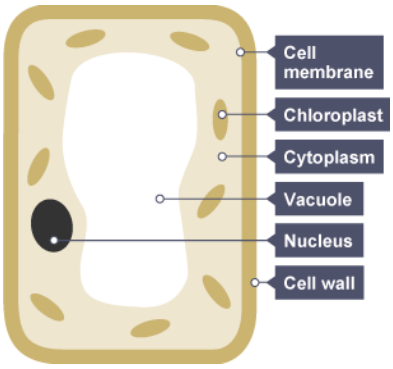
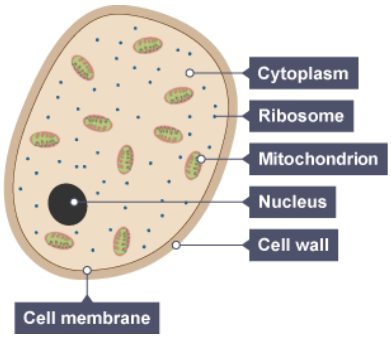
Human Biology

Cells and Tissues



Plant Cell



Animal Cell

Under an electron microscope parts of the animal cell such as the ribosomes, endoplasmic reticulum and mitochondria can be seen. Examiners often like to ask this question.

The main differences between a plant cell and an animal one is the lack of certain organelles such as a permanent vacuole, cell wall and chloroplasts. Apart from this plant cells also have a more regular structure.

The Functions of the parts of the cell:

Nucleus: contains chromosomes (46 in humans) which carry the genetic information. It controls the activity of the cell by controlling which proteins the cell will synthesise.

Cytoplasm: this is where chemical reactions occur.

Cell membrane: this controls what substances can pass in and out of the cell. It is selectively permeable.

Cell wall: this protects the cell and helps support itself.

Chloroplasts: these are needed for photosynthesis to take place in plants.

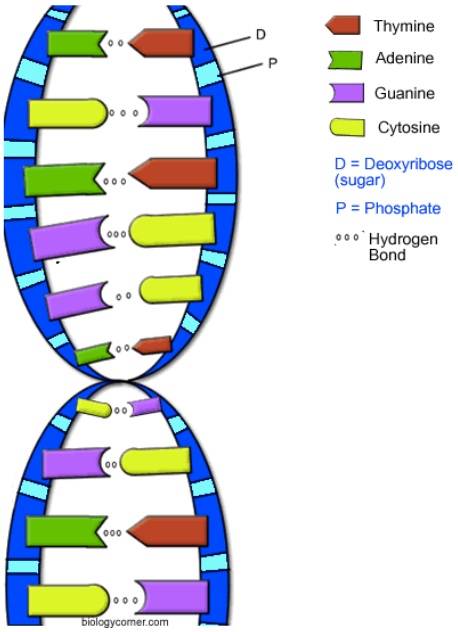
Mitochondria : this carries out some of the reactions in respiration.

Endoplasmic reticulum: an essential component in the synthesis and transport of protein. It is a network of membranes.

Ribosomes: some endoplasmic reticulum are covered with minute granules called ribosomes. These build and assemble proteins according to instructions from mRNA.

DNA

DNA or deoxyribonucleic acid contains two strands of alternating sugar and phosphate groups coiled to form a double helix. The strands are linked by two nitrogen bases at each "rung". There are four different bases: Adenine(A), Thymine(T), Cytosine(C), and Guanine(G). In DNA the bases are always paired. So if on one strand the base is A, the other must be T and likewise if on one strand it is C then on the other it must be G.

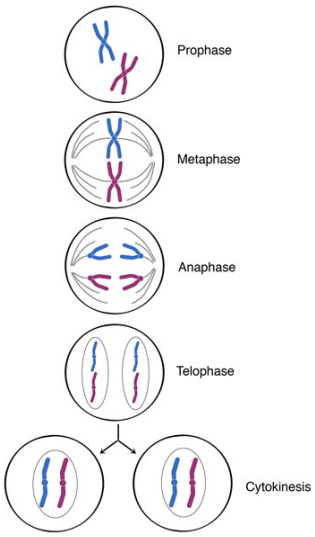


A simplified version of a DNA molecule.

Mitosis:

Mitosis is a process of separating a cell into two with identical sets of chromosomes. This occurs during growth, repair, cloning and asexual reproduction.

1. Prophase - the cell duplicates it DNA.
2. Metaphase - the centrioles (duplicated DNA) align themselves along the equator (middle) and send out tubules that connects to the centromere and connects the two strands of chromosomes (condensed DNA).
3. Anaphase - half of the chromosomes are pulled one way and vice versa.
4. Telophase - cell membranes closes in and splits the cell.



The organisation of cells:

Specialised cells that perform similar functions are grouped together as tissues:

There are many types of tissues:
1. Bones - collection of cells that secrete calcium salts.
2. Muscle - these can be voluntary, involuntary or also cardiac.

3. Blood - collection of red and white blood cells.
4. Nervous tissue - makes up the brain, nerves and spinal cord.
5. Epithelium - these are tissues that line organs. They can be both squamous or ciliated.

Tissues that perform the same function are grouped together to form organs. e.g. Heart.

Organs that perform the same function are grouped together to form organ systems. e.g. The circulation system

Organ systems are grouped together to form organisms. e.g. Humans.

Biological Molecules

Carbohydrates:
1. Contain the elements Carbon, Hydrogen and Oxygen.
2. Are split into groups polysaccharides (e.g. starch), disaccharide (e.g. sucrose) and monosaccharides (e.g. glucose).
3. The test for starch involves iodine. If it changes colour from red-orange to blue-black then starch is present.
4. The test for glucose involves Benedict's Reagent. If, when placed in heat, the solution turns from blue to brick-red then glucose is present.

Protein:
1. Contain the elements Carbon, Hydrogen, Oxygen and sometimes Sulfur.
2. Made of subunits called amino acids.
3. The test for protein involves the use of a biuret solution (Sodium Hydroxide and Copper Sulphate). If the solution goes from blue to pink-purple then protein is present.

Lipids:
1. Contain the elements Carbon, Hydrogen and Oxygen.
2. Made of a molecule of Glycerol and three fatty acids.
3. The test for lipids involves the use of ethanol. If when mixed the solution goes cloudy then lipid is present.

Enzymes are biological catalysts meaning that they are organic molecules that speed up reactions but remain unchanged. The lock and key model is used to describe the actions of enzymes. Enzymes have an active site which the substrate (reagent) fits into. After the enzymes catalyses the reaction it's then free to go elsewhere. Because of the varying shapes of the enzymes and substrates, only one type of enzyme can "fit" a substrate, they are, therefore, specific. Enzymes are used to catalyse metabolic reactions.

Enzymes are affected by temperature. The rate of reaction increases as temperature increases as there is more kinetic energy supplied which means more collisions occur between the enzymes and substrates. However, after the optimum temperature the rate of reaction falls as the enzymes are being denatured which means the active site is changed. Enzymes are also affected by pH. If the optimum pH is not reached the the active site is once again changed.

Experiment to show enzyme activity with temperature:
1. Place test tubes of amylase and another with starch in a water bath.
2. After five minutes mix.
3. Take sample and test with iodine.
4. Do this every thirty seconds until the iodine turns blue-black.
5. Repeat the experiment changing the temperature of the water bath to 20, 30, 40, 50, 60 °C

The movement of substances into and out of cells:

Diffusion - the next movement of particles from an area of high concentration to low concentration down a concentration gradient.

Osmosis - the movement of water molecules from an area of high water potential to an area of low water potential through a partially permeable membrane.

Active transport - the movement of particles against a concentration gradient using energy from respiration and carrier proteins.

The movement of substances into and out of cells can be through diffusion, osmosis and/or active transport.

Factors affecting rate of movement:

1. A high concentration gradient will increase the rate of movement.
2. A high temperature will increase the rate of movement as there is more energy meaning more kinetic energy is present. This means the particles move faster.
3. A large surface area to volume ratio will increase the rate of movement as there is more area for the particles to move across.

Experiment for diffusion:

1. Cut potassium permanganate agar jelly cubes into cubes of length 0.5, 1, and 2 cm.
2. Place cubes of jelly at the same time into three beakers containing 75ml hydrochloric.
3. Record the amount of time it takes for the jelly to go from the dyed purple colour to colourless.

Experiment for osmosis:

1. In three test tubes, pour in one 10ml of distilled water, one 10ml 0.85% salt solution and one 10ml 3% salt solution.
2. Add 1ml of fresh blood to each test tube and shake.
3. Look at the sample of each under a microscope.
4. No red blood cells should be seen in test tube one as lysis has occurred. Normal red blood cells should be shown in test tube two and shrunken red bloods cells should be present in test tube three (flaccid and plasmolysed).

Experiment for both diffusion and osmosis:

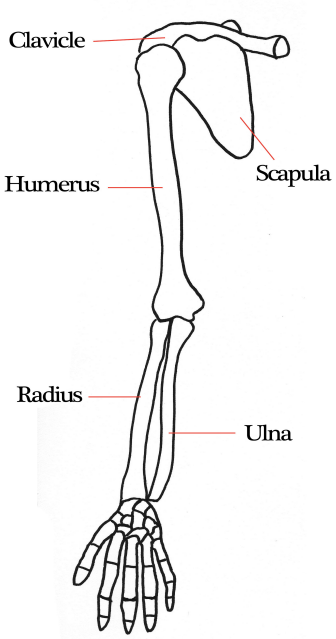
1. Fill visking tubing with a substance.
2. Place in beaker containing the substance but in different concentrations.
3. The amount of substance in each should change.

Form and movement

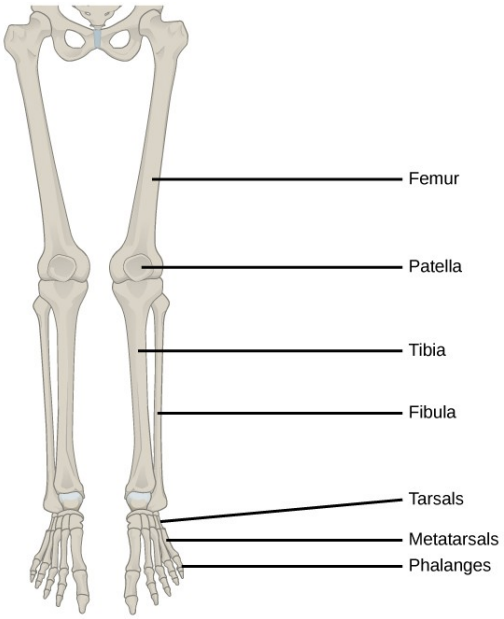
Axial skeleton - skull, ribcage, vertebral column.

