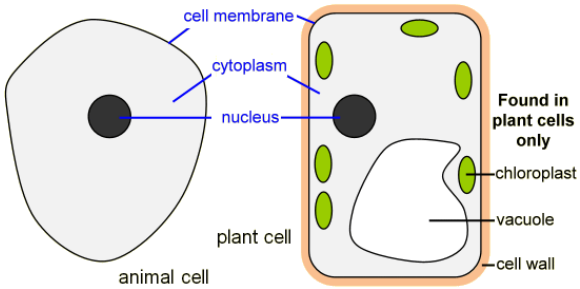
Cells and Cell Processes



- Living organisms are made of cells.
- Animal cells always have a cell membrane, nucleus and cytoplasm (which contains small vacuoles and organelles). Plants cells have a cell membrane, a cell wall, nucleus, vacuole, cytoplasm and chloroplasts.
- The nucleus is the control centre of the cell. Metabolic reactions take place in the cytoplasm. The cell wall is permeable and keeps the cell turgid. The cell membrane is partially permeable; thus it controls what goes in and out of the cell. Chloroplasts are where photosynthesis happens to make food for the plant. Vacuoles contain waste products and isolate the cell from materials that could be harmful.
- **ciliated cells -** gather dust and dirt from air so that they are not breathed in - hair like extensions (cilia)

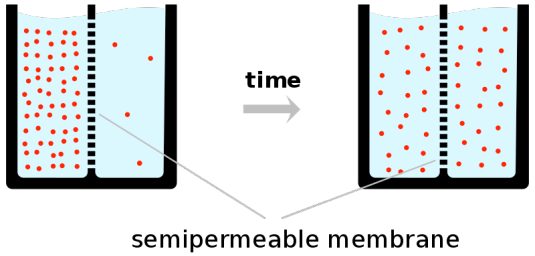
root hair cells - absorption - large surface area

xylem vessels - conduction and support - hollow

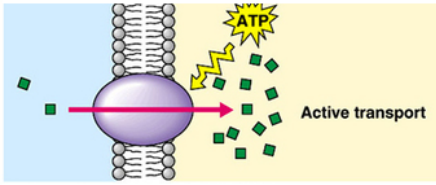
muscle cells - contraction - contractile elements

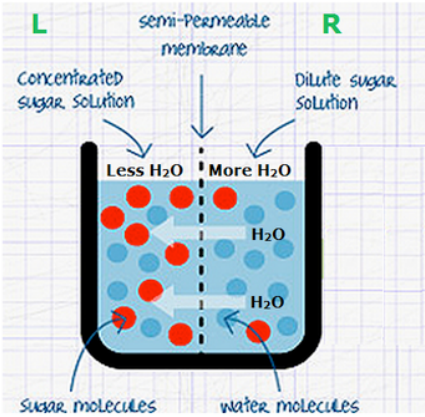
red blood cells - transport - biconcave shape (increases surface area, oxygen can diffuse in at a faster area)

- A tissue is a group of cells with similar structures, working together to perform a shared function
- An organ is a structure made up of a group of tissues, working together to perform specific functions
- An organ system is a group of organs with related functions, working together to perform body functions
- **Diffusion** is the **net movement of molecules** from a region of their higher concentration to a region of their lower concentration down a concentration gradient, as a result of their random movement.



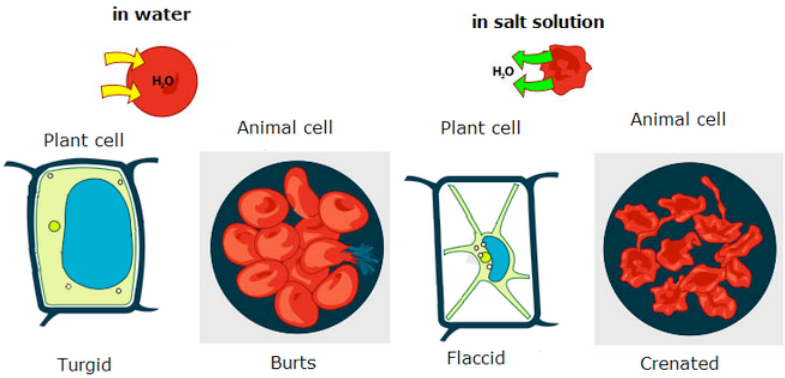
- Diffusion of gases is necessary for gas exchange in all living organisms. In plants, it's necessary for obtaining carbon dioxide and releasing oxygen. In humans, it is necessary for obtaining oxygen and releasing carbon dioxide. All known forms of life depend on water. Water is vital both as a solvent in which many of the body's solutes dissolve and as an essential part of many metabolic processes within the body. It is the solvent for the nutrients needed by the cells, and also the solvent to carry waste material away from the cells.
- **Active transport** is movement of **ions** in or out of a cell through the cell membrane, from a region of their lower concentration to a region of their higher concentration against a concentration gradient, using energy released during respiration.





• Root hair cells in plants take up mineral salts such as phosphate and nitrate from the soil by active transport. To help this, they have a large surface area and mitochondria to provide them with energy. In villi, glucose has to be taken from the small intestine into the blood plasma.

• **Osmosis** is the diffusion of **water molecules** from a region of their higher concentration (dilute solution) to a region of their lower concentration (concentrated solution), through a **partially permeable membrane**. You can also say that there is a water potential gradient, as the dilute solution has a high water potential and the concentrated solution has a low water potential.



• Osmosis occurs in red blood cells. Water also moves into the plant cells by osmosis, making them turgid and so that they can be able to stay upright.

•In the water uptake by plants, it is important that there is more water in the soil and less in the cells in plants, because otherwise water will diffuse out of the plant.

• In water, the concentration of water is higher outside the cell, than inside. Therefore, the plant cell becomes turgid (swollen) but does not burst because of the cell wall. The animal cells bursts. In concentrated sugar or salt solutions, the concentration of water inside the cell is higher than outside. Therefore, water diffuses out of the cells by osmosis. The plant cell becomes flaccid (soft and limp) and the cytoplasm is no longer pressed against the wall. The animal cells shrink and become crenated.

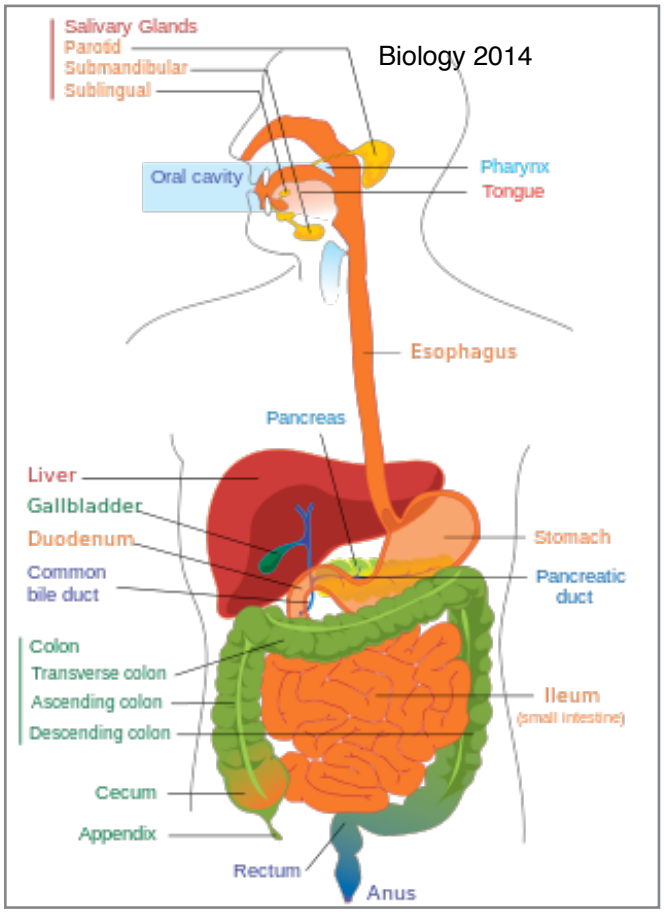
Nutrition and Enzymes

• A balanced diet is a diet which consists of all the nutrients in right proportions.

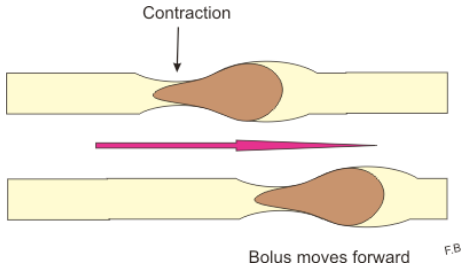
• **Malnutrition** is a condition where certain nutrients in a balanced diet are missing, in excess or taken in the wrong proportions. **Starvation** occurs when a person has a severe deficiency of energy, nutrient and vitamin intake. **Coronary heart disease** is when there is an over-abundance of intake of fatty foods, and cholesterol builds up in your coronary arteries. **Constipation** is when bowel movements are obstructed, due to the lack of fibre or water. **Obesity** is again, an over-abundance of intake of food.

• **Ingestion** is taking substances into the body through the mouth

• **Egestion** is passing out of food that has not been digested, as faeces, through the anus



- Mouth: Ingestion, physical and chemical digestion happen here. Salivary glands: Secrete amylase which breaks down starch into maltose so that it can be more easily digested. Oesophagus: Food gets passed on to the stomach (by peristalsis - series of muscle contractions and relaxations). Sphincter muscle relaxes to let food enter the stomach. Stomach: Stomach has a pH 2, because pepsin works best in acidic conditions. Protein is digested by the pepsin enzyme, which turns it into peptides. Also mixes with hydrochloric acid and rennin. Duodenum: Food mixes with pancreatic juice which contains amylase, trypsin (protease) and lipase (also contains sodium bicarbonate which neutralises the acid). Also mixes with bile from the gall bladder. Small intestine: Absorption happens here. Maltase, sucrase, lactase, proteases and lipase complete digestion. The molecules are then small enough to be absorbed into the blood (taken to liver in hepatic portal vein). Liver: Assimilation happens here. The liver produces bile, which emulsifies fats, so that they that it's easier for the lipase from pancreatic juice to digest them. Liver also converts excess glucose to glycogen to store it (metabolism of glucose). Amino acids are taken to make proteins and also to undergo deamination (nitrogen part of amino acids is removed, to form urea, which is put back into the blood). Large intestine: Water and minerals are reabsorbed in the colon. Gall bladder: Stores bile. Anus: Egestion happens.
- **Digestion** is the breaking down of large, insoluble food molecules into small, water-soluble molecules using mechanical and chemical processes
- In human **teeth**, the incisor is at the front of the mouth, is sharp-edged and used for biting off pieces of food. Canines are at either side of the incisors and have the same use. Premolars are towards the back of the mouth and have large surface areas for grinding food. Molars (wisdom teeth) are also used for grinding.
- The cause of **tooth decay** is sugar left on the teeth. The bacteria in the plaque will feed on the sugar, and change it into acid. The acid gradually dissolves the enamel and works its way into the dentine, hence causing tooth decay. Teeth should be brushed regularly, regular visit to the dentist should be arranged and eating less sugar will help prevent tooth decay.
- In the process of **chewing**, food is cut up by the teeth and mixed with saliva by the tongue. The ball of food (bolus) is pushed to the back of the mouth. The bolus goes into the oesophagus (voluntary action) and at the same time, the epiglottis is lifted so that food will not enter the larynx (reflex action).



- **Longitudinal** and **circular muscles** have a big role in **peristalsis**. Longitudinal muscles contract, shortening the oesophagus ahead of the bolus (of food). Circular muscles contract to squeeze the food forward. Circular muscles ahead of the bolus relax, allowing the walls of the alimentary canal to expand.
- **Bile** in emulsifies fats, they increase the surface area for the action of the enzymes (from big fat globule into many small droplets).
- **Fluoride** reduces tooth decay by making your teeth more resistant to tooth decay. There are side effects of too much fluoride, such as browning of the tooth enamel. People might also have allergies to fluoride and there is also personal choice involved (water impure blablabla).
- **Chemical digestion** breaks down large insoluble molecules to small soluble ones.
- **Nutrition** is the taking in of nutrients which are organic substances and mineral ions, containing raw materials or energy for growth and tissue repair, absorbing and assimilating them
- The chemical elements which make up..

