, chlorophyll is embedded in the Thylakoid membrane in **PHOTOSYSTEMS.**



The photosystems contain different **photosynthetic pigments** which absorb different wavelengths of light. A fluid filled matrix called the **STROMA** surrounds the grana and contains **enzymes** and **DNA** for protein production within the chloroplast.

Photosynthesis occurs in two stages;

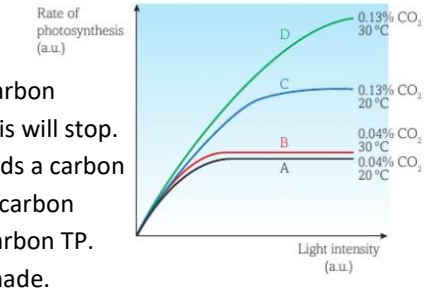
- **The Light dependent stage (LDS)**; this uses light energy and water to provide **hydrogen ions** and **electrons**, which are moved through electron carriers, to produce **oxygen** and **reduced NADP** which can pass into the next phase.
- **The light independent stage (LIS) or CALVIN CYCLE**; the Calvin cycle uses inorganic carbon dioxide gas to produce organic glucose. A five carbon compound called **Ribulose bisphosphate** accepts one carbon from the carbon dioxide with the help of an enzyme, **RuBisCo**. This forms and unstable 6 carbon compound which dissociates into two 3 carbon molecules called glycerate-3-phosphate (GP) which then accepts a hydrogen ion from the reduced NADP (brought in from the light dependent stage) to make 2 molecules of triose phosphate (TP). TP can then be synthesised into other sugars or used to synthesis amino acids, fatty acids and glycerol.

Limiting factors and Photosynthesis;

Factors that can affect the rate of photosynthesis are called limiting factors. These can be the raw materials of photosynthesis (**carbon dioxide** and **water**), **Light intensity** or factors that affect enzymes responsible for photosynthesis (**temperature** and **pH**).

Water stress; water does not generally limit photosynthesis since it is required in other cellular reactions the plant, turgidity, transpiration stream and cooling is usually dead before water is at a low enough level to affect photosynthesis.

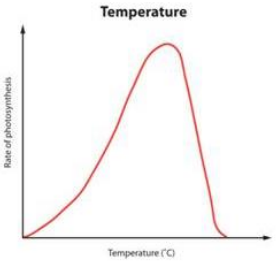
Carbon dioxide;



Without the presence of carbon dioxide then photosynthesis will stop. Ribulose bisphosphate needs a carbon from CO_2 to become the 6 carbon molecule and then the 3 carbon TP. Without TP no glucose is made.

Light intensity; Light is required to provide photons of energy in the LDS. Light can also cause the stoma to open in the leaf bringing about transpiration.

Temperature;



At lower temperatures the rate of reaction is slow due to the molecules and enzymes having less **kinetic energy** and therefore fewer collisions per second. As the temperature increases, the molecules gain more kinetic energy and collisions per second increase as does the reaction rate. However, these reactions are reliant upon enzymes. Enzymes have a specific structure to allow them to carry out the specific function. As the temperature increases then hydrogen and disulfide bonds, holding the tertiary structure, will break and the enzymes active site changes shape (**DENATURES**) and the enzyme can no longer catalyse the reaction.

pH; Similar to temperature, enzymes work best in particular pH's. If the pH alters then bonds break and the enzyme denatures.

Questions; Define photoautotroph. _____

Where in the chloroplast are the photosynthetic pigments found? _____

_____

What reactant of photosynthesis is broken down in the light dependent stage? _____

What reactant of photosynthesis is used in the light independent stage? _____

What effect does increasing temperature have on the rate of photosynthesis? _____

_____

Planning an Experiment

A Good Experiment Gives Precise and Valid Results

1) **Precise** results are **repeatable** (if the same person repeats the experiment using the same methods and equipment, they will get the same results) and **reproducible** (if someone different does the experiment, or a slightly different method or piece of equipment is used, the results will still be the same).
2) **Valid** results are **precise** and **answer the original question**. To get valid results you need to **control all the variables** to make sure you're only testing the thing you want to.

To Get Good Results You Need to Design Your Experiment Well

Here are some of the things you need to consider when thinking about **experimental design**:

1) **Only one variable should be changed** — Variables are **quantities** that have the **potential to change**, e.g. pH. In an experiment you usually **change one variable** and **measure its effect** on another variable.
   - The variable that you **change** is called the **independent variable**.
   - The variable that you **measure** is called the **dependent variable**.
2) **All the other variables should be controlled** — When you're investigating a variable you need to keep everything else that could affect it **constant**. This means you can be sure that **only** your **independent** variable is **affecting** the thing you're measuring (the dependent variable).
3) **Negative controls should be used** — Negative controls are used to **check** that only the independent variable is affecting the dependent variable. Negative controls **aren't expected** to have **any effect** on the experiment.
4) **Repeat the experiment at least three times** — Doing **repeats** and getting **similar results** each time shows that your data is **repeatable**. This makes it more likely that the same results could be **reproduced** by another scientist in an independent experiment. This makes your data **more precise**. Doing repeats also makes it easier to spot any **anomalous results** — unexpected results that don't fit in with the rest.

EXAMPLE: Investigating the effect of **temperature** on **enzyme activity**.