Appendicular skeleton - scapula (shoulder blade), clavicle (collar bone), pelvis (under vertebral column) and limbs.

Limbs:

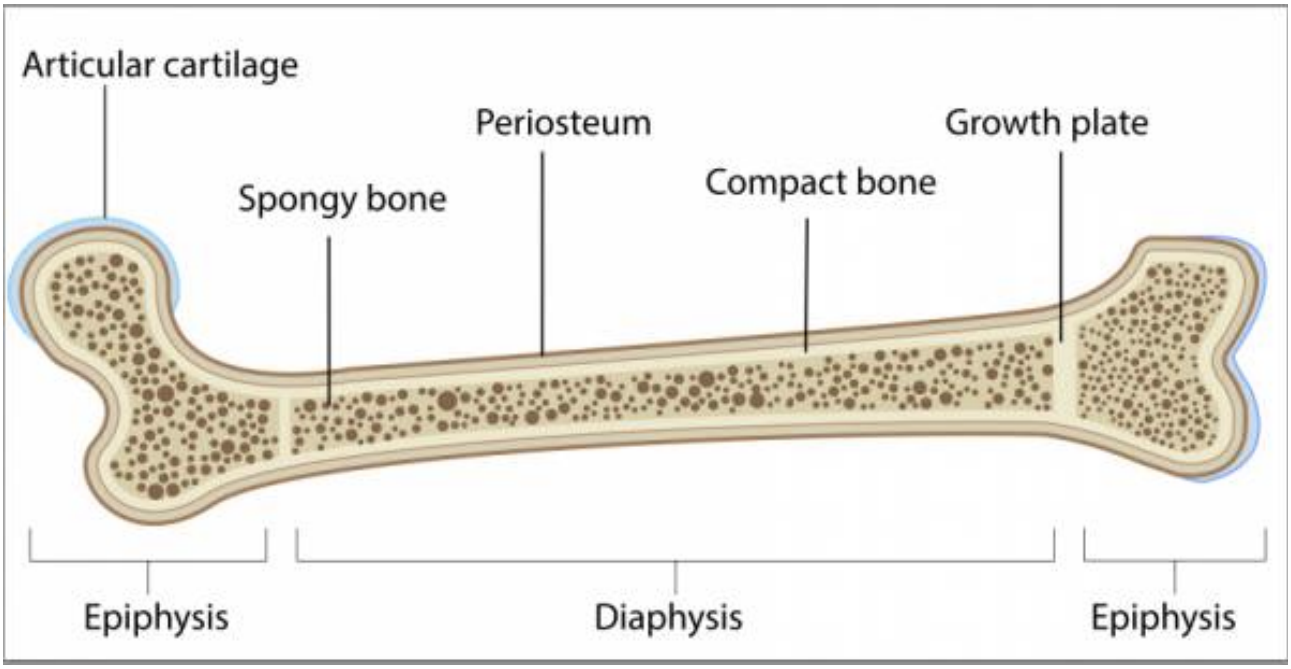


Arm



Leg

Long bones (e.g. femur, humerus) :



A diagram of a long bone

The functions of the skeleton:

1. Protection (e.g. ribcage)
2. Shape (e.g. femur)
3. Support (e.g. vertebral column)
4. Movement (e.g. radius, fibula)
5. Blood production (produced in the bone marrow of some bones)

Joints:

Joints are needed at the points where two bones meet each other and are needed for movement.

Hinge joint:
1. Present in elbow.
2. Prevents movement through more than 180°. Movement is only in one plane.

Ball and socket joint:
1. Present at the shoulder and hip.
2. Allows for movement in three planes and around 360°.

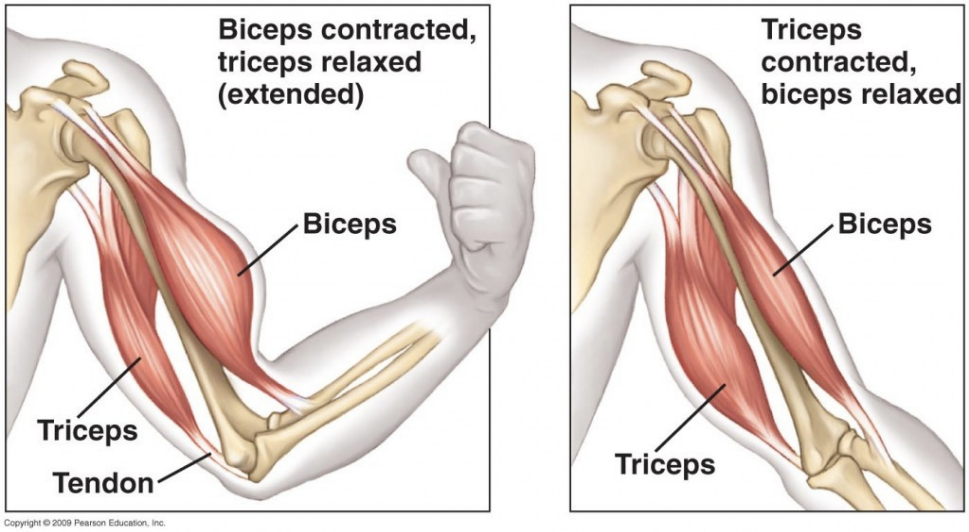
Cartilaginous Intervertebral Joint:
1. Present at the vertebral column.
2. This is where the discs of cartilage can be squashed to allow for some movement.

Immovable Joints:
1. Present at the joints in the skull.
2. Can not move.

Synovial joint:
1. Most joints are synovial joints and they are needed to allow for the smooth movement of the bones against each other.
2. It has smooth articular cartilage at the ends of the bones to reduce friction and to act also as a shock absorber.
3. A synovial joint also contains synovial fluid which lubricates the ends of the bones reducing friction.
4. It also contains ligaments which wrap around the two bones. These are used to hold the bones in place.

How a muscle induces movement:

When a muscle contracts, a tendon pulls a bone making it move. Muscles usually work in antagonistic pairs e.g. the biceps moves the radius up and the triceps moves it down.



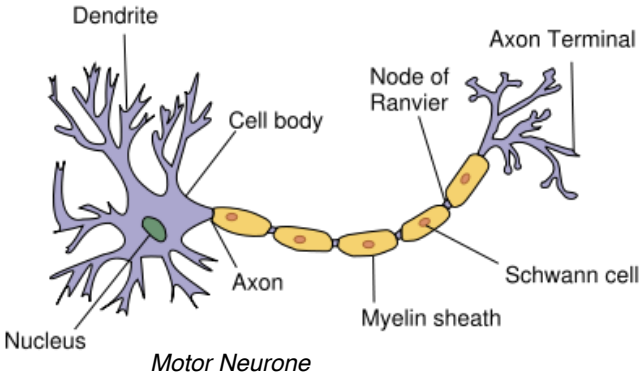
Nutrients needed for muscle and bone growth:

Muscles:
1. Protein
2. Vitamin D

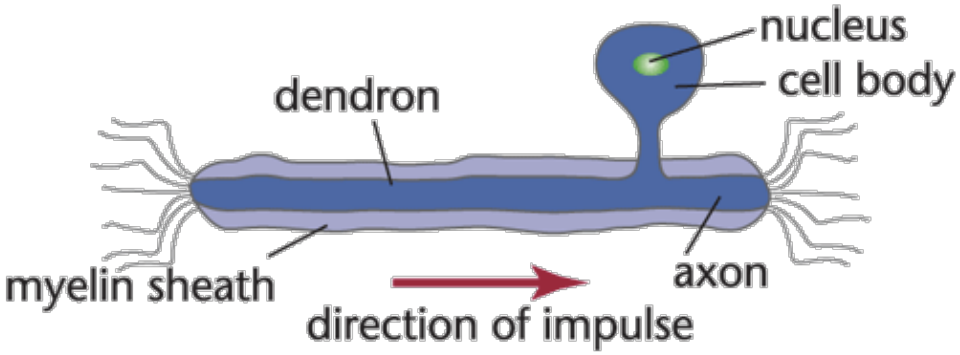
Bones:
1. Calcium
2. Vitamin D
3. Phosphate

Coordination

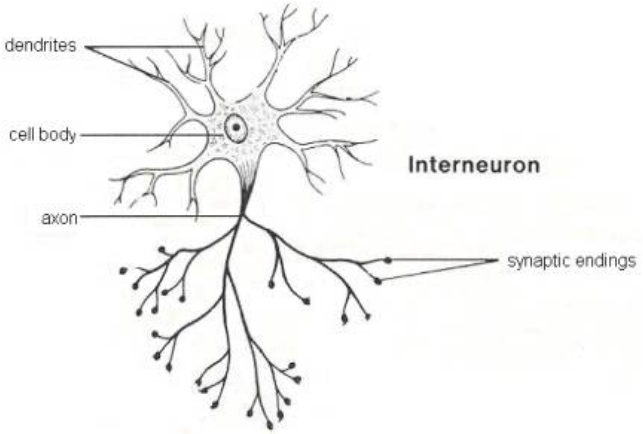
Neurones:



Motor Neurone



Sensory neurone



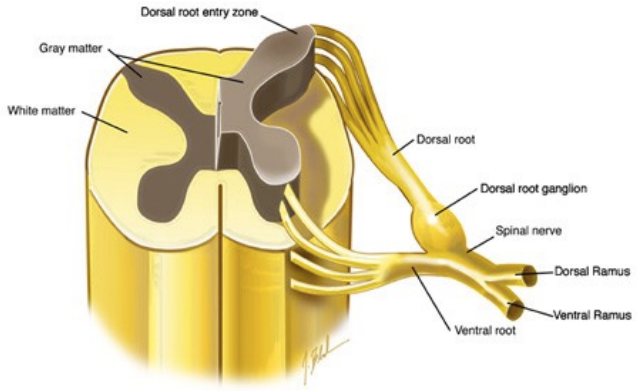
Relay neurone / interneurone

Central Nervous System: This contains the brain and spinal cord

and is what gives out orders to other parts of the body.

How neurones work:
An electrical impulse is sent from a nerve receptor and travels along the axon. At the nerve ending, there is a gap (synapse). A synapse works as the electrical impulse triggers the release of neurotransmitters. These chemicals diffuse across the synaptic cleft and binds with receptors on the second neurone. This forms a neurotransmitter-receptor complex which stimulates the second neurone to transmit the electrical impulse.The unused neurotransmitters are then either reabsorbed or broken down by enzymes.