-carbohydrates ~Carbon, Hydrogen and Oxygen
-fats ~Carbon, Hydrogen and a bit of Oxygen
-proteins ~Carbon, Hydrogen, Oxygen and Nitrogen

- The synthesis of large molecules (such as starch, proteins and fats) from smaller basic units

-simple sugars --> disaccharide --> starch and glycogen
-amino acids --> dipeptide --> proteins
-fatty acids and glycerol --> fats and oils

Enzyme	Site of action	Substrate digested	End products
Amylase	- mouth - duodenum	starch	- maltose - glucose
Protease	- stomach - duodenum	protein	- amino acids
Lipase	- duodenum	fat	- fatty acids - glycerol

- The tests for:

-starch ~add drops of iodine solution. Positive result is blue/black
-reducing sugars/glucose ~add Benedict's reagent and then heat it. Positive result is red/orange
-protein ~add drops of Biuret reagent. Positive result is purple
-fats ~mix water and the food sample. Pour some of the water into another test tube. Add ethanol to the new test tube. Positive result is milky

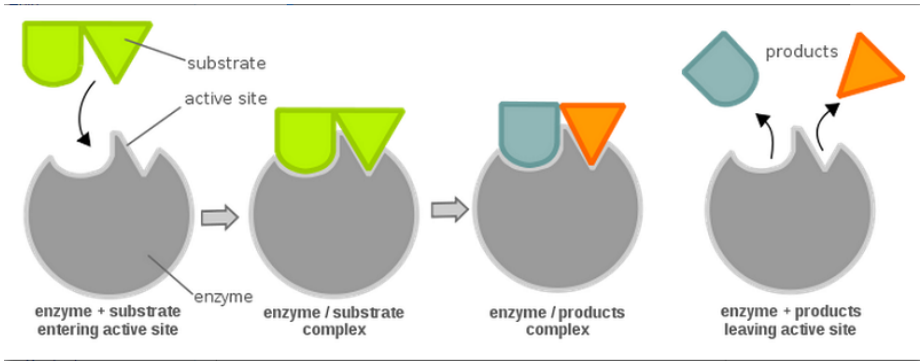
- Carbohydrates ~ source of energy. Can be found in bread and pasta. Fats ~ insulation and source of energy. Can be found in butter and oil. Proteins ~ growth and repair. Can be found in meat and eggs. Vitamin C ~ helps the immune system. Can be found in citrus fruits. Vitamin D ~ helps calcium get to your bones. Can be gotten from the sun. Minerals>Calcium ~ strengthens bones. Can be found in all dairy

products. Iron ~ to produce haemoglobin in the blood. Can be found in red meat. Fibre/roughage ~ prevents constipation. Can be found in vegetables and fruits. Water ~ transport substances. Found in drinks.

- Deficiency symptoms for:

Vitamin C ~ scurvy. Vitamin D ~ rickets. Calcium ~ brittle bones. Iron ~ anaemia. Protein ~ kwashiorkor

- Microorganisms are used in the food industry. Bacteria is used to ferment milk (at 460 degrees celsius), which produces lactic acid. The pH drops and milk begins to coagulate. The temperature is dropped (to 50) to prevent any further bacterial action. Single cell protein is produced by microorganisms such as bacteria, fungi (e.g. yeast) or unicellular algae in a fermentation vessel.
- **Food additives** include preservatives, flavourings and colourings. Preservatives prevent food poisoning and pro-long the shelf life of food. Flavouring are to make the food taste better. Colourings are to alter the colour. Some have been banned due to higher incidences of ADHD. Health hazards also include hypersensitivity to food additives (which causes diarrhoea, headache and nausea) and sodium nitrite has been linked to cancer.
- **Catalyst** is a substance that speeds up a chemical reaction and is not changed by the reaction
- **Enzymes** are proteins that function as biological catalysts
- Changes in temperature and pH have an effect on **enzyme activity**. At a low temperature, it is too cold for the enzymes to move. They work best at their optimum temperature, which is usually 37 degrees celsius, because heat gives them more kinetic energy. At a higher temperature, the enzymes get denatured and therefore stop working. Too acid or too alkaline conditions also cause enzymes to denature, thus causing a drop in enzyme activity. They usually work best at pH 7.
- Enzymes are used in the **germination of seeds**, and in **biological washing powders** and in the **food industry**. Seeds contain starch, so as the seed soaks up water, the amylase is activated. It breaks down the starch to maltose. The maltose is soluble and is transported to the embryo in the seed. Stains are either starch/sugar, protein or fat based. Amylase digests insoluble starch into maltose (starch stain), protease digests insoluble protein into amino acids (protein stain) and lipase digests fat into fatty acids and glycerol (fat stain). All these end products are soluble, thus they dissolve from the clothes in the washing water.



Respiration and Circulation

- **Respiration** is the chemical reactions that break down nutrient molecules in living cells to release energy
- The uses of energy in the body of humans are muscle contraction, protein synthesis, cell division, active transport, growth, the passage of nerve impulses and the maintenance of a constant body temperature.
- **Aerobic respiration** is the release of a relatively large amount of energy in cells by the breakdown of food substance in presence of oxygen
- The word equation for aerobic respiration is Glucose + oxygen --> carbon dioxide + water

$$Glucose + Oxygen \rightarrow Carbon\ Dioxide + Water\ (+energy)$$
$$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)\ (+energy)$$

- **Anaerobic respiration** is the release of a relatively small amount of energy by the breakdown of food substances in the absence of oxygen
- The word equation for anaerobic respiration in muscles during hard exercise is Glucose --> lactic acid
- Anaerobic respiration takes place in **yeast** during **brewing** and **breadmaking**. Breaking down sugar to alcohol and carbon dioxide is called fermentation**.** Brewing: To make beer, yeast is dissolved in a warm liquid containing sugar maltose. The yeast respires anaerobically, breaking down the maltose and making alcohol and carbondioxide (which makes the beer fizzy). Bread making: Flour is mixed with water to make dough. Flour contains starch, which breaks down to maltose when the flour is moistened. Yeast is added to the dough, breaking down the sugar as it respires. There is air in the dough, so yeast respires aerobically at first, until the oxygen is used up. It makes carbon dioxide, and bubbles of it get caught in the dough, making it rise. The yeast is killed when bread is cooked.
- The balanced equation for anaerobic respiration in muscles and the microorganism yeast is..

$$Glucose \rightarrow Lactic\ Acid\ (+energy) \qquad C_6H_{12}O_6 \rightarrow 2C_3H_6O_3\ (+energy)$$
$$Glucose \rightarrow Ethanol + Carbon\ Dioxide\ (+energy) \qquad C_6H_{12}O_6(s) \rightarrow 2C_2H_6O(l) + 2CO_2(g)\ (+energy)$$

- Anaerobic respiration produces much less energy than aerobic respiration.

- During exercise, **lactic acid** is released in the muscles. It lowers the pH in our muscles, causing enzymes (catalysing the contraction of our muscles) to denature. This causes cramps and aches in our muscles. The lactic acid must therefore be broken down by combining it with oxygen in the liver. This is why you breath heavily.
- Gas exchange surfaces in animals have specific features. Thin - gases can diffuse through them easily. Moist - stops cells from dying. Large surface area - a lot of gas can diffuse across at the same time. Close to an efficient transport system - to take gas to and from the exchange surface. Have a good supply of oxygen.

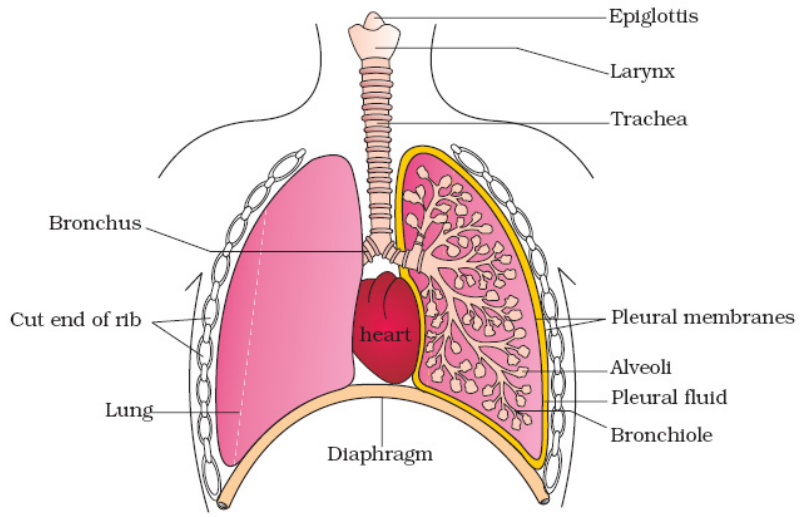
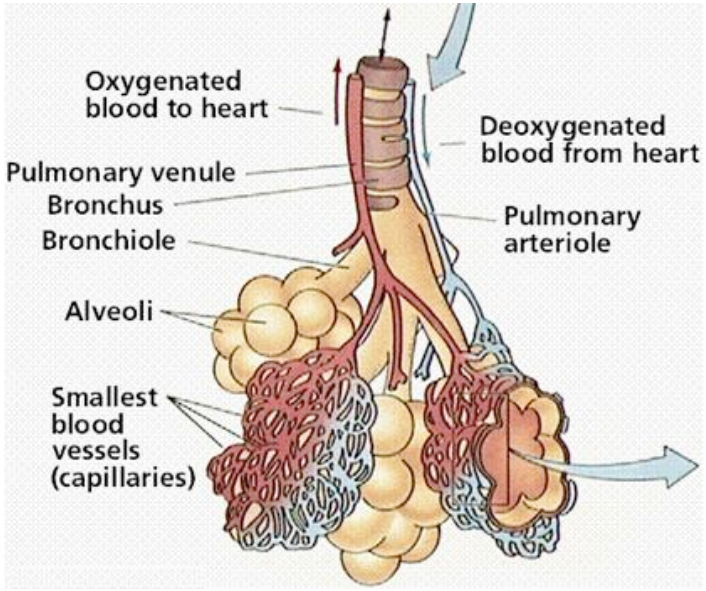


Figure 17.1 Diagrammatic view of human respiratory system (Sectional view of the left lung is also shown)



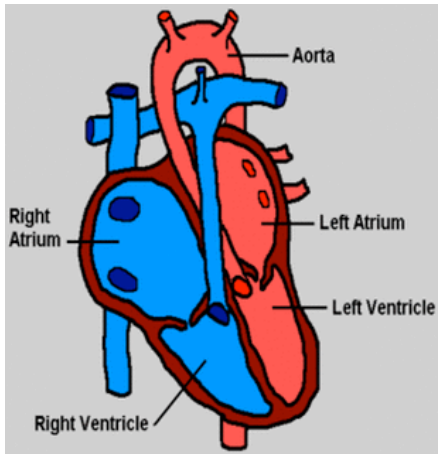
- Air is passed through to the lungs by the trachea. The larynx contains the vocal cords. The trachea divides into two bronchi (singular: bronchus). One bronchus goes to each lung and branches out into smaller tubes called bronchioles. At the end of each bronchiole are tiny little air sacs called alveoli. Alveoli are surrounded by tiny blood vessels called blood capillaries. Oxygen entering the air sacs diffuses into the blood that flows into the blood capillaries.