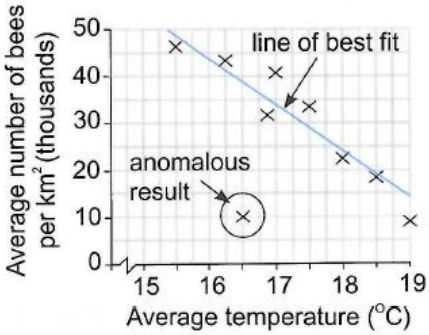
1) Temperature is the **independent** variable.
2) Enzyme activity is the **dependent** variable.
3) pH, volume, substrate concentration and enzyme concentration should all stay the **same**.
4) The experiment should be **repeated** at least three times at each temperature used.
5) A **negative control**, containing everything used except the enzyme, should be measured at each temperature. No enzyme activity should be seen with these controls.

Graphs

You Can Use Scatter Graphs to Present Your Data

1) When you want to show how **two variables** are **related** (or **correlated**, see next page) you can use a **scatter graph**.
2) Make sure that:
   - The **dependent variable** goes on the **y-axis** (the vertical axis) and the **independent** on the **x-axis** (the horizontal axis).
   - You always **label** the **axes**, include the quantity and **units**, and choose a **sensible scale**.
3) When you draw a **line** (or curve) **of best fit** on a **scatter graph**, draw the line through or as near to as many points as possible, **ignoring** any **anomalous** results.

Scatter graph



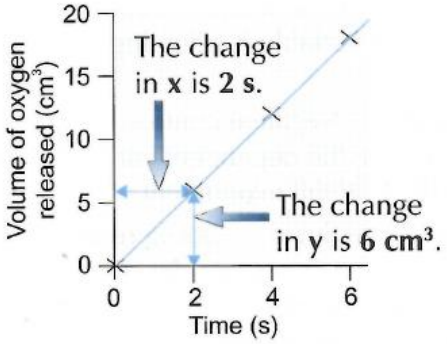
Find the Rate By Finding the Gradient

Rate is a measure of how much something is **changing over time**. Calculating a rate can be useful when **analysing** your data, e.g. you might want to the find the **rate of a reaction**. Rates are easy to work out from a **graph**.

For a **linear** graph you can calculate the **rate** by finding the **gradient of the line**:

EXAMPLE:

$cm^3\ s^{-1}$ means the same as cm^3/s (centimetres per second)



$$\text{gradient} = \frac{\text{change in Y}}{\text{change in X}}$$

So in this **example**:

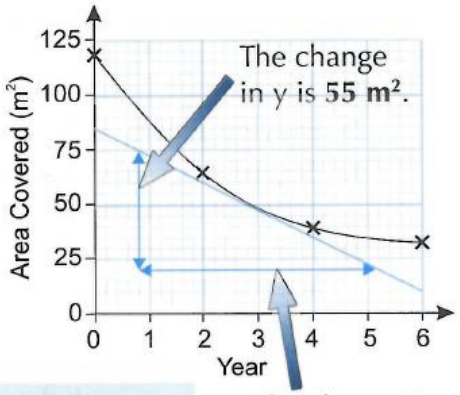
$$\textbf{rate} = \frac{6\ cm^3}{2\ s} = \mathbf{3\ cm^3\ s^{-1}}$$

For a **curved** (non-linear) graph you can find the **rate** by drawing a **tangent**:

EXAMPLE:

1) Position a ruler on the graph at the **point** where you want to know the **rate**.
2) **Angle** the **ruler** so there is **equal space** between the **ruler** and the **curve** on **either** side of the point.
3) **Draw** a **line** along the ruler to make the tangent.
4) **Calculate** the **gradient** of the **tangent** to find the **rate**.

gradient = 55 m^2 ÷ 4.4 years = **12.5 m^2 $year^{-1}$**

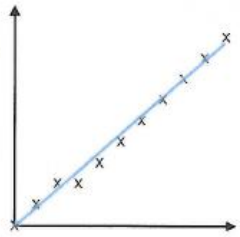


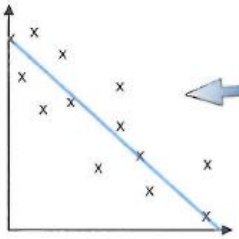
Extend the line right across the graph — it'll help to make your **gradient calculation easier** as you'll have **more points** to choose from.

Correlation and Cause

Lines of Best Fit Are Used to Show Trends

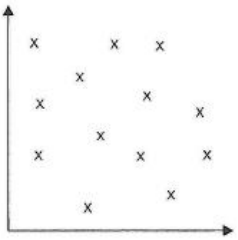
The line of best fit on this graph shows that as one variable **increases**, the other variable **also increases**. This is called a **positive correlation**. The data points are all quite close to the line of best fit, so you can say the correlation is **strong**. If they were more spread out, the correlation would be **weak**.





Variables can also be **negatively correlated** — this means one variable **increases** as the other one **decreases**. Look at the way the line of best fit **slopes** to work out what sort of correlation your graph shows.

Sometimes the graph won't show any clear trend and you won't be able to draw a line of best fit. In this case, you say there's **no correlation** between the variables.



Correlation Doesn't Always Mean Cause

1) Be careful what you **conclude** from an experiment — just because two variables are correlated, it doesn't necessarily mean that one **causes** the other.
2) In lab-based experiments, you can say that the independent variable causes the dependent variable to change — the increase in temperature **causes** an increase in the rate of the reaction. You can say this because everything else has **stayed the same** — nothing else could be causing the change.
3) Outside a lab, it can be much harder:

> **EXAMPLE:**
>
> Kate measured the level of air pollution and the incidence of TB, to see whether the two are related. Her results show a positive correlation between the variables — where the level of pollution is highest, the incidence of TB is also highest.

From Kate's results, you can't say that air pollution causes TB.

Neither can you say that TB causes air pollution.

It could be either way round... or one change might not cause the other at all — you just can't tell.