Spinal cord: the spinal cord marks the site of coordination where information sent from sensory neurones are passed via relay neurones to motor neurones for the impulses to be sent to effectors.



Reflex Arc:
1. Receptor cells detect stimulus
2. Receptor stimulated and an electrical impulse sent along sensory neurones to the central nervous system (CNS).
3. At the CNS it travels along synapses to the relay neurone.
4. The relay neurone passes it to the motor neurone.
5. The impulse travels via the motor neurone to the target muscle or gland effector.
6. This creates an effect.

Examples of this are the knee jerk reflex and the withdrawal reflex. Both of these are spinal reflexes and so are involuntary. This is because you only receive information (to your brain) after the reflex has occurred due to the speed. In fact the knee jerk reflex can take just 50ms.

The brain:
The brain is made up of two **cerebral hemispheres** divided by a longitudinal fissure. The left hemisphere (relative to patient) controls the motor function of the right side of the body and vice versa. The right hemisphere is usually responsible for music, visual imagery and spatial awareness while the left is responsible for language, maths and logic.

The **cerebellum** is located at the back of the brain and is responsible for coordinating voluntary movements. It controls posture, balance, speech etc... and damage to it will cause lack of balance, slower movements and an inability to do complex physical tasks.

The **mid-brain** is located at the lower middle part of the brain and is responsible for hearing, vision, arousal and all of the responses related to sensory information. It is also partly responsible for motor control and body temperature regulation.

The **pituitary gland**, located infront of the mid-brain, is responsible for secreting hormones that either regulate the activities of organs or of other glands. e.g. growth hormones.

The **hypothalamus**, located above the pituitary gland connects the nervous and endocrine systems and is responsible for homeostasis, sleep-wake cycle and some motor control.

Hormones:

Pituitary:
- Anti-Diuretic Hormones (ADH) - involved in osmoregulation by controlling the permeability of collecting ducts.
- Gonadotrophin - controls the production of sperm and ovulation and triggers sexual maturation.

Adrenal:
- Adrenaline - prepared the body for the "fight or flight" response in times of stress. It increases heart rate, raises blood pressure, enlarges pupil size, and raises the body's metabolism.

Thyroid gland:
- Thyroxine - controls the body's metabolic rate.

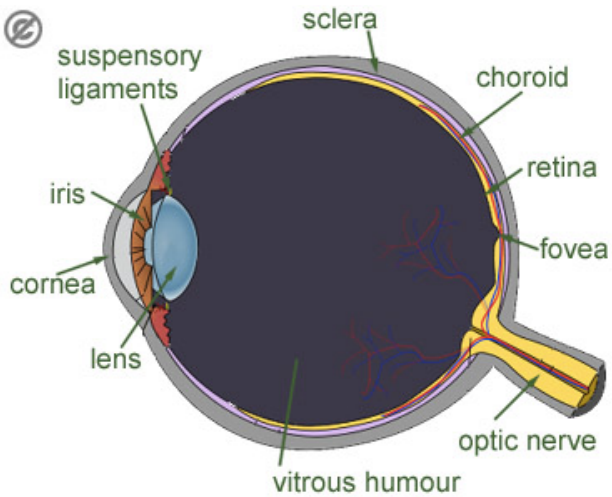
Pancreas:
- Insulin - helps control the body's blood sugar level by signalling the liver, muscle and fat cells to take in glucose and convert it to glycogen.
- Glucagon - helps control the body's blood sugar level by telling the liver to convert stored glycogen into glucose which is then released into the blood stream.

Hormones are vitally important for growth and development. The main hormones involved are the pituitary growth hormone, thyroid hormone and sex hormones.

Comparison of nervous and endocrine system:
- Both move instructions around the body and participate in homeostasis.
- Neurones use electrical impulses while hormones use chemicals.
- Neurones target specific collection of cells while hormones target specific cells.
- Hormones are relatively slow while neurones are very fast and rapid.
- Hormonal effects are relatively long lasting while neurones only create a short effect.

Negative feedback: This is an important control mechanism found in homeostasis where a response occurs to conditions that have changed from the ideal or set point. Examples are temperature control used by the skin and osmoregulation through the use of ADH.

The Eye:



A simple diagram of an eye

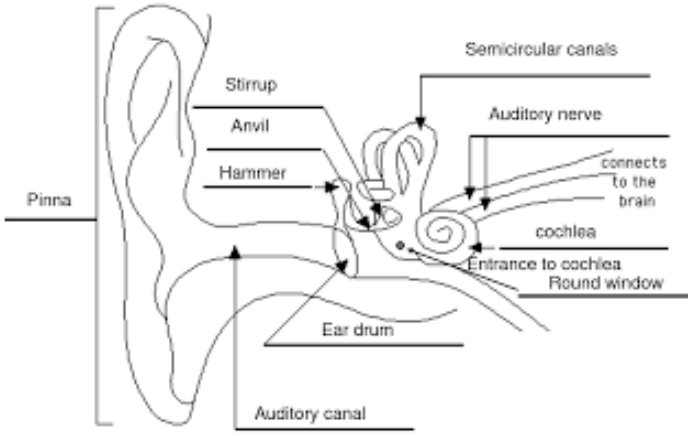
Function:
The eye is an photoreceptor (detects changes in light) and transduces light energy into electrical impulses. These are then interpreted as images by the brain. The eye is also able to respond to changes in light and is able to focus and bend light reflected of objects to allow the brain to produce a discernible image.

Focusing near and distant objects:
If an object is near, ciliary muscle will contract which relaxes the suspensory ligaments so that the lens becomes fat and slightly curved (convex). If the object is far, ciliary muscle will relax, making the suspensory ligaments tighten so that the lens stretches out and becomes thin and flat.

Responding to changes in light intensity:
In dim light, the iris dilate the pupil to allow more light to reach the retina. It does this by contracting the radial muscles and relaxing the longitudinal muscles. In bright light, the iris will shrink the pupil.

Stereoscopic vision:
This refers to the ability of humans to see the same scene with both eyes in different ways and results in our ability to perceive depth and distance. Stereoscopic vision allows us to play sports and judge distance.

The Ear:



A simple diagram of an ear

Function:
- Hearing - the pinna brings the sound waves down the ear canal which causes the ear drum to vibrate. The ossicles transmit the vibrations which set the liquid in the cochlea in motion. The ciliary cells in the liquid amplifies the vibrations and categorises them by each frequency. The auditory nerve receives this information from the ciliary cells and carries it to the brain which interprets them as noises.
- Balance - the semi-circular canals, lying at 90° to each other detects movement and sends impulses to the brain to help us know where we are.

Nutrition and Energy

Balanced Diet: eating foods on a regular basis that provide all the right nutrients (carbs, lipids, protein, minerals, vitamins, water and fibre) in the right amount and proportion for the person to remain healthy.

Your diet will change according to your age, whether you're pregnant, climate and occupation. Your energy requirement will also change according to your activity, age and whether you're pregnant.

Nutrient	Where from	Function	Illnesses
Carbohydrates	dessert, table sugar	Needed for respiration to supply energy for cells.	Dental caries such as toothache
Protein	red meats, nuts	Growth, repair and maintenance of cell issue.	Kwashiorkor which causes weakness and tiredness and also a swollen abdomen.
Lipids	butter, eggs	Long term stored energy and insulation.	Coronary heart disease such as angina and heart attacks.
Vitamin A	butter, carrots	Needed for rod and cone cells in the retina.	Nyctalopia - night blindness
Vitamin C	fruit, vegetables (e.g. broccoli)	To make connective tissue that bonds cells together.	Scurvy - bleeding gums
Vitamin D	sunlight, fish liver oil	Needed to take in calcium.	Rickets - deformation of bones
Calcium	dairy, bread	Needed to make teeth and bones.	Rickets - deformation of bones
Iron	eggs, spinach	Helps carry oxygen in haemoglobin.	Anaemia - pale and tired
Fibre	bread, cereal	Allows for the muscles in the gut to have something to push against.	Constipation - infrequent and painful bowel movements
Water	water, fruit	Transports materials and maintains the turgidity of cells.	Dehydration

Digestive System:

1. Mouth - food is ingested, and broken down by the teeth and tongue. Saliva is secreted by the salivary glands which begins the digestion of starch.
2. Oesophagus - helps food move to the stomach through peristalsis.
3. Stomach - a muscular bag where food is mixed with hydrochloric acid and pepsin. The acid is used to sterilise the food and create the optimum pH for pepsin to break down protein.
4. Pancreas - produces pancreatic juices which contains digestive enzymes and hydrogen carbonate which is used to neutralise stomach acids to create the optimum pH for these enzymes to work.
5. Small Intestine - contains the duodenum where food is mixed with bile and pancreatic juices and the ileum where enzymes complete digestion and digested food is absorbed.
6. Large Intestine - contains the colon where water and also some vitamins and minerals is absorbed from undigested food. Also contains the rectum which stores undigested faeces.

Bile: produced in the liver, stored in the gall bladder and released into the duodenum. It is used to emulsify/breakdown fats from globules into an emulsion of tiny droplets, giving a larger surface area to volume ratio for lipase to act on. It also neutralises the food.

Peristalsis: a series of muscle contractions that occurs in the gut. When the circular muscle contracts and the longitudinal muscles relaxes the gut narrows. A rhythmic series of narrowing and widening of the gut wall causes the food to be pushed along. Peristalsis needs fibre to work efficiently as this gives the gut something to push against in order to move the food along.

Digestive Enzymes:

***A*mylase** - breaks down starch into maltose. Created in the salivary glands, pancreas and the wall of the gut.
Maltase - breaks down maltose into glucose. Created in the salivary glands, pancreas and the wall of the gut.

Proteases - pepsin and trypsin breaks down proteins into peptides. Peptidases breaks down peptides into amino acids. Both are produced in the stomach wall, pancreas and gut wall.

Lipase - this breaks down lipids into glycerol and fatty acids. Produced in the pancreas.

Feature of the villus	Advantage
Has microvilli	Increases surface area to volume ratio, thereby increasing the rate of diffusion, allowing food to be absorbed quickly.
Circular shape	Again increases surface area to volume ratio.
Steady supply of blood	Maintains a steep concentration gradient.
Epithelium cell only one cell thick	Creates a short diffusion pathway, thereby creating a faster diffusion rate.

Experiment to find energy content of food:
1. Clamp test tube with 20ml of water and record the temperature.
2. Set the food alight with a bunsen burner and place the food under the water, relight it if it goes out.
3. When the food cannot be relit, record the new temperature of the water.

energy content = (mass of water * temperature change * 4.2) / mass of food

Experiment with digestive enzymes:
1. Place protein, starch and lipid samples in nine test tubes.
2. Place drops of amylase, lipase and pepsin (with hydrochloric acid) in each sample type.
3. Do iodine, biuret and ethanol test.