Components	Inspired air (%)	Expired air (%)	Reasons
Oxygen	21	16	Oxygen is used by cells in respiration
Carbon dioxide	0.04	4	Carbon dioxide is made inside respiring cells
Nitrogen	79	79	
Water content	Variable	Always high	Gas exchange surfaces are moist, so some of this moisture evaporates into the air
Temperature	Variable	Always warm	Air is warmed as it passes through the respiratory passages

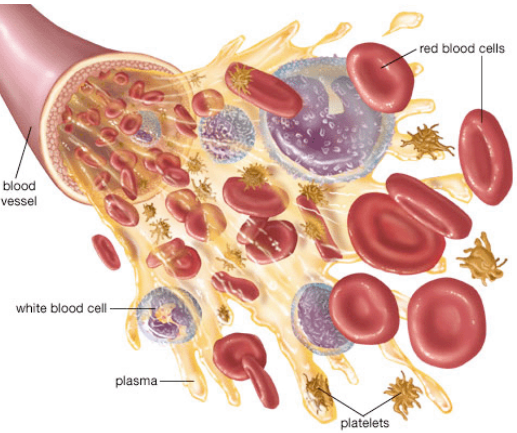
- **Lime water** is used to test for carbon dioxide to investigate the differences in composition between inspired and expired air. Carbon dioxide turns limewater milky/cloudy. Therefore, when inspired air goes into the limewater, the limewater should remain the same, but should turn milky when expired air is blown into it.
- Physical activity increases the rate and depth of breathing. The carbon dioxide concentration in the blood increase and pH in tissues decreases because of the lactic acid being produced.
- The **ribs**, the internal and external **intercostal muscles** and the **diaphragm** have a role in producing volume and pressure changes leading to the ventilation of the lungs. <u>When breathing in:</u> Muscles of diaphragm contract, which pulls the diaphragm downwards to increase volume in the thorax. The external intercostal muscles contract, which pulls the ribcage upwards and outwards (also increasing volume of thorax). As the volume of the thorax increases, the pressure inside falls below atmospheric pressure. Extra space is made and thus, air is drawn into the lungs. <u>When breathing out:</u> Muscles of diaphragm relax, causing it to spring back up because it is made of elastic tissue, thus decreasing the volume in the thorax. The external intercostal muscles also relax, causing the ribcage to drop back to its normal position. The volume of the thorax decreases, so pressure inside increase, thus air is forced out of the lungs.

! Sometimes you breathe out more forcefully (for example when you cough), and this is when the internal intercostal muscles contract, to make the ribcage drop down even further. Muscles of abdomen wall also contract !

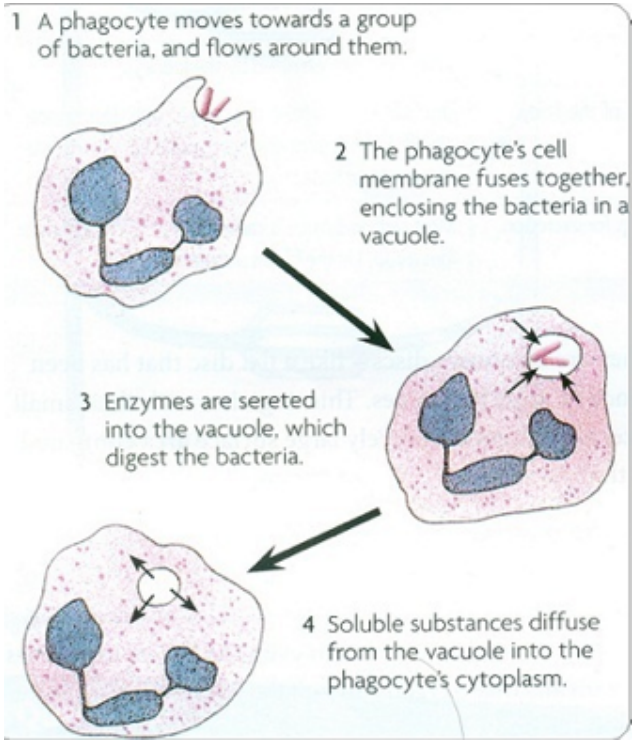
- **Mucus** and **cilia** protect the gas exchange system from pathogens and particles. The bronchus in the lungs are lined with hair-like projections called cilia that move pathogens and particles up and out of the airways. Scattered throughout the cilia are goblet cells that secrete mucus which helps protect the lining of the bronchus and trap microorganisms.
- The **circulatory system** is a system of tubes with a pump and valves to ensure one way blood flow
- **Double circulation** works in terms of a low pressure circulation to the lungs and a high pressure circulation to the body tissues and relate these differences to their different functions. Circulation to the lungs (pulmonary circulation) is at low pressure because the lungs are close to the heart. Circulation to the body tissues (body circulation) is at high pressure because they are further away from the heart.
- In the **heart,** deoxygenated blood comes in from the **vena cava** into the **right atrium**. It passes through the **tricuspid valves** and into the **right ventricle**. Then the blood is pumped out through the **semilunar valves** and **pulmonary artery**, into the lungs. Oxygenated blood comes back to the heart through the **pulmonary vein**. It passes into the **left atrium** and then through the **bicuspid valves** into the **left ventricle**. It is then pumped out through the **semilunar valves** and **aorta** to the body. The left and right ventricle are separated by the **septum**. The muscle wall on the left ventricle is much thicker because it has to pump blood all around the body.



- The heart is made out of a special type of cardiac muscle, which contracts and relaxes regularly. It has its own artery (coronary artery) to supply with oxygen and glucose because it is so active. The valves in the heart prevent the backwards flow of the blood.
- Physical activity increases pulse rate. This is because blood needs to pump around the body faster as muscle contract and relax faster. To do this they need more energy, so muscle cells respire at a faster rate. Therefore demand of oxygen and glucose increases and heart rate increase to increase supply of oxygen and glucose.
- **Coronary heart disease** is when cholesterol builds up in the coronary arteries, thus cardiac muscles do not get enough oxygen, thus heart stops beating. This is called a **heart attack** or **cardiac arrest**. It is caused by a poor diet with lots of saturated fat (cholesterol builds up in arteries), stress (increase blood pressure, thus fatty material collected in arteries), obesity (extra strain on heart, more difficult for person to exercise) and smoking (nicotine damages heart and blood vessels). Preventive measure include quitting smoking, exercising, maintaining a controlled diet and relaxing.
- These are the main blood vessels to and from the heart, lungs, liver and kidney. Vena cava and pulmonary vein > heart > aorta and pulmonary artery. Pulmonary artery > lungs > pulmonary vein. Hepatic artery and hepatic portal vein > liver > hepatic vein. Renal artery > kidney > renal vein.



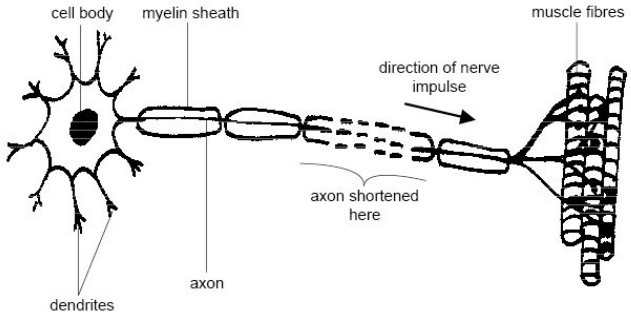
- **Arteries**: carry blood away from the heart, divide again and again to form capillaries. Thick outer wall, small lumen and thick wall of muscles and elastic fibres. This is because strength and elasticity is needed to withstand the high pressure blood coming from the heart. **Capillaries**: gradually join up to form veins. They have a small lumen and a wall made of single layer of cell. This is to facilitate diffusion and narrow lumen slows down the flow, and facilitates diffusion with surrounding tissues. **Veins**: carry blood towards the heart. Thin muscle wall, wide lumen and thin outer wall. This is to reduce resistance to blood flow which is flowing at a very low pressure.
- **Plasma** and **white blood cells** leak out of the capillaries into the surrounding area. They form **tissue fluid**. The capillaries supply cells with oxygen and nutrients (glucose, amino acids etc) and take away carbon dioxide. This all happens by **diffusion**. Lymph vessels drain the tissue fluid (it is now called lymph, a yellowish fluid containing water, salts, white blood cells, toxins and bacteria). They bring it back to circulatory system through **subclavian vein**.
- There are much more red blood cells than white blood cells in blood. White blood cells have a nucleus and red blood cells don't.
- The components of blood are red blood cells, white blood cells, platelets and plasma.
- The functions of blood: red blood cells - transportation of oxygen and haemoglobin. White blood cells - Phagocytosis and antibody formation. Platelets - clotting. Plasma - transport of blood cells, ions, soluble nutrients, hormones, carbon dioxide, urea and plasma proteins.
- **Antibodies** are produced by **lymphocytes**, in response to the presence of **pathogens** such as bacteria. This is because alien cells have chemicals called **antigen** on their surface. A different antibody is produced for each antigen. After infection, the pathogen is drained in the **lymph**. It meets all kinds of lymphocytes until one recognises it. Lymphocyte receives a signal to clone itself. The pathogen has to die. The antibodies bind to the antigens and destroy them. **Transplants** involve replacing a damaged organ with a donor organ. The problem with this is that the person's immune system might recognise the new organ as foreign and secrete antibodies to destroy it. This is called **tissue rejection**. To prevent this from happening, the donor organ needs to be a similar tissue type to that of the patient. Immunosuppressive drugs are also taken, which switch off the body's immune response. During this time, the patient can die from any kind of disease they're expose to, so they're kept in isolation. **Phagocytes** can move out of capillaries to the site of the infection. They then ingest the pathogens and kill them by **digesting** them.

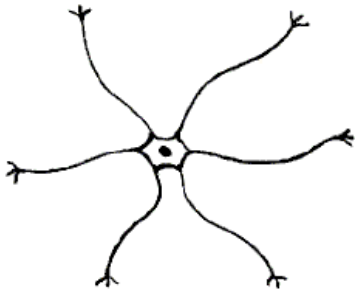


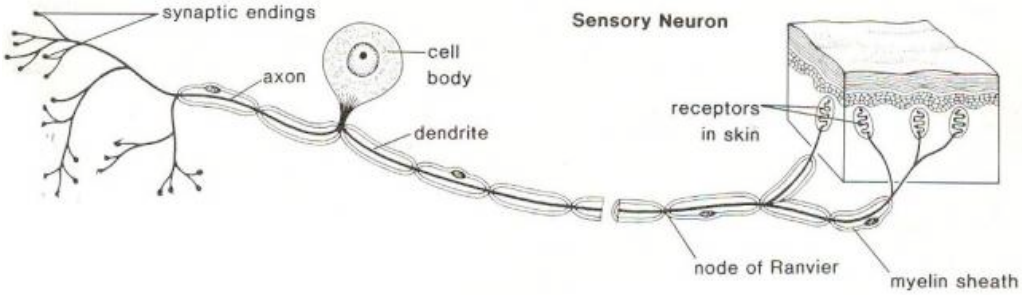
- The **lymphatic system** is a collection of lymph vessels and glands. It's main roles are fluid balance, protection from infection and fat absorption. From capillaries, white blood cells and plasma leak out to form tissue fluid. This helps oxygen and nutrients diffuse into cells and carbon dioxide and other waste products to diffuse out. This tissue fluid is then drained into lymphatic capillaries, where it turns into lymph. The lymphatic capillaries gradually join up to form subclavian veins. On the way there, there are lymph nodes which contain white blood cells which destroy bacteria in the lymph. Lymphocytes are made in lymph glands.
- When a blood vessel is cut, **platelets** bump into the rough edges and release a chemical. The damaged tissues also release chemicals. These chemicals react to turn **fibrinogen**, in the blood plasma, into fibrin. **Fibrin** is insoluble and forms fibres. This forms a mesh across the wound where red blood cells and platelets get trapped, forming a **blood clot**.

