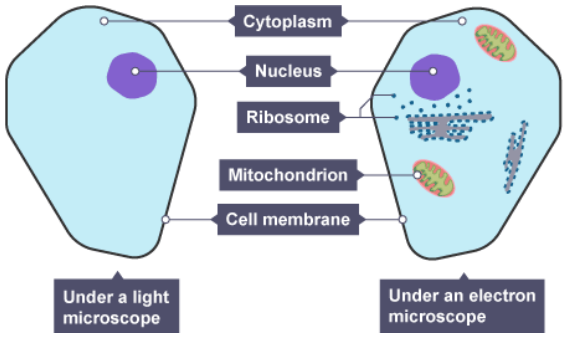
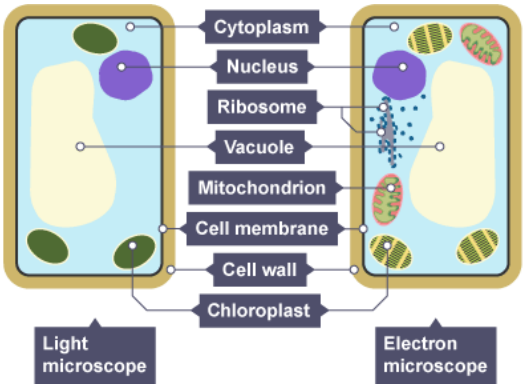
Higher Biology Revision Notes = Please Use for Mocks – GCSE / IGCSE
Use these as part of your Revision Aid to Achieve a 9 in Biology

B1.1 Cell Structure

Animal cell

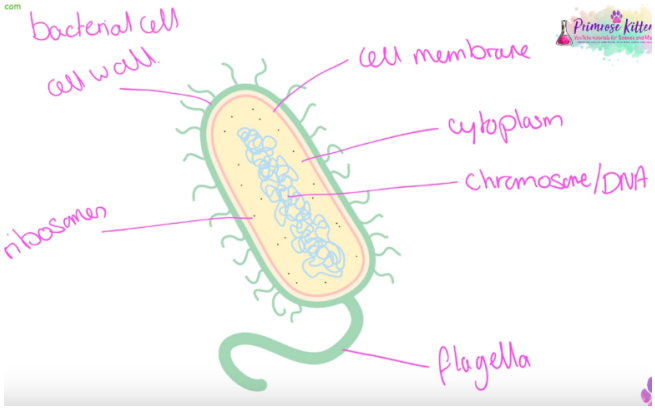


plant cell



Organelle (common)	Function
Cytoplasm	A jelly-like material that contains dissolved nutrients and salts and structures called organelles. It is where many of the chemical reactions happen.
Nucleus	Contains genetic material, including DNA, which controls the cell's activities.
Cell membrane	ts structure is permeable to some substances but not to others. It therefore controls the movement of substances in and out of the cell.
Mitochondria	Organelles that contain the enzymes for respiration, and where most energy is released in respiration.
Ribosomes	Tiny structures where protein synthesis occurs.
Organelle (plant only	-
Chloroplast	Organelles that contains the green pigment, chlorophyll, which absorbs light energy for photosynthesis. Contains the enzymes needed for photosynthesis.
Cell wall	Made from cellulose fibres and strengthens the cell and supports the plant.
Permanent vacuole	Filled with cell sap to help keep the cell turgid.

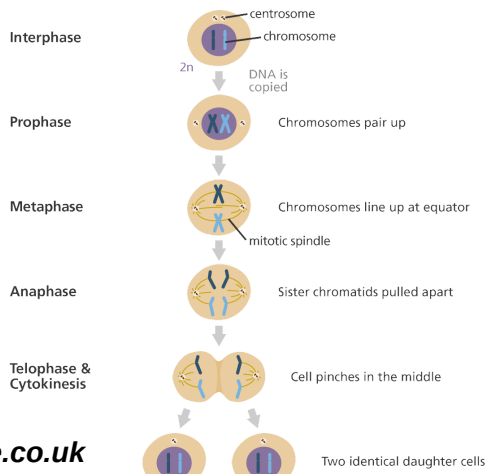
At 0.1–5.0 μm in diameter, prokaryotic cells are significantly smaller than eukaryotic cells, which have diameters ranging from 10–100 μm.
DNA is stored in the nucleoid of a Prokaryotic cell.