Teeth:

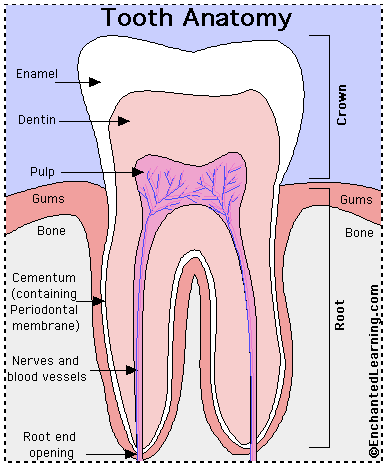
Incisors - there are eight in total and are located at the front of the mouth. They are used for cutting and shearing food into chewable chunks.

Canines - there are four in total and are located next to the incisors. They are used to grip and tear food.

Premolars - there are eight in total and located next to the canines. They are used to crush and tear food.

Molars - there are twelve in total and are located nest to the premolars. They are used to chew, crush, and grind food.

Structure:



Factors affecting the growth of teeth:

1. Calcium
2. Vitamin D
3. Genetics
4. Care of teeth

How to care for teeth and gums:

1. Brushing teeth twice a day and correctly.
2. Flossing
3. Not eating too much sugar or acid.
4. Visiting the dentists regularly.
5. Rinsing with mouthwash

Respiration:

Respiration is used to release energy in living organisms.

Anaerobic respiration is respiration without oxygen while aerobic respiration means that oxygen is used.

Aerobic respiration : $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy

Experiments to test for carbon dioxide from respiration:

1. Collect gas of germinating seeds and bubble through lime water to see if it turns cloudy.
2. Bubble air through double bubbler with bicarbonate indicator. If it turns yellow or orange the carbon dioxide is present.

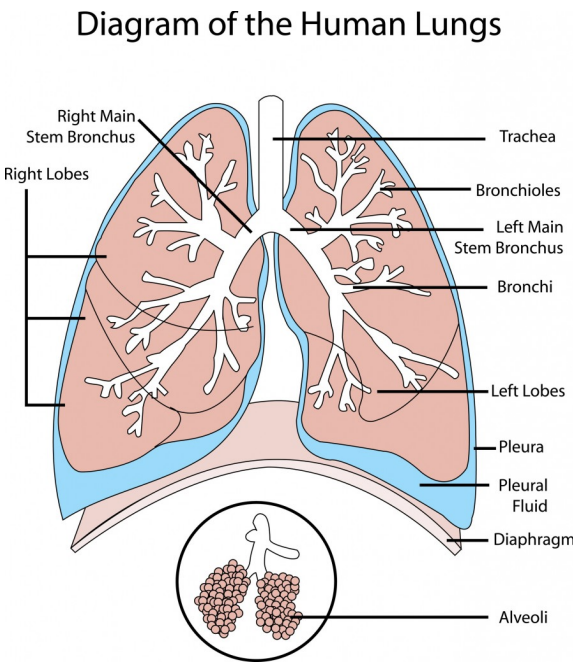
ATP (adenosine triphosphate) is known as the “currency” of energy. It is created during respiration using energy from oxidising glucose. This is then used to provide energy. In the process, a phosphate ion joins with adenosine diphosphate when energy is supplied and it breaks away when energy is needed.

Lactic acid is formed when there is no oxygen present and therefore during anaerobic respiration.

$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$ + less energy

Gaseous Exchange

Lungs:



During inhalation the external intercostal muscles contracts and the internal relaxes which pushes the ribs up and out. Apart from this, the diaphragm contracts, puling the diaphragm down and flat. All this creates a high volume in the chest (thorax) and therefore low pressure. This causes air to be pulled into the lungs as there is higher pressure outside. During exhalation, the opposite happens meaning the ribs are pulled down and in and the diaphragm goes back to a dome shape. This creates high pressure which pulls the air out of the lungs.

Adaptations of alveoli	Advantagess
Large surface area	This allows for faster diffusion as more particles can diffuse across the membrane at one time.
Good blood supply	Maintains a steep concentration gradient between alveoli and the blood capillaries.
Walls one cell thick	Creates a short diffusion pathway.
Moist	Increases the rate of oxygen diffusion as it dissolves.

Lung capacity - the volume of air the lung takes in different phases of the respiratory cycle. This can be measured with a spirometer.

1. Vital capacity - maximum lung capacity
2. Tidal volume - normal volume of air in the lungs during quiet breathing.

When the brain detects a too large or too little concentration of oxygen or carbon dioxide in the blood it changes the breathing rate to change the amount of air it takes in. e.g. if there is too much carbon dioxide, the breathing rate rises to breath out the carbon dioxide.

Diseases from smoking:

1. Emphysema - chemicals from cigarettes damage the elastic tissue in the lungs, reducing the surface area of the alveoli and therefore the speed and mount of oxygen it absorbs.
2. Lung cancer - carcinogenic chemicals in cigarette tar causes cancer.

3. Bronchitis - cigarette smoke paralyses cilia in the trachea meaning phlegm and microbes enter the lungs, this can cause infections.
4. Heart disease - nicotine in the cigarettes leads to the hardening and narrowing of blood vessels. This can lead to heart attacks.
5. Lethargy - cigarette smoke contains carbon monoxide which means less oxygen are carried around the body.
6. Nervousness - cigarettes contain nicotine which is addictive so withdrawal symptoms occur when one is not smoking.

Investigating the effects of exercise on breathing:
1. Breath into a double bubbler with limewater or bicarbonate indicator for twenty seconds.
2. Do vigorous exercise for three minutes.
3. Repeat step one with new double bubbler.

After exercise the limewater is usually more cloudy and the indicator should be more yellow. This is because your breathing is more concentrated in carbon dioxide and also because the breathing rate is high after exercise.

Effects of exercise:
1. Muscles need more energy so breathing rate increases to supply more oxygen for respiration and to oxidise carbon dioxide.
2. Heart rate increases to pump more oxygen around the body and faster.
3. Arterioles widen to stop blood pressure from increasing.
4. Blood diverted from inactive organs (e.g. stomach/liver) towards muscles through vasodilation and constriction

Benefits of regular exercise:
1. Improves body posture, muscle tone and weight loss.
2. Strengthen bones and muscles.
3. Improves endurance, flexibility and overall fitness.
4. Less risk of coronary diseases by lowering blood pressure.
5. Lowers the heart rate and relaxes blood vessels.

Internal Transport

The Blood Contains…
- Plasma
- Red blood cells (erythrocytes)
- White blood cells (lymphocytes and phagocytes)
- Platelets

Sickle Cell Anaemia:
This is a disease where the genetic code for the production of haemoglobin has mutated. This causes the haemoglobin, when the oxygen concentration is low, to become sickle shaped. Effects of this are:
1. The sickle cells stick together to form blockages in the capillaries causing severe pain, especially in the joints. This is known as sickle cell crisis.
2. A stroke may occur because of this as there is reduced supply of blood to the brain.
3. The sickle shape means less oxygen can be carried. They also often burst and are destroyed by the spleen at a higher rate than normal cells. This causes anaemia.

Haemophilia:
This is caused by a mutation of a gene which produces chemicals needed to form clots. This means that the person infected would often need a blood transfusion after minor injuries and would need injections of the missing clotting factor every time they are injured.

Plasma transports hormones from the glands to organs of the body, nutrients such as glucose, amino acids, proteins and lipids from the gut to cells, urea to the kidneys, carbon dioxide (90%) and heat energy from muscles and the liver to organs that produce less hear maintaining an even body temperature.

Red Blood Cells:

Adaptation	Explanation
Contains haemoglobin	Used to combine with oxygen to form oxyhemoglobin. This allows oxygen to be transported.
No nucleus	Leaves more space fir haemoglobin so that more oxygen can be transported.
Biconcave shape	Allows for a more efficient exchange of oxygen in and out of cells by increasing surface area.
Thin	Short diffusion pathway increases the rate of diffusion.
Flexible	This allows it to squeeze through blood capillaries.

White Blood Cells:
White blood cells prevent diseases. Around 70% of these cells are phagocytes which produce extensions of their cytoplasm called pseudopodia to enclose the foreign organism in a vacuole. Enzymes then break them down. Phagocytes essentially consume them. 25% of these cells are lymphocytes. They are used to make antibodies which stick to the antigens on microorganisms to kill or make it easier to kill it. This is because antibodies makes pathogens group together making them easier to kill. Some lymphocytes also produce memory cells which makes us immune to diseases.

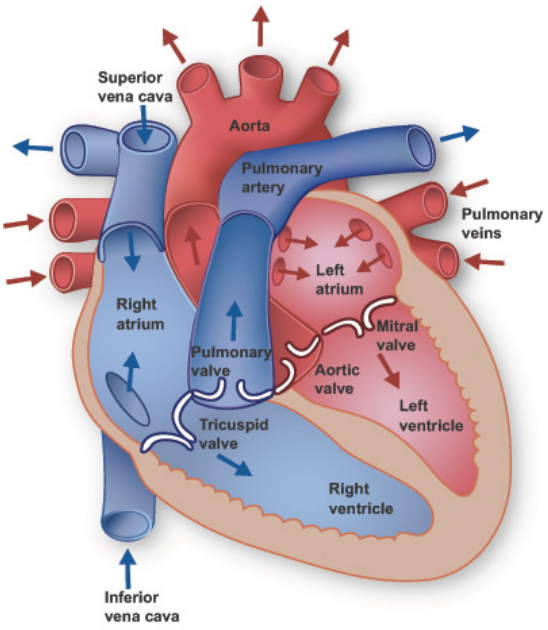
Platelets:
Exposure to air stimulates the platelets and damaged tissue to produce chemicals. This causes the soluble protein fibrinogen to change into an insoluble fibre of a protein called fibrin. Fibrin forms a network across the wound, trapping the red blood cells and forming a clot. This prevents further loss of blood and entry of pathogens. The clot will develop into a scab which protects the damaged tissue while the new skin grows.

Blood Groups:
Each person either is in blood group A, B, O or AB. This is dictated by what antigens are located on your red blood cells. Blood group A will have antigen A, blood group B will have antigen B, blood group AB will have both antigen A and B and blood group O will have neither antigen. This is important for blood transfusion as you also have antibodies in the blood which cause the red blood cells with a particular antigen to agglutinate (clump together) and die. For example, if you are blood group A, you will have antibody B meaning only group A or group O blood can be transfused to you. Group O is called the universal donor as it has neither antigen A or B meaning it will never agglutinate. Group AB is called the universal recipient as it has neither antibody A or B meaning all blood groups can be transfused to the patient.