Control and coordination

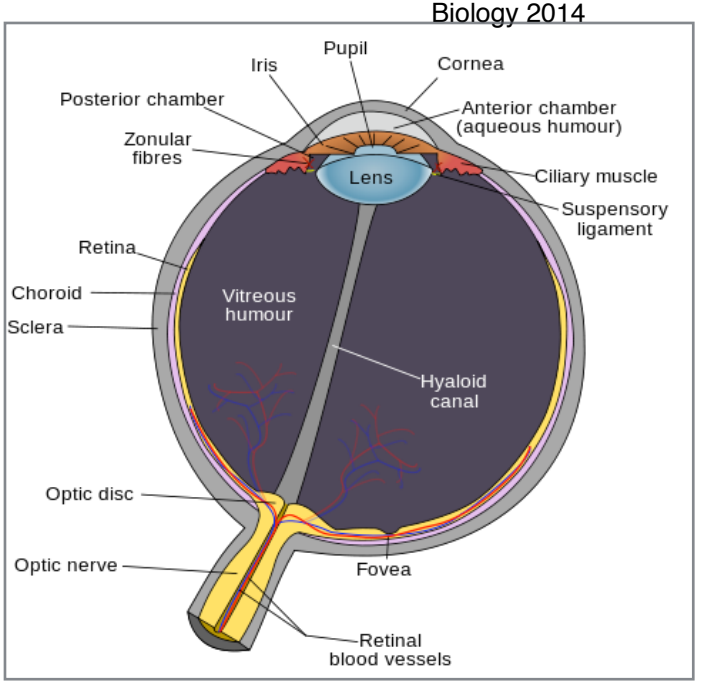
- The human nervous system consists of the **central nervous system** (brain and spinal cord as area of coordination) and the **peripheral nervous system** which together serve to coordinate and regulate body functions.
- Voluntary actions are done consciously and you are in control of the action. Involuntary is done without your control, unconsciously.
- Identify **motor, relay** and **sensory neurones** from diagrams



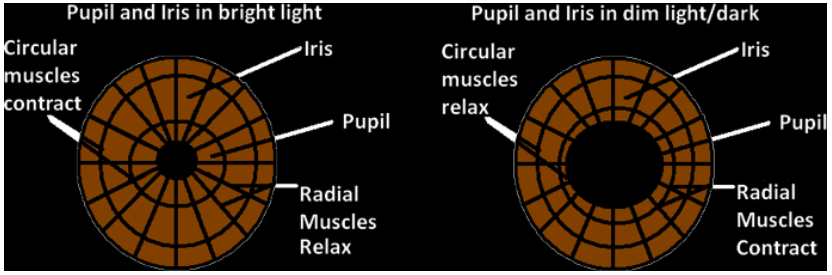




- Stimuli is detected by receptor cells. This message is then passed onto sensory neurones, then relay neurones, then motor neurones and then the effector (which can be muscles or glands). The route which the electric impulse takes is called a **reflex arc**.
- A **reflex action** is a means of automatically and rapidly integrating and coordinating stimuli with responses

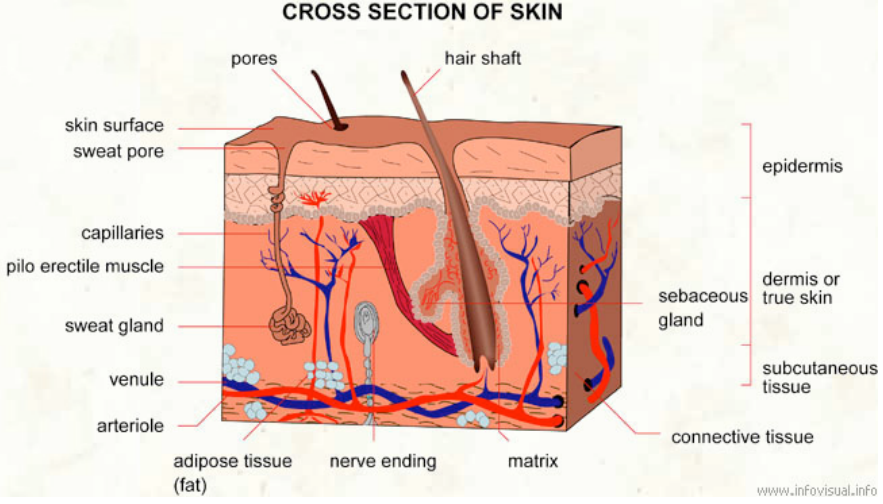


- **Antagonistic muscles** work against eachother. Biceps and triceps are a pair of antagonistic muscles; when the biceps contract, the triceps relax. When the triceps contract, the biceps relax.
- **Sense organs** are a group of receptor cells responding to specific stimuli: light, sound, touch, temperature and chemicals
- **Pupil:** hollow space in the middle of the iris, lets light through. **Iris:** controls size of the pupil. **Conjunctiva:** protective layer infront of cornea **Cornea:** clear tissue infront of the pupil and iris, refracts light **Aqueous humour:** clear fluid in front part of the eye **Vitreous humor:** clear jelly like substance in midpart of the eye, supports eyeball **Lens:** refracts light, does fine focusing **Ciliary muscles:** contract and relax to stretch lens or make it fat **Suspensory ligaments:** connect lens to ciliary muscles. **Sclera:** white part of the eye, protects the eye **Retina:** photo-sensitive area of the eye (detects light), made up of rods and cones **Blind Spot:** Part of retina in front of optic nerve which does not contain rods or cones **Fovea:** Directly opposite the pupil, with high density of cones (colour detection) **Optic nerve:** sensory neurone, sends sensory information to the brain **Choroid:** cells behind retina, rich in blood vessels and provides nutrients to the receptor cells.
- The iris contains radial and circular muscles. In **bright light**, the pupil needs to constrict so that too much light doesn't get to the retina and damage it. Thus the circular muscles contract and radial muscles relax. In **dim light**, the pupil needs to dilate to increase the amount of light reaching the retina. Thus the circular muscles relax and radial muscles contract. This is called the **pupil reflex**.



- To see an object that is very close, we need to refract a lot of light. Thus the ciliary muscles contract and suspensory ligaments are loose to make the lens thick. To see an object that is very far, light does not need to be refracted greatly. Thus the ciliary muscles relax and suspensory ligaments are stretched tight. This is called **accommodation**.
- Rods and cones can be found in the retina. **Rods** work best in dim light and detect light intensity. They can be found all over the retina and give a low resolution image. **Cones** work best in bright light and detect different colours. They are tightly packed in the fovea and give a sharp image.

- A **hormone** is a chemical substance, produced by a gland, carried by the blood, which alters the activity of one or more specific target organs and is then destroyed by the liver.
- BST is a **hormone** produced by cows. It controls their production of milk. Farmers inject extra BST in their daily cattle, to increase milk yield. Pros: economic advantage - higher milk yield per cow means you need less cows to produce the same amount of milk, thus cheaper. Cons: higher risk of infections of the udder (mastitis), discomfort for the cow, people worry about hormone product being in final product and affecting them negatively. Other hormones are used to grow bigger cattle, ripen fruit artificially and as weed killers.
- The hormone **adrenaline** is involved in chemical control of metabolic activity, including increasing the blood glucose concentration and pulse rate. Adrenaline secretion increases in a stressful or dangerous situation.
- **Nervous system**: Transmitted by neurones, electrical impulse, very fast transmission, very short, one target response. **Hormonal control system**: produced by glands, carried in blood, chemical message, very slow, long lasting, many target organs.
- Positive **geotropism** is when roots grow towards gravity. Negative geotropism is when shoot grows against gravity. Positive **phototropism** is when the shoot of a seedling grows towards light. Negative phototropism is when roots grow away from the light into the soil.
- **Auxin** is a plant hormone that promotes growth. It is produced in the tip of the shoot and diffuses down to the tissues beneath it. When light comes from all sides, auxin is evenly distributed and shoot grows straight up. When light comes from one side only, auxin is unevenly distributes. There is a higher concentration of auxin on the shady side (either auxin is destroyed by light or it diffuses to the shady side). This causes unequal growth and leads to shoot bending towards light.
- **Homeostasis** is the maintenance of a constant internal environment
- Temperature and blood glucose are controlled in similar ways. A sensor (eg hypothalamus) detects changes and sends messages to an effector (eg skin) which responds to the change. It acts to bring temperature or blood glucose back to normal. This change is sensed by the sensor, which produces different messages to make effector act to swing changes. This is called **negative feedback**.



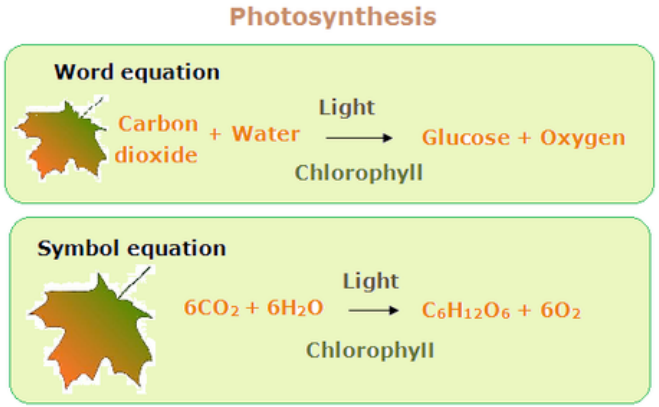
- **Glucose** is vital for cell respiration. The liver and pancreas are responsible for controlling blood glucose levels in the blood. When blood glucose is **high**: pancreas secretes **insulin** which causes the liver to absorb glucose from the blood and store some as glycogen. When blood glucose is **low:** pancreas secretes glucagon and the liver to break down glycogen into glucose.
- The maintaining of a **constant body temperature** is important in humans because our metabolic reactions depend on it. In the brain, cells in the **hypothalamus** constantly monitor the temperature of the blood and send signals to various muscles

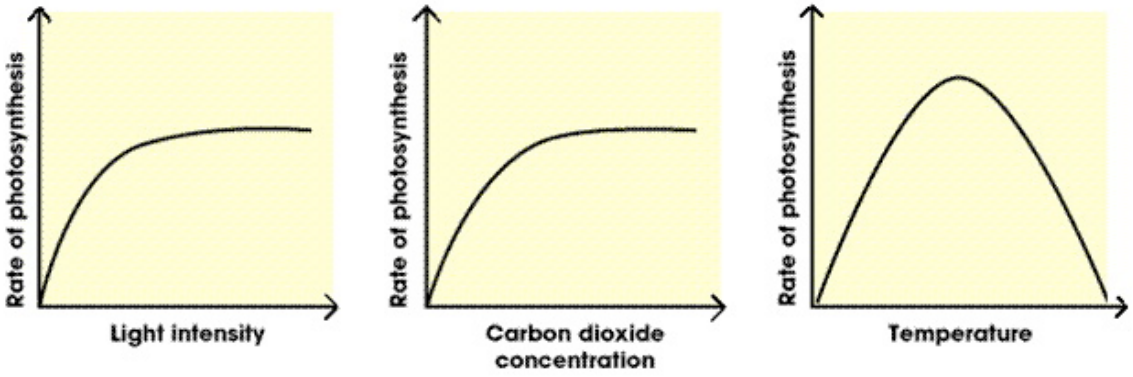
and sweat glands. If it is too **cold**: muscles in some parts of the body contract and relax very quickly to produce heat (a.k.a **shivering**), surface blood vessels constrict (**vasoconstriction**), hairs stand up to trap warm air near the skin and capillaries are supplied with less blood from arterioles so that they remain narrow. If it is too **hot**: sweat glands secrete **sweat** which takes away heat with it when it evaporates, surface blood vessels dilate (**vasodilation**), hairs lie flat to not trap any heat and respiration slows down.

- A **drug** is any substance taken into the body that modifies or affects chemical reactions in the body
- **Antibiotics** fight bacteria. They do not harm living cells and most are made by fungi. They target **metabolic reactions** that are specific to bacteria. Antibiotics are not effective against **viruses** as these are nonliving and do not have a metabolism.
- **Heroin** is a powerful depressant, it slows brain functions and relieves pain. It is highly **addictive** because once you start taking, your body requires more or you feel ill. Symptoms of withdrawal include cramps, vomiting and hallucinations. This leads to heroin addicts only looking forward to their next heroin intake, and will do anything to get it (**crimes**). As heroin is injected into the veins, the use of unsterilized needles can lead to infection, especially with the **HIV** virus. This has lead to increased spread of AIDS.
- **Alcohol** is a depressant; it reduces **self-control** and slows down your **reaction** time. The liver is responsible for breaking down alcohol, thus regular alcohol intake can lead to **cirrhosis** (liver disease). It damages the brain aswell, leading to **memory loss** and confusion.
- **Tobacco** smoke contains tar, nicotine, carbon monoxide and smoke particles. **Tar** irritates goblet cells, so there is an increased mucus production. It blocks gas exchange by coating the alveoli and also blocks cilia. **Nicotine** is highly addictive, speeds up the heart rate and constricts blood vessels leading to high blood pressure (higher risk of **heart disease**). **Carbon monoxide** is toxic and binds to haemoglobin in red blood cells, preventing them from carrying oxygen. **Smoke particles** are attacked by white blood cells, which can end up damaging the alveoli walls, thus reducing gas exchange. This can lead to **emphysema**.