Cell differentiation
Sperms cells are: streamlined, have tails to swim faster, and have more mitochondria to provide more energy.
Nerve cells are: have axon to carry electrical impulse, myelin sheath speeds up the transmission of nerves
Muscle cells: contain muscle fibers that can change stretch and contract, have lots of mitochondria
Root hair cells: increase surface area for absorption, no chloroplasts
xylem: carry water and minerals, thick walls provide structure
Phloem: carry dissolved sugars up and down the plant, mitochondria in the companion cell provide energy to the phloem vessel cell
Cells can be specialized to perform a certain task.
Electron microscopes have higher resolution and magnifying power.
Binary fission ("division in half") is a kind of asexual reproduction used in bacteria cells.
To grow uncontaminated cultures: use a sterilized petri dish, nutrient agar, and inoculating loop, inoculate the agar, and flip upside down with the lid covered (leaving a small gap for air)

B1.2 Cell division

the nucleus of a cell contains chromosomes made of DNA (Deoxyribonucleic acid) molecules. Each chromosome carries a large number of genes. In body cells, the chromosomes are normally found in pairs.
Mitosis is a type of cell division that results in two daughter cells each having the same number and kind of chromosomes as the parent nucleus. Typical of ordinary tissue growth.



Cell division by mitosis is important in the growth and development of multicellular organisms.
Examples of mitosis happening: constant replenishment of skin cells, in organs such as the intestines, and hair.
Stem cells are unspecialized cells that can turn into any cell in the body.
There are two types of stem cells: Embryonic (from embryos) and adult stem cells.
stem cells from human embryos and adult bone marrow can be cloned and made to differentiate into many different types of human cells. These can be used to treat Alzheimer's and diabetes.
You are using human embryos which may cause ethical issues. Additional stem cells may be damaged if your body recognizes them as foreign.
stem cells from meristems in plants can be used to produce clones of plants quickly and economically. They can be used to create crops with greater yields.

B1.3 Transport in cells

Diffusion is the net movement of particles from an area of high concentration to an area of low concentration
Oxygen moves into cells as there is a lower concentration on the inside. Carbon dioxide and urea move out of the cell because there is a lower concentration on the outside.
The factor that affects the rate of diffusion: differences in concentrations, temperature, and surface area of the membrane.

Diffusion will occur faster if the membrane: has a higher surface area, is thinner and the diffusion distance is shorter.

Osmosis is the net movement of water particles from an area of high water concentration to an area of low water concentration through a partially permeable membrane.
active transport moves substances from a more dilute solution to a more concentrated solution (against a concentration gradient). This requires energy from respiration
Active transport occurs in humans in the digestive system (sugar moves into villi), in plants when mineral ions need to be absorbed into root hair cells.

2.1 Principles of organization

In order of increasing complexity, multicellular organisms consist of:

organelles → cells → tissues → organs → organ systems

Structure	Description
Organelle	Cell structure that is specialized to carry out a particular function or job
Cell	The basic structural and functional unit of a living organism
Tissue	Group of cells with similar structures, working together to perform a shared function
Organ	Structure made up of a group of tissues, working together to perform specific functions
Organ system	Group of organs with related functions, working together to perform body functions

2.2 Animal tissues, organs, and organ systems

The digestive system is an example of an organ system, as multiple organs work together.
Enzymes are biological catalysts that increase the rate of reactions without being used up
Enzymes are proteins folded into complex shapes that allow smaller molecules to fit into them.
The place where these substrate molecules fit is called the active site.
The optimum condition of an enzyme is the temperature or pH at which the enzyme works best.
The optimum temperature for most enzymes is 40°C.
Denaturation is when the molecular structure of a protein or enzyme is permanently changed.

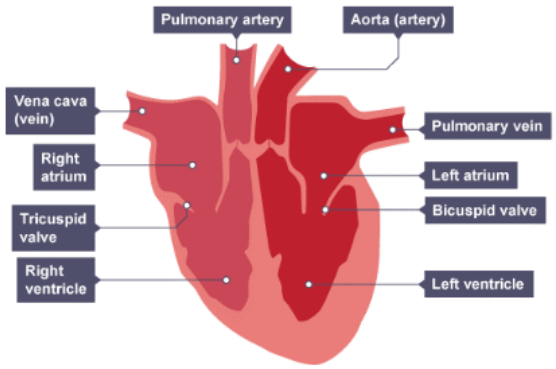
Enzyme	Substrate	Product	Produced in
Carbohydrase	Carbohydrate	Simple sugar, glucose	Salivary glands, small intestine, pancreas
Amylase	Starch	Simple sugar, glucose	Salivary glands, pancreas
Protease	Protein	Amino acid	stomach, pancreas, small intestine
Lipase	Fat (lipid)	Glycerol and fatty acids	pancreas, small intestine

The products are absorbed into the bloodstream and some are used for respiration and others are used to build new structures.
Bile is a slightly alkaline substance that is made by the liver and is stored in a very small organ called the gallbladder. It is secreted into food coming from the stomach in order to neutralize it. Bile also emulsifies fats.
Factors affecting enzyme usefulness include pH, temperature, and concentrations of enzymes and substrates.