Transplants:

Transplants are dangerous because of organ rejection. This is where the lymphocytes recognise the antigen on the new cells to be foreign and produces antibodies to destroy them. This can be prevented through tissue typing to keep the antigens as close as possible to the ones already inside the body. This can be achieved by using organs from relatives. Organ rejection can also be prevented through the use of immunosuppressive drugs which stop the immune system from damaging the foreign organ.

Heart:



How the heart works:

1. Blood enters the atria.
2. The walls of the atria contract, raising pressure and forcing open the bicuspid and tricuspid valves.
3. When the ventricles fill with blood, the ventricles contract, raising pressure and closing the valves.
4. The ventricles continue to contract and raise pressure. This forces the semilunar valves (pulmonary valve and aortic valve) to open.
5. Blood flows into the aorta which carries blood to parts of the body and the pulmonary artery which carries blood to the lungs.
6. High pressure in the aorta and pulmonary artery closes the semilunar valves and the process restarts.

Heart attacks are caused when the coronary artery is blocked completely meaning the heart muscles will stop contracting. This blockage is usually caused by a build up of fat called an atheroma. Many factors can make heart attacks more likely:

1. Heredity
2. Permanent high blood pressure/hypertension puts more strain on the heart muscles as it has to work harder to pump blood.
3. Diet - a diet rich in fats raises cholesterol. High cholesterol and fats creates the atheroma which can block the coronary arteries.
4. Smoking - nicotine constricts blood vessels, raises blood pressure, speeds up the heart rate and increases blood cholesterol.
5. Stress - hormones released during stress constricts blood vessels, raising blood pressure.
6. Lack of exercise - regular exercise reduces blood pressure and strengthens the heart.

Heart rate:
Your heart rate increases during exercise to supply oxygen needed for the increased need for aerobic respiration to release more energy to be supplied to the muscle. This occurs as the aorta and the carotid artery detects extra carbon dioxide from the exercise and sends a signal to the medulla in the brain. The medulla sends impulses along the acceleration nerve. When carbon dioxide production slows, the medulla sends impulses along the decelerator nerve.

Arteries:
1. Used to carry food away from the heart.
2. Small lumen (central cavity).
3. Thick wall with thick muscle fibres and elastic tissue.

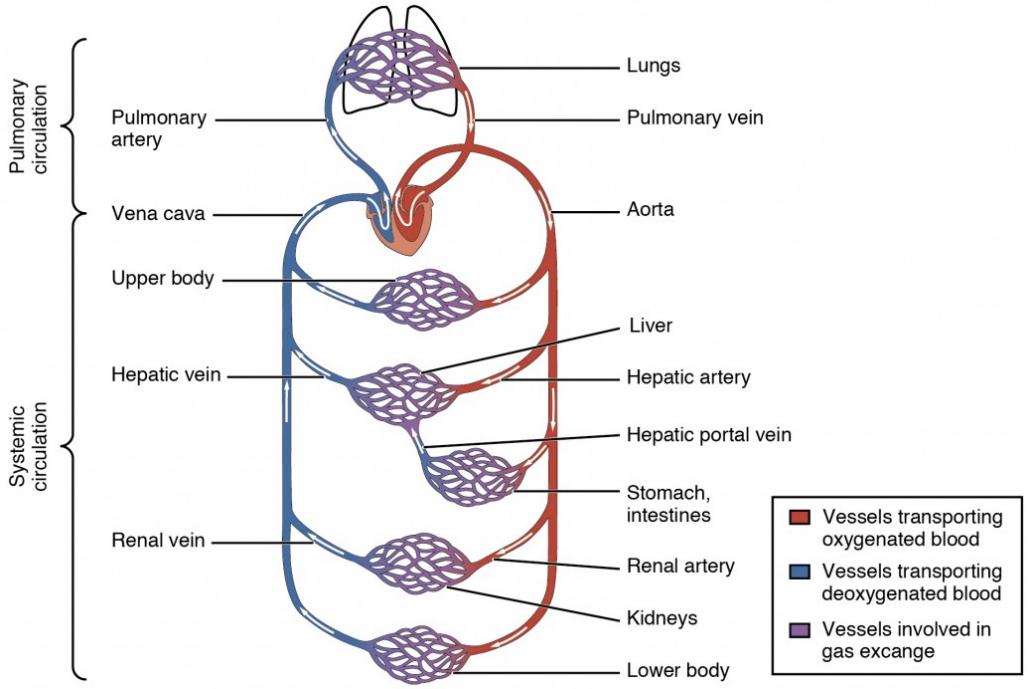
Vein:
1. Used to carry blood to the heart.
2. Large lumen (central cavity).
3. Thin wall with little muscle fibres and elastic tissue.
4. Have valves which prevents the back-flow of blood.

Capillaries:
1. Carry blood through organs and between cells.
2. Capillary walls are one cell thick and allow substances to diffuse in or out.

Pulse:
A pulse occurs when the aorta stretches the wall of the aorta because of high pressure. When the ventricle of the heart relaxes, the stretched section of the aorta recoils, increasing the pressure inside it and thereby creating a wave of stretching followed by constrictions along the aorta and through the arterioles. There is no pulse in veins as it is too far away for the wave to reach.

Tissue Fluid:
This surrounds the capillaries and is the liquid that leaks out of the capillaries under high pressure. It is like blood plasma except lacking in protein which are too large to pass through the capillary walls. Tissue fluid forms a pathway for diffusion of substances between the capillaries and cells.

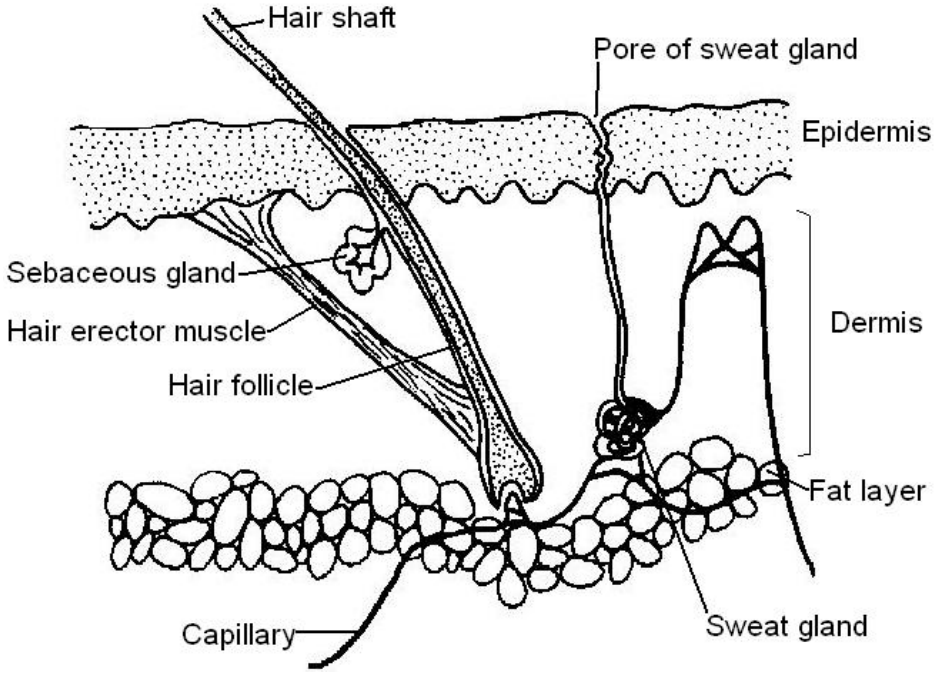
Circulation System:



Homeostatic Mechanisms

Organisms are able to respond to changes in their environment by adapting their internal body conditions. *Homeostasis* is the maintenance of a constant internal condition. Examples of homeostasis are osmoregulation, thermoregulation and the regulation of the composition of the blood.

Skin:

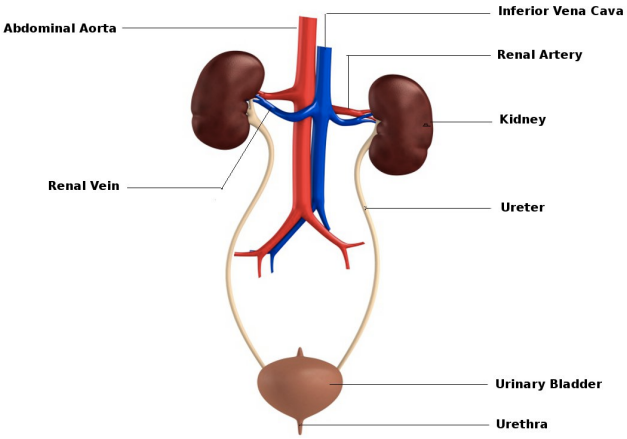


Function:
1. Protection
2. Waterproof barrier
3. Thermoregulation

Thermoregulation:
1. Sweat glands release sweat when the internal temperature is too high. The evaporation of sweat uses heat energy of the skin. This takes away heat energy.
2. Vasodilation occurs when the body is too warm. The shunt vessel constricts and the capillaries widen meaning more blood flows through the surface of the skin and so more heat is lost through the radiation of heat. Vasoconstriction occurs when you are too cold. The opposite occurs meaning less heat is lost through radiation.
3. Hair erector muscles relax to flatten the hair when it is warm. This means less trapped air is present and therefore there is less insulation. The opposite occurs when it is cold.
4. Adrenaline is used to raise metabolism meaning more energy is released and so more heat is also released.
5. Shivering - more respiration occurs in muscles meaning more heat is released.

Excretion: the removal of metabolic waste created in cells such as urea, carbon dioxide and water. The lungs, kidneys and skin are all organs of excretion.