Photo synthesis and Plant Transportation

- **Photosynthesis** is the fundamental process by which plants manufacture carbohydrates from raw materials using energy from light.
- Plants take in **CO_2** by diffusion through their leaves. **Water** is taken up by osmosis through the roots and transported to the leaf through xylem vessels. **Glucose** is changed to sucrose to transport around the plant or to starch for storage and used for energy or to make protein and other organic substances.





• **Chlorophyll** traps light energy to convert it to chemical energy for the formation of glucose and its subsequent storage.

• Plants have three main **limiting factors**. They need **light** energy to convert it to chemical energy to form carbohydrates. In the dark, plants don't photosynthesize at all and in dim light, they do so slowly. As light intensity increases, so does the rate of photosynthesis until the plant is photosynthesising as fast as it can (thus even if light is brighter, plants won't photosynthesis any faster). The more carbon dioxide a plants is given, the faster it can photosynthesise up to a point (max. is reached). The chemical reactions of photosynthesis take place very slowly at low temperatures, and increase on warmer days. After the maximum temperature the plant can withstand, photosynthesis drops completely because enzymes get denatured.

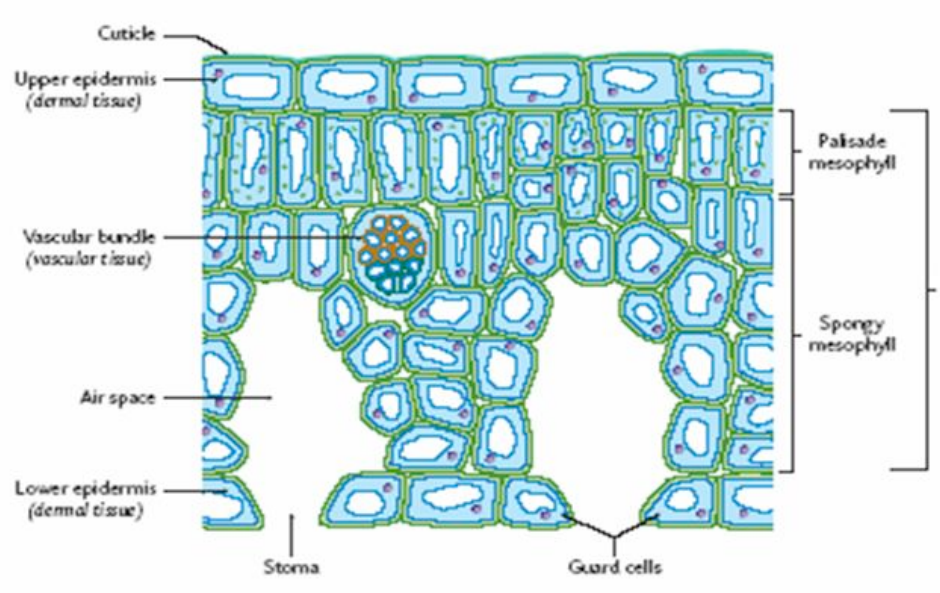
• **Limiting factor** is something present in the environment in such short supply that it restricts life processes

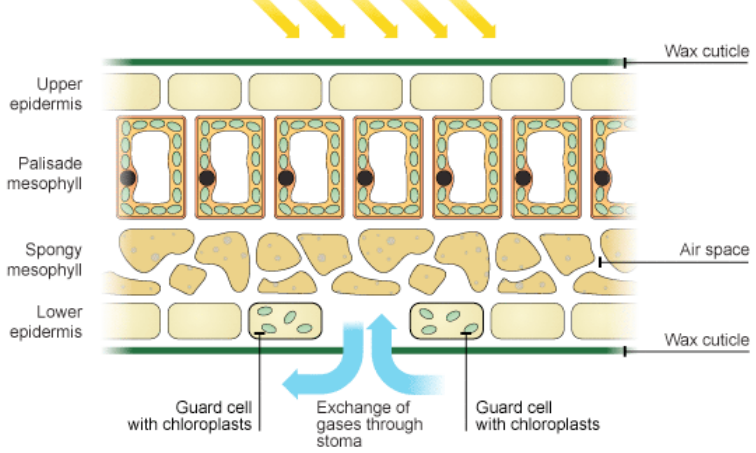
• In **glasshouses**, it is possible to control the conditions for the growth of the plants so that they are photosynthesising as fast as possible. The temperature can be kept at optimum level and extra lighting and carbondioxide can be provided.

• When **testing** a leaf for starch, it must first be boiled to break down cell membranes and to allow **iodine** solution to make contact with any starch inside the cells. Hot **alcohol** will remove chlorophyll from the leaf, making it easier to see any colour changes.

• In this diagram of a **dicotyledonous** leaf, the structure is related to the function. The chloroplasts are largely distributed to facilitate photosynthesis. The stomata and mesophyll cells are used in gas exchange. The vascular bundle (containing xylem and phloem) is for transport and support of the plant.

• In the diagram, the top and bottom part are covered with a layer of closely fitting cells called **epidermis**. Their function is to protect the inner layers of the cells in the leaf. The cells of the upper epidermis often secret a waxy substance called the **cuticle** which helps to stop water from evaporating from the leaf. In the lower epidermis there are opening called the **stomata** which are surrounded by **guard cells** which can open of close the hole. Guard cells, unlike other cells in the epidermis, contain chloroplasts. The middle layers of the leaf are called **mesophyll** and they contain chloroplasts. The cells near the top form the palisade mesophyll and beneath them is the rounder spongy





mesophyll. Running through the mesophyll are veins. Each vein contains large, thick-walled **xylem vessels** and small, thin-walled **phloem tubes**. A group of xylem vessels and phloem tubes are called a **vascular bundle**.

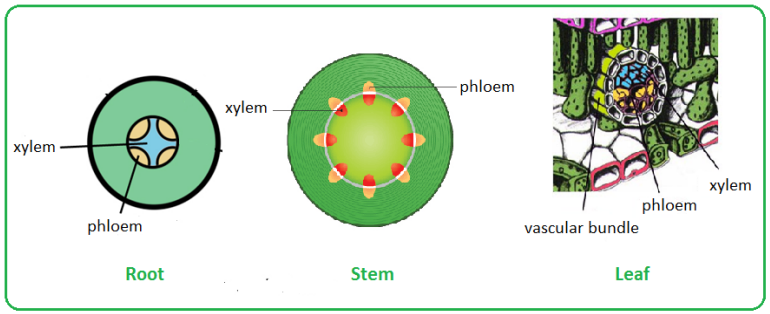
• Plants need **nitrate ions** to make **protein**. They can't use the nitrogen from the air because it is very unreactive. Therefore they absorb nitrate ions (nitrogen in a more reactive form) from the soil, by diffusion and active transport. The nitrate ions combine with glucose to make amino acids. Plants also make **chlorophyll**. For this they need nitrogen and also **magnesium**, which is obtained from the soil.

• If nitrogen is not obtained to make proteins, plants have a weak growth and the bottom leaves go yellow, since nitrogen is transported to help new developing leaves. If magnesium is not obtained to make chlorophyll, this will seriously affect plant growth and the leaves will turns yellow.

•Nitrogen **fertilisers** increase the yield of plants, since they provide the plant with amino acids, minerals and other things needed for growth. Overuse of these fertilisers can lead to **eutrophication**. This is when the nitrate from the soil leaks into water (nitrate is very soluble) and this feeds the **algae** and **green plants** in rivers. They may grow so much that they completely cover the water. This blocks out light for plants growing beneath them, which eventually die. The large population uses up all the oxygen from the water (respires actively) so fish die.

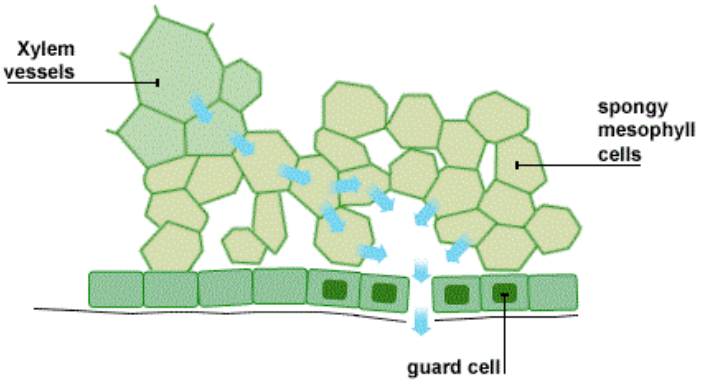
• Plants have transport systems to move around food, water and minerals. **Xylem vessels** carry water and minerals from the roots to the leaves. **Phloem tubes** carry organic nutrients that the plant has made.

• In **roots,** xylem and phloem are in the centre to withstand stretching forces. In the **stems** they are arranged in bundles near the edge to resist compression and bending forces. They are grouped together in veins and vascular bundles as they pass through **leaves.**



• Water enters the **root hairs** by osmosis. Water travels through the **cortex**, from cell to cell, by osmosis. Once it reaches the **xylem**, it is sucked in, because transpiration is constantly removing water from the xylem vessels. This causes the pressure at the top of the cells to be lowered, and the pressure at the bottom to be increased, creating this 'suction'.

• **Root hairs** increase the external **surface area** of the root for **absorption** of water and mineral ions (the hair increases the surface area of the cell to make it more efficient in absorbing materials).



• **Transpiration** is the evaporation of water at the surfaces of the mesophyll cells followed by loss of water vapour from plant leaves, through the stomata

• In leaves, the water molecules leave the xylem vessels and move from cell to cell. They move through the spongy mesophyll layer by **osmosis** and water then evaporates into air spaces in the spongy mesophyll. Water diffuses through the stomata into the surrounding air. This creates a high **concentration** of water molecules. Water in leaf cells form a tiny layer on their surface.

• On a hot day, water will evaporate quickly from the leaves of the plant. Transpiration increases as **temperature** increases. **Humidity** means the moisture content of the air. The higher the humidity, the less water will evaporate because there is no longer much of a diffusion **gradient**. In bright light, a plant may open its stomata to supply plenty of carbon dioxide for photosynthesis. More water can therefore evaporate from the leaves.

• If the leaves loose too much water, the roots may not be able to take up enough water to replace it. If this happens the plant **wilts** because cells loose water by osmosis and become **flaccid.**

• When a plant **transpires**, water vapour is lost through the stomata. There is a **water potential gradient** because there is more water in the xylem and less in the leaves because of transpiration. This creates a **pull**, drawing cohesive water molecules up the plant.

- **Desert** plants can easily run short of water, especially if the temperatures are hot. To prevent excess loss of water, plants **close their stomata** to close transpiration. However plants cannot photosynthesize if stomata is closed, so stomata only closes in the night (when they can't photosynthesize anyways) or when it's very hot and dry. The leaves of desert plants are often covered with a **waxy cuticle**, which prevents transpiration (because it's a fat) and also makes the leaf shiny, so light reflects back. They have **hair** on their leaves to trap moisture and also longer **roots**. Their leaves can be rolled up and the stomata may be on the bottom side of the leaf, which is cooler.
- **Pond** plants have large air spaces so that they can float, to obtain oxygen, carbon dioxide and more sunlight. The stomata is on the upper surface of the leaves because it facilitates gas exchange.

Comparison of transpiration and translocation

	Transport	From	To	Mechanism	High rate
Transpiration	H_2O, Mineral irons	Soil	Leaves, Flowers Fruits	Passive process using a tension in the xylem produce by evaporation of water.	on hot, sunny, windy and dry days
Translocation	Sucrose, Amino acids	Leaves	Shoot,root tips, root cortex, seeds, flowers, fruits	Active process, the water enters the tubes to build up a head of pressure that forces the phloem sap to the sinks.	on warm, sunny days when plants are producing more sugar

• **Translocation** is the movement of sucrose and amino acids in phloem from regions of production to regions of storage OR to regions of utilisation in respiration or growth

•**Systemic pesticides** are effective because when sprayed onto the leaves of the plant, they are absorbed by it through the cuticle or stomata and into the phloem tubes. They move through the plants in the phloem and are taken in by any **insect** eating the plant or sucking the phloem sap. Once an insect has ingested enough pesticide it will die, and harmless insects remain safe.