The alveoli in the lungs are adapted for gas exchange because: have a very high surface area, moise surface, and thin lining.
The heart is an organ that has blood around the body in a double circulatory system. The right ventricle pumps blood to the lungs where gas exchange takes place. The left ventricle pumps blood around the rest of the body.

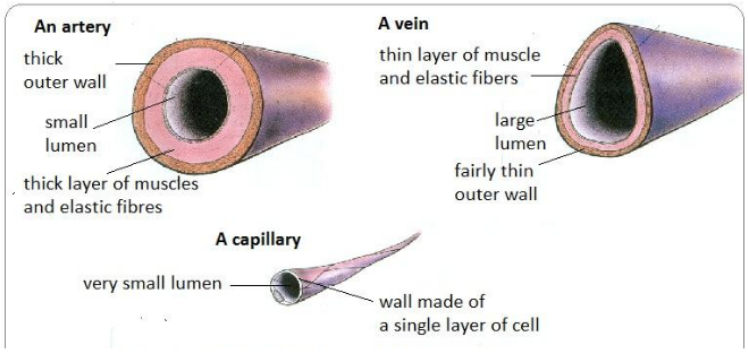
The Heart

- The heart is a muscular pump.
- When it beats it pumps blood to the lungs and around the body.
- The heart has four chambers. The two atria collect the blood. The two ventricles pump the blood out of the heart.
- Valves prevent the blood from flowing backwards.
- The septum separates the two sides of the heart.
- The right side of the heart pumps de-oxygenated blood (blood not containing oxygen) to the lungs to pick up oxygen.
- The left side of the heart pumps the oxygenated blood from the lungs around the rest of the body.



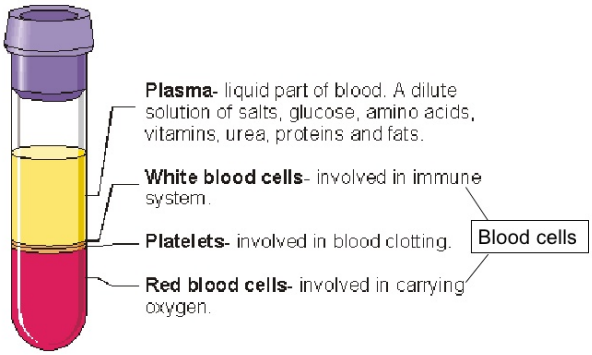
Veins take blood to the heart and arteries take blood away from the heart.

Blood Vessels

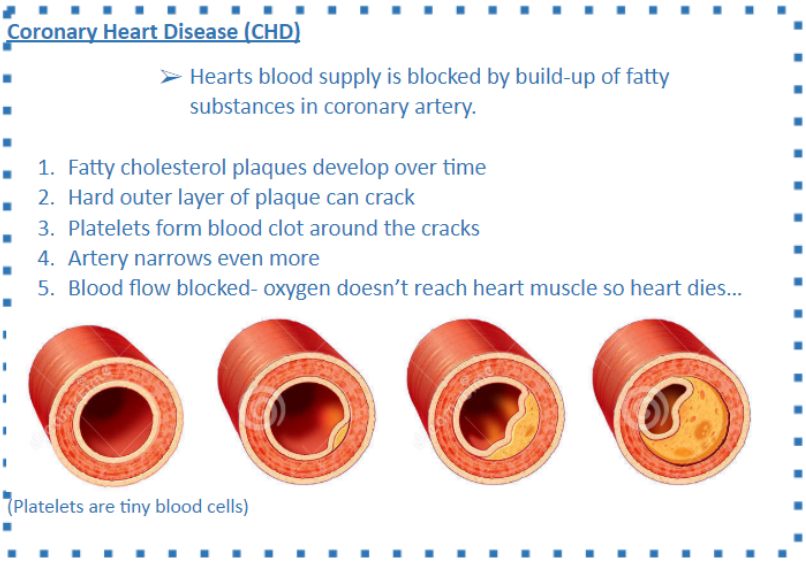


A pacemaker provides an electrical impulse to prompt the heart to beat at a normal rate. An artificial pacemaker is a small device that's placed in the chest or abdomen to help control abnormal heart rhythms.