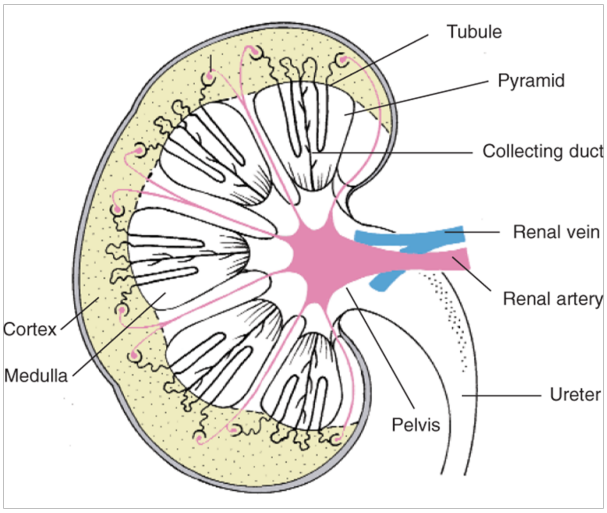
Renal/Urinary system:



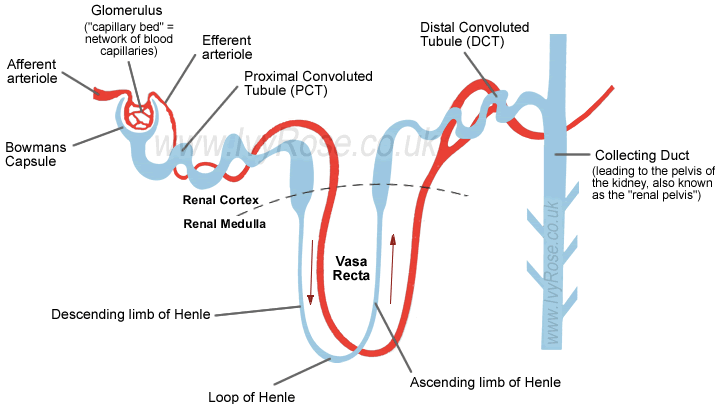
Function:
The urinary system is used to create, store and remove urine which in turn removes wastes such as urea. Blood flows to the kidneys which separates it into the components of urine: water, urea, some salts. The urine them moves down the ureters and is stored in the bladder until the two sphincter muscles relax where it then exits the body.

The components and various concentrations of urine may vary depending on the amount of water and salt intake and whether you have kidney failure or diabetes.

Kidneys: the kidney is involved in both excretion and osmoregulation.



Nephron: there are millions of these in each kidney and they are the main areas of the kidney where filtration occurs.



Ultrafiltration is the separation of smaller molecules such as glucose, water, urea, oxygen, salts, and amino acids from the blood at the glomerulus in high pressure.

Selective reabsorption is where molecules in the glomerular substrate are retaken by the capillaries at the proximal convoluted tubule. It is selective as only some molecules such as glucose, amino acids and some salts are retaken.

Water is reabsorbed into the blood both through selective reabsorption and through osmosis at the collecting ducts. The latter is controlled by ADH (anti-diuretic hormone). When the hypothalamus detects the blood is too concentrated, it tells the pituitary gland to release ADH which travels via the blood stream to the kidneys. ADH makes the collecting ducts more permeable to water meaning more water is absorbed. This is how the kidneys act in **osmoregulation.**

Transplant:

If the kidneys were to fail, without a kidney transplant or dialysis you would die very quickly as the blood will become full of urea, which is toxic. Dialysis is where a machine is used to artificially create a kidney as it essentially performs the job of the kidneys.

Problems:
- Risk of surgery
- Difficulty in finding donors and tissue matching.
- Use of immunosuppressants means chance of infection is high.
- Chance of organ rejection.

Advantages:
- Relatively cheaper than dialysis.
- Dialysis takes a long time (around thirty hours a week).
- Dialysis may cause damage to arteries and veins.
- Dialysis has a high chance of infection.
- A transplant is a permanent solution.
- A transplant will mean that urea concentration will remain constant while under dialysis it will spike up and down.

Oral rehydration method: this is one of the medication used to prevent dehydration. It is water containing several salts and glucose.

It is vitally important to rehydrate after vomiting or diarrhoea. This is because if you are dehydrated then there is less water to transport vitamins, minerals and glucose and also less water to remove metabolic waste such as carbon dioxide. It is also needed for cell turgidity. As a result the oral rehydration method is often used following vomiting or diarrhoea.

Liver:

Functions:
1. Produces bile which is used to emulsify fats and to neutralise foods in the duodenum to allow enzymes to work at optimum pH.
2. Regulates blood sugar. When glucose levels are too high the liver converts glucose to glycogen while the opposite occurs if glucose levels are low.
3. It controls amino acids concentration. Urea is a byproduct of the breakdown of amino acids.
4. The above is an example of detoxification where the liver breaks down toxic substances into less toxic ones. Alcohol is another example of this.

Effects of alcohol:

On liver:
1. It causes fat deposits to develop in the liver as metabolism of alcohol needs oxygen, this means more respiration.
2. After continued excessive drinking the liver may become inflamed causing alcoholic hepatitis which can result in liver failure and death.
3. Excessive alcohol can permanently scar and damage the liver, resulting in liver cirrhosis and an increased risk of liver cancer.

On the nervous system:
1. Cells of the central nervous system are affected by alcohol.
2. After excessive alcohol, a syndrome called blackout may occur where a person may appear to be functioning in an alert state while not recalling the events afterwards.
3. Impaired reaction times and motor co-ordination as vision and hearing are affected.
4. Neuropathy where there are alternating feelings of pain, burn, numbness and weakness in hands and feet.

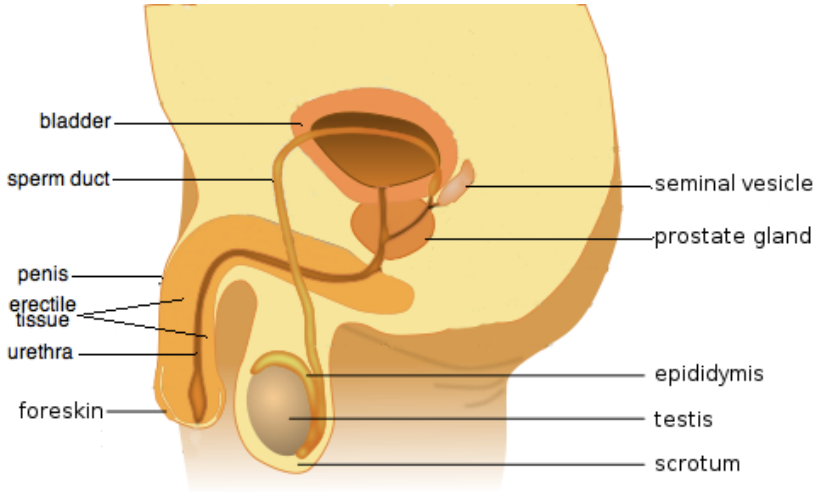
On your behaviour:
1. People have less control over their actions as less oxygen is supplied to their brains. The person is therefore more likely to commit crimes or do things that they wouldn't normally do or would be irresponsible.

Reproduction and Heredity

The process of fertilisation involves the fusion of a male and female gamete (sex cell) to produce a single cell called a zygote.

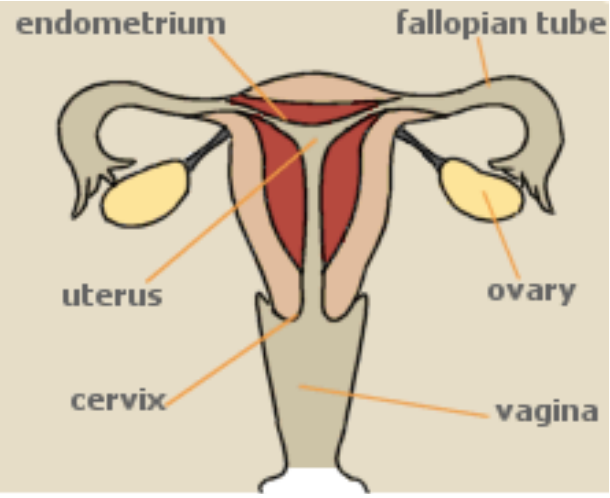
Reproductive System:

Male:



Sperm is stored and created in the testes. During intercourse it travels along the sperm duct in the penis and mixes with secreted liquid from the seminal vesicle to form semen. One ovum is released into the fallopian tube each month and when it is in the tube a sperm can fertilise it.

Female:



Menstruation:

Hormones are very important for this process. First the follicle stimulating hormone (FSH) stimulates the growth of the follicle containing an ovum. At the same time FSH stimulates the release of oestrogen which begins the re-thickening of the uterus lining and also slows the release of FSH and stimulates the release of LH (lutenising hormone). When LH is at its peak, ovulation occurs where the ovum is shed by the ovary. If sexual intercourse occurs, what is left of the follicle forms a structure called the corpus lute. This releases progesterone which completes the thickening of the uterus walls and inhibits production of FSH and LH, stopping any further ovulation. If the egg is not fertilised then the corpus lute breaks down and the lining of the uterus is shed through menstruation. Progesterone is also used during pregnancy to stop menstruation. It is produced by the placenta.

Definitions:

- **Genes** - a small section of DNA that determines a particular feature by instructing cells to produce a particular protein are called genes.
- **Alleles** - an alternative form of a gene which gives rise to differences in inherited characteristics.
- **Dominant** - a feature will always have two alleles. If one allele's characteristic is present while the other is not then it is said to be dominant.
- **Recessive** - if one allele is dominant then the other is said to be recessive.
- **Homozygous** - contains two copies of one allele (e.g. TT, aa).
- **Heterozygous** - contains two different alleles (e.g.Tt, Aa).
- **Genotype** - describes the alleles each cell has for a certain feature.
- **Phenotype** - a feature that results from the genotype.
- **Codominance** - if two alleles are expressed in the same phenotype.
- **Diploid cells** - cells with chromosomes in homologous paris are said to be diploid.
- **Haploid cells** - cells with chromosomes not in a homologous pair is said to be haploid.

Meiosis:

1. Each chromosome in the nucleus duplicates itself.
2. The cell divides into two as in mitosis.
3. The cell divides again to form four cells containing half the number of chromosomes. This results in the formation of genetically different haploid (half the number of chromosomes) cells that are not in homologous pairs.

A zygote is formed when two gametes (sex cells) formed through meiosis fuse to form a cell with a full chromosome count. Following this, mitosis duplicates the cell millions of times to form an embryo.

The embryo in the uterus develops a placenta which not only anchors the embryo to the uterus but also allows the embryo to obtain nutrients such as oxygen and glucose from the mother's blood. It also allows the embryo to get rid of waste products such as urea and carbon dioxide. An embryo

also is enclosed by a membrane called the amnion. This secretes amniotic fluid which protects the embryo from jolts and bumps.

Secondary Sexual Characteristics:

Boys: controlled by testosterone
- Growth of penis and testes.
- Growth of facial and body hair.
- Muscle development.
- Breaking of the voice.

Girls: controlled by oestrogen
- The breast develop.
- Menstruation starts.
- Growth of armpit and pubic hair.