Classification

- All **living things** haven seven characteristics: **m**ovement, **r**espiration, **s**ensitivity, **n**utrition, **e**xcretion, **r**eproduction and **g**rowth. Nutrition is the taking in of nutrients which are organic substances and mineral ions, containing raw materials or energy for growth and tissue repair, absorbing and assimilating them. Excretion is the removal from organisms of toxic materials, the waste products of metabolism (chemical reactions in cells including respiration) and substances in excess of requirements. Respiration is the chemical reactions that break down nutrient molecules in living cells to release energy. Sensitivity is the ability to detect or sense changes in the environment (stimuli) and to make responses. Reproduction is the processes that make more of the same kind of organism. Growth is a permanent increase in size and dry mass by an increase in cell number or cell size or both. Movement is an action by an organism or part of an organism causing a change of position or place.
- The **binomial system** is a system in which the scientific name of an organism is made up of two parts: the Genus and the species
- Main **features** of... **fish**: scaly skin, gills, fins. ...**amphibians**: moist and scale-less skin, eggs laid in water, tadpoles/larva live in water, adult often lives on land, larva has gills, adult has lungs. ..**reptiles**: scaly skin, lay eggs with rubbery shells. ...**birds**: feather forelimbs have become wings, lay eggs with hard shells, homeothermic, have a beak. ...**mammals**: hair, have a placenta, young feed on milk from mammary glands, homeothermic, have a diaphragm, heart has four chambers, have different types of teeth.
- Types of **invertebrates**... **Annelids**: ringed worms, no legs e.g. earthworms. **Nematodes**: un-segmented worms, no legs, e.g. nematodes. **Molluscs**: un-segmented, have gills and one muscular foot e.g. snails. **Arthropods**: jointed limbs, exoskeleton, there are different types:

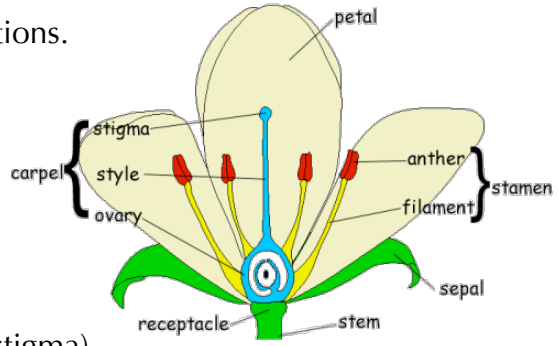
-**Insects**: 6 legs, 3 body parts (head, thorax and abdomen), two pairs of wings and composed eyes e.g. bees.
-**Crustaceans**: over 10 legs, 2 body parts (head-thorax and abdomen), made of many segments e.g. crabs.
-**Arachnids**: 8 legs, 2 body parts (cephalothorax and abdomen), no wings e.g. spiders.
-**Myriapods**: many legs, many segments, each segment has one or more pairs of legs e.g. Centipede.

- Types of **flowering plants**... **Monocotyledonous**: have strap-shaped leaves with parallel veins, one cotyledon inside each seed, fibrous roots. **Dicotyledonous**: have leaves which can be broad, and which have a network of branching veins, two cotyledons inside each seed, tap root.
- **Cladistics** is the way of classifying organisms based on their DNA sequence

	Virus	Bacteria	Fungi
Cell structure		X	X
Genetic content	Dna/Rna	Dna	Dna
Cell wall		X	X
Membrane	X/	X	X
Nucleus			X
Capsule		X	
Reproduction	In host	Binary fission	Budding/ spores

Plant Reproduction

- **Asexual reproduction** is the process resulting in the production of genetically identical offspring from one parent
- **Bacteria** reproduce by **binary fission**, each bacterium divides into two identical copies of the original cell. Single celled **yeast** reproduces by binary fission aswell (divides into parent and daughter cell) but all other **fungi** reproduce by **spores**. When sporangium bursts, it spreads the spores and once they land, they grow mycelium (roots). **Potatoes** reproduce by producing **stem tubers**. Some stems grow under the soil and swelling called tubers form on them. The tubers swell because starch is stored in them, they are then harvested and planted underground to grow shoot and roots to form a new plant.
- **Sexual reproduction** is the process involving the fusion of haploid nuclei to form a diploid zygote and production of dissimilar offspring
- In the flower structure, different parts of it have different functions.



Sepals: protect the flower while it is a bud
Petals: attract insects to the flower
Anthers: contain pollen grains (which contain male gametes)
Stigma: catch pollen grains
Ovary: contains ovule (which contains female gametes)

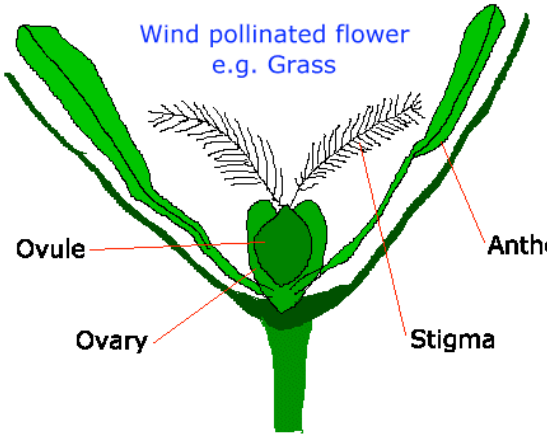
- **Pollination** is the transfer of pollen grain from the male part of the plant (anther of stamen) to the female part of the plant (stigma).

Agents of pollination include insects, birds, mammals, water and the wind.

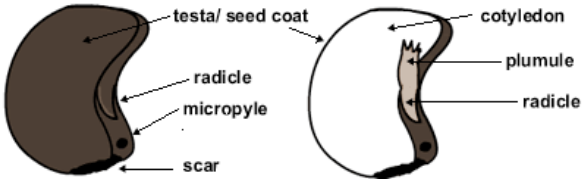
- **Insect pollinated flowers:** large colourful petals, strong scent, nectaries, quite large amount of pollen made, pollen is sticky, anthers and stigma inside the flower. **Wind pollinated flowers:** small dull petals, no scent, very large amount of pollen made, pollen is light, anthers and stigma are dangling out of the flower. It doesn't look like a flower.
- When the pollen lands on the stigma, it grows a pollen tube. The pollen tube grows through the micropyle (hole in the ovary) and into the ovule. The male gamete travels through the pollen tube and into the ovule, where it fuses with the female gamete. Fertilisation has taken place.

Advantages of asexual reproduction:
-fast: no need to find partner, fertilise etc.
-good characteristics are kept
Disadvantages:
-they are all genetically identical so if there is a change in the environment they could all die
-there is a competition for resources, as they all want the same things (food etc)

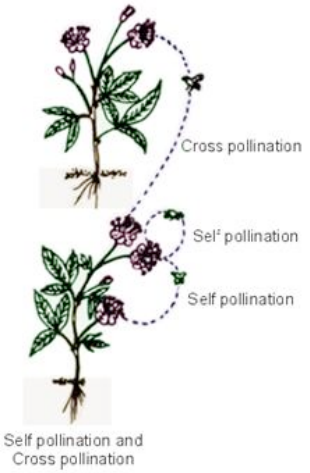
Advantages of sexual reproduction:
-produces genetically different offspring so they don't all die from change in the environment
-vary in use of resources, less competition
Disadvantages:
-it takes lots of time and energy
-good characteristics can be lost
-need to find a partner



The stigmas are feathery to catch pollen and the anthers hang out of the flower. There are not coloured petals, no scent and no nectar.



- Once the ovule has been fertilized, many of the parts of the flower aren't needed anymore. Eg Sepals, petals and stamens all fall off. Inside the ovary, the ovule begins to grow and contains a **zygote.** The zygote divides by mitosis to form an **embryo**, which consists of a radicle, which will grow into a root, and a plumule, which will grown into a shoot. Once it dehydrates (becomes dormant), stores starch (in the cotyledon) and gets an outer skin (testa), it is called a **seed.** The ovary grows aswell and is now called a **fruit.**
- **Growth** is the permanent increase in size and dry mass by an increase in cell number or cell size or both. **Development** is the increase in complexity.
- **Germination requirements** (for seed to grow) are water, to rehydrate the seeds which activates the enzymes and metabolism starts again. Oxygen, needed for aerobic respiration, which releases energy that can be used to grow. Warm temperature, which is best for enzyme action.
- Seed and fruit **dispersal** by wind and by animals provides a means of colonising new areas. This is done because new areas have less competition for light, space and nutrients, so seeds are more likely to develop. Example of wind dispersed seeds/fruit: dandelion, sycamore. Example of animal dispersed seed/fruit: apple, tomato etc.
- **Self pollination:** higher chance of fertilisation, less variation (but it's still sexual reproduction) **Cross pollination:** riskier so less chance of successful pollination, more variation (better to adapt to changes in environment)

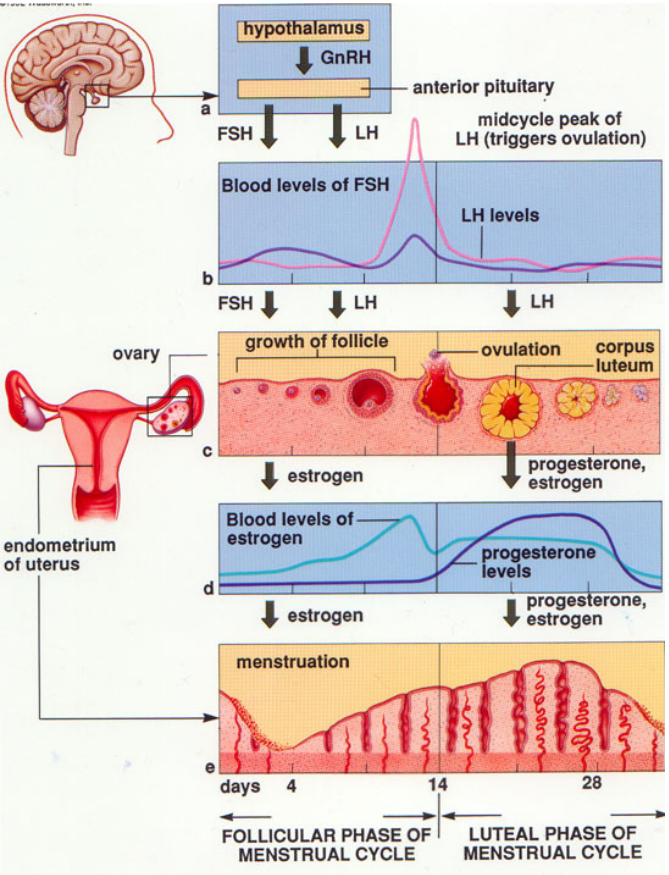


Sexual Reproduction in humans

- The **male reproductive system** consists of the testes, scrotum, sperm ducts, prostate gland, urethra and penis. The testes contain coiled tubes which produce sperm. The scrotum hold the testes outside of the body as sperm production is very sensitive to heat. The sperm ducts are tubes carrying sperm away from the testes and joining with the urethra. Where they join is a prostate gland which makes a fluid in which sperm swims in (prostate/seminal fluid). The urethra carries semen from the sperm duct to the tip of the penis, nevertheless it can also carry urine. The penis is the male sex organ, used to transfer semen to the female. In most mammals, it is also used to expel urine from the body.
- The **female reproductive system** consists of the ovaries, oviducts, uterus, cervix and the vagina. The ovaries produce the eggs, which are then carried away by the oviducts (aka Fallopian tubes). The oviducts lead to the uterus (aka womb), where the fetus develops. At the base

of the uterus is an opening called the cervix which leads to the vagina. This receives the penis during intercourse, and is the way out for the baby at birth.

- **Female gametes:** produce eggs from puberty till menopause (1 egg released per month), the eggs are big and do not move by themselves (roll down the oviducts). **Male gametes:** produce sperm from puberty till death (several million per ejaculation), sperm are very small and they swim.
- The **menstrual cycle** is controlled by the hypothalamus. It produces a hormone which travels to the anterior pituitary gland which produces 2 hormones: FSH and LH. They circulate in the blood and their target organ is the ovaries. The ovaries then release two hormones called oestrogen and progesterone. Their target tissue is the lining of the uterus. **Menstruation** is the breakdown of the lining of the uterus.