Birth Process:
1. Cervix dilates to allow the baby to pass through. The muscles of the uterus contract strongly and rupture the amnion, allowing the amniotic liquid to escapee. This is called the water break.
2. Strong contractions of the uterus pushes the baby head first through the cervix and vagina.
3. After the birth the uterus continues to contract to push out the placenta and the amnion. This is called the afterbirth.

Breastfeeding:

Advantages:
1. Perfect food for healthy growth of baby.
2. Contains antibodies which protect the baby against infection diseases.
3. Forms an emotional bond between the mother and the baby.

Growth and development:
gametes—> zygote—> embryo—> foetus—> baby—> child —> adolescent —> puberty—> adult

Contraception:

Hormonal - oral contraceptive pill such as the combined pill (oestrogen and progesterone) or the mini pill (progesterone). The mini pill creates a thickening of the mucus in the cervix which acts as the barrier and the combined pill prevents the production of FSH and LH, preventing menstruation. Its advantage is that it has a low failure rate however it must be taken everyday and at a certain time.

Barrier - uses a barrier to prevent sperm from reaching the ovum. Examples include the condom and femidom. The advantages are that they are easy to obtain and use and that they also protect against STI. However, they may slip off during intercourse.

Natural - withdrawal from intercourse or having intercourse during a “safe period” is easy however there is a high failure rate and women will also have to have a regular cycle and will need to keep track of it.

Inter-uterine - an IUD (inter-uterine device) or coil is inserted through the cervix into the uterus. It is a piece of plastic or copper that prevents a fertilised egg from implanting in the uterus. Its main advantage is that it has no effect on intercourse however it does have to be fitted by a doctor and cause heavy periods.

Sterilisation - a surgical process that prevents sperm from passing to the penis or eggs from passing to the uterus. In men it is called a vasectomy and is where the sperm ducts are cut and tied under general anaesthetic. In woman a similar process occurs on the fallopian tubes and is called tubal ligations. Its advantage is that it has a very low failure rate while its disadvantages are that it is non-reversible and that it has to be performs by a doctor.

The nucleus of a cell contains chromosomes which contain DNA. A small section of DNA that determines a particular feature by instructing cells to produce a particular protein are called genes. In humans, the diploid number of chromosomes is 46 and the haploid number is 23.

ABO blood groups are determined by multiple alleles (more than two alleles) with each allele determining which antigens are on red blood cells. The alleles are : I^A, I^B, I^O
I^A and I^B are codominant and I^O is recessive to both.

To show patterns of inheritance we often s a genetic diagram called a **pedigree**.

The sex of a person is determined by a pair of chromosomes, XY in a male and XX in a female. The overall ratio of male and female births is 1:1
This can be shown by this diagram:

	X	X
X	XX (female)	XX(female)
Y	XY(male)	XY(male)

There are certain diseases which are *sex linked*. This means that they exist on the X chromosome and means that often boys are more susceptible to them. An example of this is a blood disorder called **haemophilia**. The allele for this is recessive and is “h”. It is only found in the X chromosome. A woman with the gene X^HX^h would not have haemophilia but would be a carrier.

A carrier female and a healthy male has a 25% chance of a having a haemophiliac boy but no chance of a haemophiliac girl.

	X^H	X^h
X^H	X^HX^H (healthy female)	X^hX^H (healthy female)
Y	X^HY (healthy male)	X^hY (haemophiliac male)

Another example of a sex linked disease is **red-green colour blindness.**

The offspring formed through intercourse vary genetically because of the huge variation in sex cells. It is also because of the random nature of fertilisation where over a billion different sperms can fertilise one of thousands of ova

Variation can be produced both through genes and through the environment. e.g. body mass, height, skin colour, intelligence.

Mutations are rare, random genetic changes to the genetic material that can be inherited.

Most mutations are harmful, some are natural and a few are beneficial.

Mutations that are beneficial can cause the mutant organism to increase in population through natural selection. An example of this is in bacteria that have mutated to be resistant to antibiotics. These bacteria live for longer and can therefore multiple more.

The chances of mutations can be increased through mutagens. Examples of these are ionising radiation such as ultraviolet light, X-rays and gamma rays and many different chemicals, both natural and man made (e.g. benzene).

Disease

The general course of a disease:

1.Infection:
- Droplet infection - coughs, sneezes e.g. cold, influenza
- Drinking contaminated water - e.g. cholera, typhoid
- Eating contaminated food - e.g. polio, salmonella
- Direct contact - skin to skin contact e.g. athlete's foot, ringworm
- Sexual intercourse - e.g. AIDS, syphilis, cklamydia
- Blood to blood contact - e.g. AIDS, hepatitis B
- Animal vectors - e.g. malaria, sleeping sickness

2. Incubation period:
The time between when a person is infected and when they first show symptoms. This occurs as the pathogen may need time to multiply for the effects to become large enough. It also may need time to reach its destination.

3.Sign:
A disease that can be seen by other people. It can be seen, heard or be measured (e.g. blood sugar). A sign is different from a symptom as a symptom does not have to be visible to other people as it is what the patient experiences.

Endemic disease - a disease that is always present in the population of a particular geographical area.

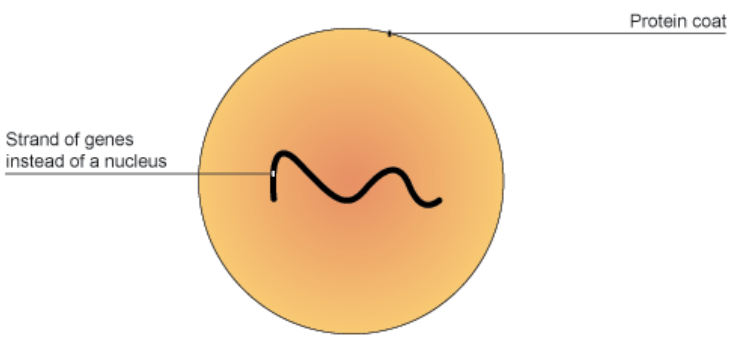
Epidemic disease - a widespread outbreak of a disease spreading over a large area and many people.

Pandemic disease - a worldwide outbreak of a disease e.g. Swine Flu (2009).

Pathogens:

Viruses:

Structure:

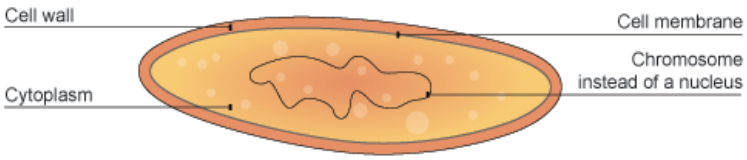


Reproduction:
A virus takes over the host cell and its genetic machinery and uses it to make more virus particles. The host dies after more viruses are reproduced and the viruses then spread to other cells in the body.

Diseases:
- Influenza: transmitted through airborne droplets produced when a person sneezes or coughs. Influenza primarily affects the cells in the upper airways of the respiratory system. There is little that can be done to treat the disease although antibiotics can be used to combat the secondary bacterial infections. The disease can however be prevented 60-70% of the time through vaccinations. Staying away from infected people also prevents transmission.
- Poliomyelitis: this is spread through animal vectors such as flies and also through contaminated water and food. There is no effective treatment but this can be prevented through a vaccine and/or a good hygiene so that flies do not make contact with human sewage or food and drink.
- AIDS: this is spread through the HIV virus through sexual intercourse or blood to blood contact. There is no cure or vaccine. It can be prevented through not sharing needles or limiting the number of sexual partners.

Bacteria:

Structure:



Nutrition:
Most bacteria are heterotrophic meaning they live off other organisms and eat organic matter. Saprobes are bacteria that live off dead organic material while heterotrophic parasites are those that cause disease. Some bacteria are also autotrophic meaning they produce their own food through photosynthesis.

Reproduction:
Bacteria reproduce asexually through binary fission. This is where the DNA of a bacterium duplicates creating two daughter bacteria with the same genetic information as the parent bacterium.

Diseases:
- Typhoid: spread through contaminated water containing the bacteria Salmonella Typhi or flies transferring the bacteria from faeces to food. It can be treated with antibiotics such as penicillin and the oral rehydration method is useful in combating the effects. It can be prevented through a vaccine, better sanitisation and better hygiene.
- Tuberculosis (TB): this is spread through droplet infection of a bacteria called mycobacterium tuberculosis. Long term use of antibiotics can treat the illness but it can take up to 15 months to treat it. In that time the bacteria may become resistant to the antibiotics meaning it will have to constantly be changed. It can be prevented though better standards of living as if people are less crowded then there is less chance of infection. Also the vaccine BCG can be used although it only works for children.
- Gonorrhoea: spread through sexual intercourse. It can be treated through antibiotics although resistance to them are growing. It is prevented through the use of condoms or through avoiding sexual intercourse with someone infected with the disease.

Fungi:

Diseases:

- Thrush: transmitted through direct contact of the fungus candida albicans. It is treated with anti-fungal drugs and prevented through a good hygiene.
- Athletes Foot: transmitted through direct contact it can once again be treated with anti-fungal drugs and prevented through a good hygiene.

Parasites:

Schistosomiasis (or Bilharzia): this is spread by the parasite Schistosome.

1. Larvae of the worms are released by fresh water snail.
2. The larvae swim in the water and penetrate the skin of people in the water.
3. The larvae develop in the body to adult worms, living inside the liver, intestine and bladder. They feed of red blood cells.
4. They mate and release eggs which pass out in faeces or urine to infect more snails.

Effects: Schistosomiasis is a long term illness (chronic). Symptoms are generally quite mild although in serious cases symptoms may include fever, chills, diarrhoea, severe rashes and blood in the urine. Organs may also become damaged and the liver, spleen and/or lymph nodes may become enlarged.

Prevention:

1. Treatment with drugs to kill the worms in the body.
2. Killing the fresh water snails through chemicals or introducing natural predators such as crayfish. This interrupts the life cycle.
3. Improving sanitisation also disrupts the cycle as it prevents faeces containing the worms from faeces and urine from entering the rivers and lakes and infecting the snails.
4. Health education needed to inform the villages about the dangers of going into the river.

Malaria and Typhoid: spread through animal vectors. Malaria parasites are spread through mosquitos while typhoid bacillus is spread through houseflies.

Malaria:

1. Mosquitos feed from an infected person's sex cells.
2. Fertilisation occurs in female mosquitos. The zygote develops into malarial parasites.
3. Infected mosquitos infect the person.
4. Parasites enter liver cells and change form. They rupture the liver cells, enters the blood stream and infects the red blood cells.
5. The red blood cells burst, releasing more parasites and sex cells.
6. The process repeats.