Changing hormone levels during the menstrual cycle.

Day 1: Menstruation begins (bleeding begins)
Day 5: FSH is released from the pituitary gland, which targets the ovaries
Day 14: **Ovulation** is the release of an egg from an ovary. Ovulation is triggered by a peak in LH, the follicle starts degeneration and is now called Corpus luteum (this produces progesterone which maintains lining of the uterus).
Day 28: If there's no embryo in the previous cycle then there is a drop in progesterone which triggers menstruation. **However**, if implantation occurs, this makes the hormones keep the corpus luteum maintained. This means that progesterone is high and keeps endometrium thick for pregnancy.

1) triggers production of oestrogen. Oestrogen promotes build up of the lining of the uterus
2) FSH stimulates the development of a follicle (tissue surrounding the egg, helping it mature)

Day 5 is theoretically the day that the bleeding stops.

Between day 5 and day 14, a new egg is growing

Between day 14 and day 28, progesterone maintains the lining of the uterus

- **Sexual intercourse** is when the penis fills with blood and becomes erect to enter vagina. Vagina walls secrete a lubricant. Rubbing of the glans (end of penis) against the vagina wall sets of a reflex action, causes sperm to be released from the testes, and is transported by peristalsis along sperm

ducts and urethra, where seminal fluid is added to make semen. The exit of semen from the penis is called ejaculation. Sperm then swim through the cervix and oviducts to the first third of the oviduct.

- **Fertilisation** is when the nucleus of the sperm fuses with the nucleus of the egg.
- After fertilisation, the zygote divides by mitosis to become the embryo. The embryo, a ball of cells, then implants (attaches itself to the lining of the uterus). Several weeks later a placenta develops to separate maternal and fetal blood.

→ The embryo is producing a hormone which tells the corpus luteum not to degenerate, thus progesterone levels stay high. Production of LH

→ and FSH stops, preventing a new cycle from starting. The placenta takes over progesterone production.

Placenta allows exchange of materials by diffusion such as; dissolved nutrients, antibodies, oxygen and CO_2, excretory products

→ Umbilical cord connects fetal circulation to placenta. It contains 2 arteries (blood from fetus to placenta) and 1 vein (from placenta to fetus)

- After 8 weeks, the embryo is called a fetus, as it has a heart and backbone.

→ The amniotic sac is the membrane which encloses amniotic fluid, which protects the fetus from mechanical shock, drying out and temperature fluctuations.

- **Antenatal care** that the mother can take is change her dietary habits. She should eat more protein (growth of fetus' cells), more carbohydrates (she needs more energy to walk around), more iron (to produce haemoglobin), plenty of calcium (growth of bones and teeth) and more vitamin C and D (blood vessel walls and bones). The mother should also make sure that she remains in good health. She should also continue to take exercise, which is gentle eg swimming and walking. The mother should also avoid illnesses and intake of harmful substances (alcohol and nicotine).
- **Birth** begins when strong muscles in the wall of the uterus start to contract; this is called **labour.** The contractions break the amniotic sac and amniotic fluid escapes; this is when a woman's 'water breaks'. In the beginning, the contractions slowly stretch the cervix and after several hours, it is wide enough for the head of the baby to pass through. The muscles of the uterus then contract to push the baby out and the wall of the vagina stretches to allow the baby to be pushed through. The umbilical cord of the baby is cut, as it can now breath on its own. The placenta is also no longer needed and it falls away from the wall of the uterus and passes out through the vagina; this is called the **afterbirth.**
- At **puberty** the pituitary gland starts to stimulate the primary sex organs – the testes in males and the ovaries in females. Sex hormones: testosterone in males and oestrogen in females are released into the bloodstream. They only affect the target organs which have receptors which can recognise them. This

Advantages of using breast milk:
-it is free
-contains antibodies from the mother
-it's always body temperature
Disadvantages of breast milk:
-it can only come from the mother, so she always has to be there

Advantages of formula milk:
-mother can hand over feeding to someone else
Disadvantages of formula milk:
-it is expensive
-antibodies not included
-has to be heated

causes secondary sexual characteristics such as the growth of under-arm hair and pubic hair and maturation of sexual organs.

- There are many methods of **birth control.** There is... The natural method: abstinence (not having sex at all) or rhythm method (don't have sex during the fertile period, only during the safe period). The chemical method: taking a contraceptive pill (stops eggs being produced in ovaries) or spermicides (kill sperm, but very unreliable). The mechanical method: condom (thin rubber), diaphragm (rubber inserted into vagina and covers the cervix), femidom (female condom) or IUD (copper coil left inside the vagina, irritates uterus wall thus preventing implantation). The surgical method: vasectomy (sperm ducts cut) or female sterilisation (oviducts cut).
- **Artificial insemination** is used if a man isn't producing healthy sperm, which makes impregnation impossible. In this case they would use a **donor** who would give them his sperm and which would be place into the woman's vagina. Another way is by using **fertility drugs** which is used when a woman is not producing enough eggs. She is given hormones, including FSH, to cause her to produce eggs. Sometimes they are allowed to be released into the oviducts the normal way. Sometimes they are removed from her ovaries just before they are due to be released, and placed in a warm liquid to which the sperm is then added. The zygotes are placed into her uterus, where they can develop the usual way.
- This method is expensive and some people think that it should not be freely available to anyone who wants it. Others think the inability to
- have children is so devastating that this should be free of charge. The treatment is not always successful and may have to be repeated many times before it actually works. Another problem is that more than one embryo might develop, thus causing the couple to get twins or triplets when they only wanted one child.
- **Gonorrhoea** is a sexually transmissible disease and is a bacterial infection. **Symptoms**: burning sensation when urinating, a creamy discharge from penis/vagina, inflammation of testicles. **Effects**: in men the urethra becomes infected, in woman it is the cervix. If left untreated, the disease can travel through the reproductive tract (causing sterility) and spread to the bloodstream, infecting the brains, heart valves, and joints. **Treatment**: gonorrhoea can be easily treated with antibiotics and this is almost always successful. The best way would be not to catch it in the first place by not being sexually active, having only one sexual partner or ensuring the man uses a condom.
- The disease AIDS is caused by **HIV** which stands for human immunodeficiency virus. It can only be transmitted through direct contact of body fluids, mainly getting spread by sexual intercourse. It can also be obtained by contact with an infected person's blood, from mother to child during pregnancy or childbirth or sharing syringes while injecting drugs. HIV affects the immune system by attacking the very cells which would normally kill viruses - the T cells. This makes a person very vulnerable (after a period of time) to other infections and diseases, which would be likely to kill them. The ways in which HIV/AIDS can be prevented from spreading is by not participating in unprotected sexual intercourse, not reusing needles/syringes, having fewer sexual partners and getting regularly tested. There is no cure, only ways to slow it down.

Genetics and Inheritance

- **Inheritance** is the transmission of genetic information from generation to generation
- **Chromosome** is a thread of DNA, made up of a string of genes
- **Gene** is a length of DNA that is the unit of heredity and codes for a specific protein. A gene may be copied and passed on to the next generation
- **Allele** is any of two or more alternative forms to a gene
- **Haploid nucleus** is a nucleus containing a single set of unpaired chromosomes
- **Diploid nucleus** is a nucleus containing two sets of chromosomes
- Inheritance of sex (gender) in humans: the woman's gamete can only carry an "X" chromosome, and a male gamete can carry either an "X" or "Y" chromosome, so the male chromosome determines the sex of the child. So if you do a Punette square the results will be XX, XX, XY, XY so there is a 50% chance of getting a boy and vice versa.
- **Mitosis** is nuclear division giving rise to genetically identical cells in which the chromosome number is maintained by the exact duplication of chromosomes.
- Mitosis is needed for growth. When we are zygotes, our cells begin to divide by mitosis to soon form a ball of cells that eventually grow into us. It is also needed for when you cut your skin, here mitosis provides the new cells to cover up the cut. Moreover mitosis happens in asexual reproduction. For example, potatoes reproduce by growing stem tubers. All the new cells in the tubers are produced by mitosis.
- **Meiosis** is the reduction division in which the chromosome number is halved from diploid to haploid. Gametes are a result of meiosis. Meiosis results in genetic variation so that the cells produced are not all genetically identical.
- **Genotype** is the genetic makeup of an organism in terms of alleles present (eg. Tt or GG)
- **Phenotype** is the physical or other features of an organism due to both its genotype and its environment
- **Homozygous** is having two identical alleles of a particular gene. (eg TT or gg). Two identical homozygous individuals that breed together will be **pure breeding.** On the contrary, **heterozygous** is having two different alleles of a particular gene, not pure breeding.
- Alleles can be described as dominant, recessive or codominant. **Dominant** is an allele that is expressed if present. **Recessive** is an allele that is only expressed when there is no dominant allele of the gene present.
- Continuous variation is influenced by genes and environment, resulting in a range of phenotypes between two extremes eg height in humans. Discontinuous variation is caused by genes alone and results in a limited number of distinct phenotypes with no intermediates eg A, AB, B and O blood groups in humans. There are three alleles for blood group given by the symbols IA, IB and IO. IA and IB are co-dominant giving blood group AB or I^AI^B, and both dominant to I^O.

- A **mutation** is a change in a gene or a chromosome. Ionizing radiation and chemicals change the chemical structure in body cells, thus rate of mutation increases. Examples of ionizing radiation are gamma, ultraviolet and x-ray radiation, as they all have an ionising effect which damages cells and causes mutations. Examples of chemicals are tars in tobacco smoke, high concentration of some preservatives and some plant control hormones.
- A mutation is a source of variation, as shown by Down's syndrome. In Down's syndrome, a parent's chromosomes are unevenly distributed in meiosis (e.g. one chromosome has 22 and the other has 24). In fertilisation, a zygote with a number of chromosomes that is not 46 is created (e.g. 23 + 24 gives 47 chromosomes). This causes a variation in characteristics: broad forehead, short neck, fold in eyelid, spots in iris, downward-sloping eyes, short nose, protruding tongue, congenital heart defects and mental retardation.
- **Sickle cell anaemia** is a disease in which the red blood cell has a sickle shape instead of a round biconcave shape, controlled by a recessive allele, which causes weakness, aching joints and poor circulation. The fact that it is recessive means that a heterozygous person can be a carrier: they have the allele but it is not expressed. Being a carrier of sickle cell anaemia makes you resistant to malaria. In equatorial Africa, being sickle cell anaemic causes death, malaria causes death, but the carriers have immunity to malaria and have some symptoms of anaemia, in severe cases they are very weak.


Normal red blood cell

Sickled red blood cell

- **Artificial selection** is breeding the organisms with the valued characteristics together in order to try to produce offspring which shares those useful characteristics (selective breeding). This can be used to produce wheat that has been bred so that all the stems are the same height to make harvesting easier or cattle that produce more milk than others, increasing their economical importance.
- **Natural selection** is the greater chance of passing on of genes by the best adapted organisms. Natural selection is a possible mechanism for evolution.
- **Variation** is natural or random changes in all living organisms. Variation leads to survival of the fittest, since variation allows some organisms to have different advantages over others. The surviving organisms reproduce, so the species evolves.
- Strains of antibiotic-resistant bacteria are developing as the use of antibiotics is increasing. In a group of many, many bacteria, one might mutate to be resistant to the antibiotic, as a result it reproduces and the others die making a new strain of bacteria, which is resistant to antibiotics.
- **Genetic engineering** is taking a gene from one species and putting it into another species. The gene coding from a pancreas cell for the production of human insulin is 'cut' from chromosome fragments. The plasmid (circle of DNA) from a harmless bacteria cell is cut to remove a part. They are combined to form a recombinant DNA. The bacteria are put in a fermenter or bioreactor to get a large population, and then the product is processed. This is how insulin is produced by genetically engineered bacteria.

Ecology

• The Sun is the principal source of energy input to biological systems. Energy flows through an ecosystem, but energy does not go back into the sun. Thus we cannot call it a cycle.

• A **food chain** is a chart showing the flow of energy (food) from one organism to the next beginning with a producer (e.g. mahogany tree → caterpillar → song bird → hawk)

• A **food web** is a network of interconnected food chains showing the energy flow through part of an ecosystem

• A **producer** is an organism that makes its own organic nutrients, usually using energy from sunlight, through photosynthesis

• A **consumer** is an organism that gets its energy by feeding on other organisms

• A **herbivore** is an animal that gets its energy by eating plants

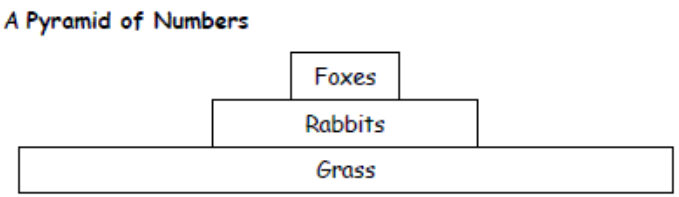
• A **carnivore** is an animal that gets its energy by eating other animals

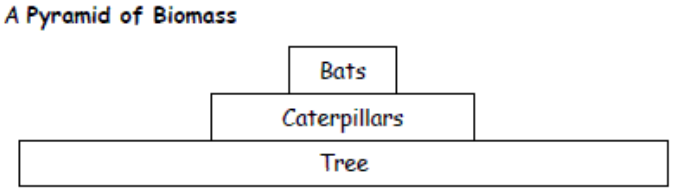
• A **decomposer** is an organism that gets its energy from dead or waste organic matter

• A **ecosystem** is a unit containing all of the organisms and their environment, interacting together, in a given area

• A **trophic level** is the position of an organism in a food chain, food web or pyramid of biomass, numbers or energy

• Food chains usually have five levels at most as energy transfer is inefficient. Energy is lost between trophic levels (respiration / movement / heat; urine / excretion / faeces) and there is not enough energy to support more than five levels.

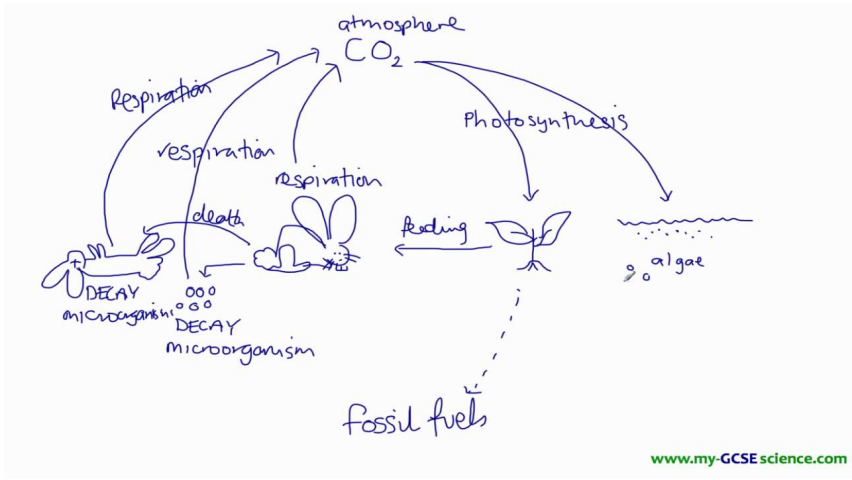




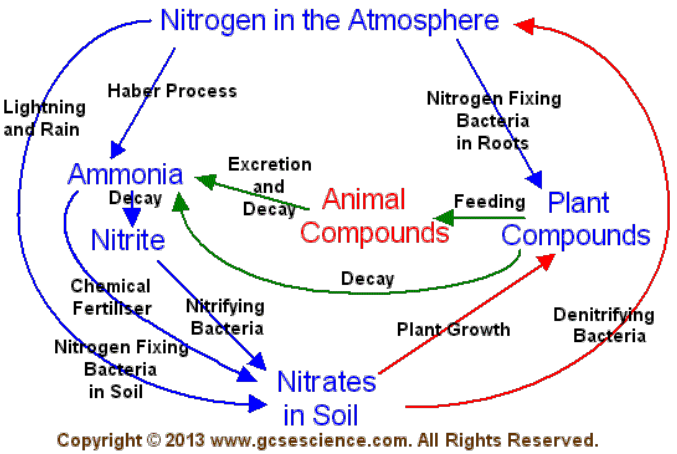
• Pyramid of **numbers**: Shows the number of each organism in a food chain. When moving up the pyramid, the number of individuals decreases.

• Pyramid of **biomass**: Shows the biomass of each organism in a food chain (number of individuals × their individual mass)

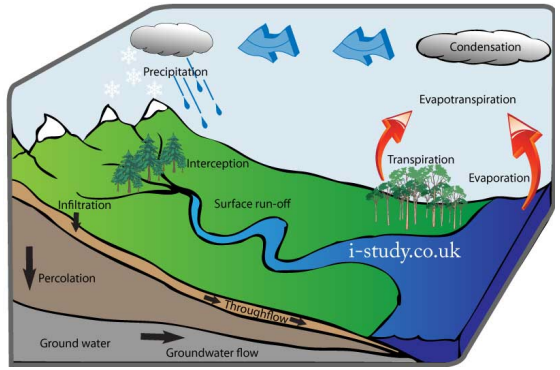
• The nearer to the beginning of the food chain we feed, the more energy there is available for us. Thus it is good to eat producers such as green plants. However when we eat meat, we are feeding further along the food chain where there is less available energy. It would be more efficient to eat the grass than let the cattle eat it and then eat them (however we can't digest cellulose so it would not work).



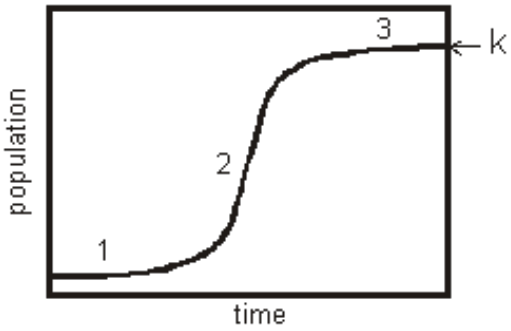
- **Carbon cycle**: When plants photosynthesise, carbon atoms from carbon dioxide in the air become part of glucose / starch molecules in the plant. Some the glucose is broken down in respiration and the carbon from the glucose becomes part of CO_2 again. Some of the carbon in the plant will be eaten by animals, who will release the carbon into the air when they breathe. Some of the carbon comes out in their faeces and urine. This goes into the soil, as do decaying organisms. Decomposer feed on them, and the carbon becomes part of the decomposers body. When they respire, they release CO_2 into the air again. Carbon compounds in microorganisms can also fossilise to make fossil fuels, which when burned, release CO_2 into the air.
- **Nitrogen cycle:** nitrogen in the air cannot be used by organisms because it is too unreactive. Changing nitrogen into a more reactive form is called nitrogen fixation. This is done by lightning and artificial fertilisers but more commonly by nitrogen fixing bacteria. This bacteria lives in the soil in root nodules, and once it has fixed the nitrogen, it is taken up by the plant and converted into protein. When the animal eats the plant, they ingest the nitrogen aswell. The nitrogen is excreted in the form of urea. When an animal or plant dies, bacteria or fungi decompose the body. The protein is broken down to ammonia and this is released. Nitrifying bacteria turn the ammonia to nitrites and then into nitrates (nitrification), which the plant can use again. Denitrifying bacteria turn nitrates and ammonia in the soil into nitrogen gas which goes back to the atmosphere.



- The combustion of fossil fuels has a negative impact on the environment. It adds to the greenhouse effect, as carbon dioxide is a greenhouse gas. This leads to global warming / climate change. Also, it produces sulphur dioxide which forms acid rain. This is harmful to the environment as it damages buildings, harms plants and animals. It also makes water unsafe to drink.
- Cutting down forests and deforestation happens, animals lose their habitats. This disrupts the food chain and decreases biodiversity (can even lead to species becoming extinct). It also disrupts the water cycle, leading to flooding and changes in rainfall. This can cause soil erosion and desertification.



- A **population** is a group of organisms of one species, living in the same area at the same time
- The factors affecting the rate of population growth are disease, predation and limitation to food supply (and describe their importance)
- The diagram on the right represents the sigmoid population curve for a population growing in an environment with limited resources. 1) **Lag phase** - slow reproduction rate, little/no growth 2) **Log / Exponential phase** - reproduction rate increases, plenty of resources/no limiting factors 3) **Stationary phase** - reproduction rate slows K) **Death phase** - death rate becomes larger than the birth rate and not enough resources for the population to keep living / more limiting factors



- As the human population size increases, more land is needed for building / urbanisation. This can mean that there is not enough land to grow crops. The increase in demand for food makes food too expensive for poorer people to buy. Richer countries take more of the food, and it becomes more difficult to distribute food. The increase in food production damages land, causing salination, desertification and there is not enough water. This leads to disruption to water supply, such as dams.

- Explain the factors that lead to the lag phase, exponential (log) phase and stationary phase in the sigmoid curve of population growth making reference, where appropriate, to the role of limiting factors
- Outline the effects of humans on ecosystems, with emphasis on examples of international importance (tropical rain forests, oceans and important rivers)

- **Eutrophication** - Fertilizers that have run off into lakes cause the growth of algae, which blocks light for plants to photosynthesise. Hence plants die and stop producing oxygen. Bacteria and decomposers feed on the dead plants, and use up oxygen as they respire anaerobically. Low levels of oxygen cause fish to die/suffocate. The bacteria also produces toxins which causes fish to die.
- There are many undesirable effects of **pollution**. The burning of fossil fuels produces sulphur dioxide which causes acid rain (damages on environment explained later). Running motor vehicles causes acid rain as well as producing carbon monoxide, which reduces amount of oxygen being carried in the blood. They also cause noise pollution and many animals are run over by these vehicles. Nuclear fall out (nuclear power that has escaped by radiation) damages animals and plants, as it causes cancer, leukaemia and mutations. Water pollution by sewage and chemical waste. Pollution due to pesticides including insecticides and herbicides. Herbicides might kill / harm other plants and will disrupt the food chain. Moreover plants may develop resistance to the herbicides.

- **Non-biodegradable plastics** in the environment are not broken down / do not decay and can get eaten by animals. These animals can suffocate and other animals can get trapped or entangled in the non biodegradable plastics.
- **Acid rain** is caused by the release of sulfur dioxide from power stations and factories, aswell as from car exhausts, burning of fossil fuels in houses and volcanic eruptions. Acid rain causes leaves and trees to be harmed / damaged. The trees are more likely to get diseased, their bark is damaged and their roots are killed. The soil pH decreases and aluminium ions become mobile (can run off into lakes and they are toxic to fish). The food chains are disrupted and this can lead to loss of habitat, less biodiversity and even extinction of species.
- To reduce pollution so that there is less acid rain, we could use renewable sources of energy such as wind, wave or solar power. We can use low sulfur fuels, reduce the use of coal, use catalytic converters, use more public transport or car pool. One can also walk or cycle instead of taking their car.
- The **greenhouse gases** come from many sources. Carbon dioxide is released in the burning of fossil fuels and vehicle exhausts. As there is deforestation, less carbon dioxide is absorbed by plants. This is even more harmful for the atmosphere.
- Radiation is constantly being reflected by the earth's surface. Heat is prevented from leaving (the atmosphere) because gases absorb/trap the infra red rays. Hence, the atmosphere gets warmer, thus greenhouse gases (carbon dioxide and methane) contribute to the **greenhouse effect**.
- Hence an increase in carbon dioxide in the atmosphere adds to the greenhouse effect. This can lead to desertification, global warming and climate change. Plants, however, will produce more oxygen.

- Describe the need for conservation of:
- species and their habitats
- natural resources (limited to water and non- renewable materials including fossil fuels)

- Limited and nonrenewable resources can be recycled. If paper is recycled, fewer trees are cut down. If plastic is recycled, there is less waste and less material burnt. They will take up less space in landfill sites, as they are nonbiodegradable and do not decay on their own. Recycling conserves these raw materials. treatment of sewage to make the water that it contains safe to return to the environment or for human use)