Prevention:

1. Use of insecticides to kill mosquitos and houseflies.
2. Draining swamps and rubbish dumps where mosquitos and houseflies gather.
3. Use of drugs to target the life cycle of the malarial parasites.
4. Stocking ponds with a fish called Tilapia which feed on mosquito larvae.
5. Using insect repellants, wearing long sleeved shirts and sleeping under insect nets prevent bites from mosquitos.
6. Improving hygiene and sanitisation.

Defence:

Immunity: immunity can be…
- Natural - created through organic processes.
- Artificial - created through man made intervention.
- Active - created through an immune response and so is in the long term.
- Passive - created without an immune response. Normally this only happens twice in our lives. First when we receive antibodies across the placenta and second through our mothers in colostrum and breast milk.

Vaccines:
These are a form of an artificial active immunity and works by injecting a person with an "agent" that carries the same antigens as a specific disease causing microorganism. This can be achieved by injecting…
- An attenuated (weakened) strain of the actual microorganism (e.g. polio, TB and measles)
- Dead microorganisms (e.g. whooping cough, typhoid)
- A modified toxin of the bacteria (e.g. tetanus)
- Just the antigen (e.g.influenza)
- Harmless bacteria, genetically engineered to carry the antigen of a different disease carrying microorganism.

The Antibody/Antigen reaction:
1. Lymphocytes recognise individual marker chemicals called antigens on the surface of the pathogens.
2. Lymphocytes' receptor proteins bind with the antigens.
3. When it binds the lymphocytes divide rapidly, producing millions of the same type of lymphocyte that is capable of recognising the microorganism.
4. Most of this occurs with B and T lymphocytes.
5. Most B-lymphocytes begin to produce antibodies which bind with the antigens, causing the pathogens to clump together. This makes it easier for phagocytes to ingest it through phagocytosis where pseudopodia encloses the pathogen. Some antibodies also cause the pathogens to burst apart. Some also develop into memory cells which remain for a long time and if the cells re-infect, the memory cells will start to reproduce and produce antibodies. Because of this the secondary immune response is much faster than the primary.
6. T-lymphocytes destroy our own cells. These cells have become infected with a virus or are cancerous. This is done through releasing chemicals that "punch a hole" in the cell or activates a "programmed cell death" that is put into the genetic coding of every cell. Some also become memory cells like B-lymphocytes.

Antibiotics:
- Source - antibiotics such as penicillin are created by fungi. For example, penicillin is excreted by the fungus penicillium.
- Role - bacteria can be stopped by antibiotics. Antibiotics can be both bactericidal where bacteria are killed or bacteriostatic where the bacteria is stopped from multiplying. For example, penicillin and tetracycline are bactericidal while nalidixic acid is bacteriostatic.
- How - penicillin works by weakening cell walls by interfering with the manufacture of bacteria cell wall. Water therefore enters through osmosis and bursts the cell. Nalidixic acid interferes with DNA replication meaning bacteria cannot multiply. Tetracycline interfered with protein synthesis meaning no enzymes can be made to control the cell.

Non-pathogenic organisms and their importance:
Non-pathogenic bacteria and fungi are useful to humans because they are decomposers which break down complex organic materials into simple substances. These are then released into the environment. For example, decomposers are used to break down protein into ammonia and then nitrates which are essential for plants.

Decomposers are involved in sewage treatment. Sewage must be treated as they contain pathogenic bacteria which can cause diseases if drunk and also because aerobic bacteria in the water will deplete the amount of oxygen in the water by breaking down the organic material in the sewage. This then causes death to species not adapted to low oxygen levels. The sewage must therefore be treated first to remove any organic material.

There are two ways of treating sewage. The **percolating (biological) filter method** is one of them and works like this:

1. Sewage is screened to remove any large objects and left to stand in a large setting tank to allow other solid material to settle out.
2. The sewage is then pumped through sprinklers rotating over a filter bed. The filter bed contains bacteria, fungi, and protozoa which oxidises any organic material.
3. The treated sewage is discharged into a waterway.

The second method is called the **activated sludge method:**

1. Sewage is screened and stood in a large settling tank.
2. It is then passed into an aeration tank which when oxygen is pumped in, allows the bacteria to oxidise the organic material.
3. It passes to a sedimentation tank where the activated sludge settles.
4. Some are returned to the aeration tank carrying bacteria. The purified effluent is discharged.

A **pit latrine** is used in less developed countries and is basically a hole in the ground with a pit underneath containing microorganisms which can break down the urine and faeces.

All these different methods of sewage treatment rely on both aerobic and anaerobic microorganisms. **Aerobic microorganisms** are used to oxidise any organic matter in the sewage creating an effluent that contains much less organic material and fewer pathogens.

Anaerobic microorganisms are needed to treat the waste sludge that settles in the settling tanks. The microorganisms are placed with the sludge in a fermentation tank and the organic material are converted to biogas, a mixture of methane and carbon dioxide. The biogas can be used as a fuel in electricity generator or for heating. The remaining dry, solid material can be used for fertiliser or disposal of in a landfill site.

Eutrophication occurs when excess minerals such as nitrates and phosphates enter a body of water from sewage or fertilisers. Fertilisers can enter the water through leeching as nitrates and such are washed out of the soil by rain since it dissolves in water. This can also occur through surface run offs. Excess minerals stimulates the growth of algae. An algal bloom will develop and block out the light needed for photosynthesis and are also decomposed as they die. This is done by aerobic bacteria which uses up oxygen in the water. This causes oxygen depletion, causing many fish and plants to die. In severe cases, the water will become anoxic (containing very little oxygen) and become smelly from the gases such as hydrogen sulphide and methane which are released by the bacteria. Only anaerobic bacteria can survive conditions like these.

Environment:

Humans inhabit many of the Earth's ecosystems. An *ecosystem* is a distinct, self-supporting system interaction with each other and with their physical environment.

Ecosystems have:

- Producers - green plants that photosynthesise.
- Consumers - animals that eat plants or other animals.
- Decomposers - Microorganisms that break down dead material and help in recycling nutrients.
- Physical environment - the non-biological components such as water, soil and air.

Plants are the source of all the food that animals, including humans, eat. They also create oxygen which aerobic organisms need for respiration. Plants can create from glucose, starch, sugars such as fructose or sucrose, cellulose and lipids.

Photosynthesis:

Carbon Dioxide + Water —> Glucose + Oxygen

Food chains are made up of *trophic levels*:

Producer —> consumer—> decomposers

Energy and substances are transferred along a food chain. Every time energy is transferred, a large amount of it is lost through the lack of digestion and therefore passes out as faeces. Some form excretory products such as urea and some is respired to release energy. Not only this, but a large amount of energy is also lost through respiration. Because of this, only around 10% of energy is used to create new cells and therefore can be passed on to the next trophic level.

Transfer of energy:

1. Photosynthesis creates glucose.
2. Respiration releases energy from compounds such as glucose.
3. Almost all biology processes use the energy released in respiration.
4. If the energy is used to create new cells then it can be passed on to the next trophic level.
5. If not then once used it will eventually escape as heat.

Food preparation, storage and preservation:

Preparation: cooking food properly to kill any microorganisms present.

Storage:

- Packaging of food to prevent transmission of microorganisms.
- Display before and best before dates to tell you when the food is unsafe to eat.
- Placing cooked and raw food separately.
- Not refreezing after cooking as bacteria will multiply very quickly.
- Food should not be left open to the air on a work surface.

Preservation:

- Salting - bacteria lose water by osmosis and are killed. (e.g.fish, some meats)
- Pickling - food butler in vinegar (ethanoic acid). The low pH inactivates most microorganisms.
- Pasteurisation - 63-65°C for 30 minutes or 71.5°C for 15 seconds (milk)
- Canning - packed in cans, heated, sealed, then finally heats to 105-160°C. (e.g. soup, beans).
- Drying - blowing hot air to remove water (e.g.cereal, grains)
- Freezing - frozen to -10°C rapidly (e.g. meats, prepared meals)
- Irradiation - high energy gamma rays are passed through food (e.g.potatoes, onions)

Water purification:

1. Water is taken from a source.
2. It is then passed through a screen to filter large solid objects such as weeds and other debris.
3. It is pumped to a settling tank for particles to settle. The sludge is removed at intervals and used as fertiliser or in landfill.
4. Pumped to a filter bed where it is sprayed onto it from a revolving arm. It slowly trickles down from sand at the top to stones and gravel at the bottom. Bacteria and fungi among the particles break down any organic matter and protozoa feed on the bacteria, including pathogens.
5. Chlorine is added to kill any remaining pathogens.
6. It is then stored in covered reservoirs which prevent the growth of algae and contaminants from entering.
7. Water is finally pumped to homes.

Air pollution:

Carbon Monoxide:
This is a colourless, odourless and tasteless gas which can cause death by asphyxiation. Haemoglobin bind with this rather than oxygen and so a person may become unconscious if it's breathed in for a certain time as a result of a lack of oxygen.

Sulfur Dioxide:
This is a major constituent of acid rain which kills plants and also ruins the landscape.

Green House Gases:
These include water vapour, carbon dioxide, nitrous oxide, methane and CFCs (chlorofluorocarbons).

The level of greenhouse gases has risen rapidly in the past 100 years. The increasing burning of fossil fuels such as coal, oil and natural gases as well as petrol and diesel in vehicle engines has led to this. The increasing deforestation also means that the greenhouse gas carbon dioxide is used less in photosynthesis.

The increasing levels of greenhouse gases has resulted in the enhanced greenhouse effect. The normal greenhouse effect is where gases absorb some long wavelength infra-red radiation from the sun and re-emit some as longer wavelength IR. This heats up the surface of the Earth. However, with too much greenhouse gases, global warming has occurred where the earth heats up quicker then it should. This has caused the melting of the ice caps and therefore sea level rises, changing ocean currents meaning warm water is redirected to cooler areas, more rainfall in some areas (climate changes), species to become extinct as they cannot adapt fast enough and changes to agricultural practices as some pests become more abundant.

Deforestation:
Each year tens of thousands of hectares of rainforests are cut down. This causes several problems:

1. Soil erosion occurs as it is exposed due to lack of a canopy meaning the soil is down or washed away.
2. Leeching occurs where minerals are washed out by rain. This occurs as there are no tree roots to hold the soil together.
3. Destruction of habitats and reduced biodiversity occurs. Around 50-70% of all species live in rainforests.
4. The water cycle is disturbed as trees are an important part of returning water vapour from the soil.
5. The balance in atmosphere oxygen and carbon dioxide changes as photosynthesis decreases. This will cause global warming