Four main components in blood

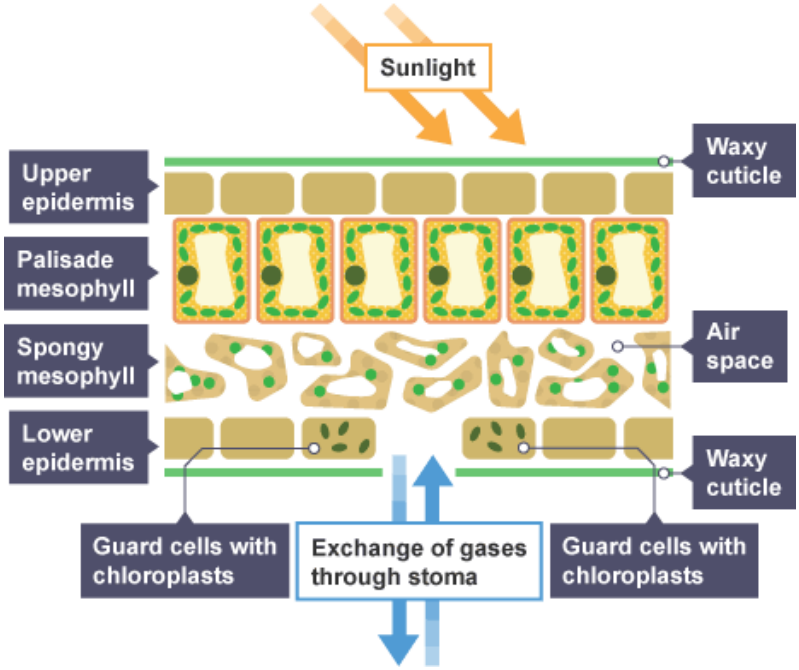


Four components of blood are: Plasma (55%), Red blood cells (45%), and White blood cells and platelets (>1%)
Plasma transports dissolved substances around the body. (glucose, CO_2, and urea)
Red blood cells transport oxygen from the lungs to the body cells.
White blood cells are part of the immune system as they make antibodies.
Platelets help in blood clotting.



Health is the state of physical and mental wellbeing.
Defects in the immune system mean that an individual is more likely to suffer from infectious diseases. Immune reactions initially caused by a pathogen can trigger allergies such as skin rashes and asthma.
Things such as smoking and drinking alcohol increase the chances of disease occurring.
Benign tumors and malignant tumors result from uncontrolled cell division by damaged cells. Malignant tumor cells are cancers.
There are genetic and lifestyle risk factors for some cancers.

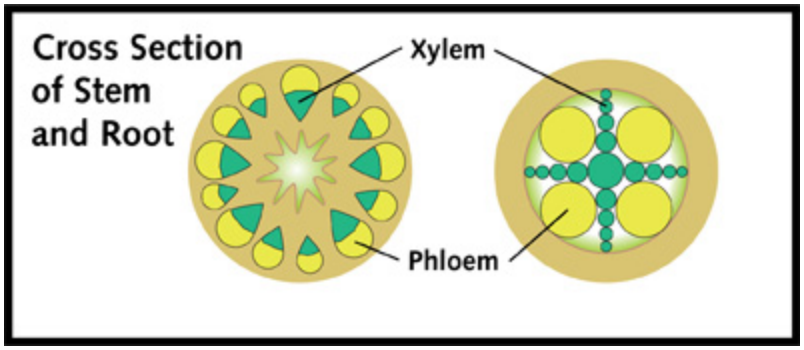
2.3 Plant tissues, organs and systems



Organelle	Function
Upper epidermis	Clear to let light through, acts as a protective layer
Waxy cuticle	Prevents water loss and infection
Palisade mesophyll	Has lots of chloroplasts to absorb all available light
Spongy mesophyll	Allows carbon dioxide to diffuse through the leaf.
Lower epidermis	Acts as a protective layer
Guard cells	Open and close to regulate the rate of transpiration

Stomata	The hole between the guard cells

Transpiration is the process where plants absorb water through the roots and then give off water vapor through pores in their leaves.
xylem: carry water and mineral
Phloem: carry dissolved sugars up and down the plant
Meristems are growing parts of the plant.



3.1 Communicable diseases
Pathogens
A pathogen is a microorganism that causes a disease. There are four main types of pathogen:

Pathogen	Example in animals	Example in plants
Viruses	HIV potentially leading to AIDS	Tobacco mosaic virus
Bacteria	Salmonella	Agrobacterium
Fungi	Athlete's foot	Rose black spot
Protists	Malaria	Downy mildew

Diseases caused by pathogens are called communicable diseases because they can be transferred from one host to another.
All types of pathogens have a simple life cycle. They infect a host, reproduce themselves or replicate if it is a virus, spread from their host, and infect other organisms.
How bacteria make us ill: They get inside our blood flow until they reach some tissue fluid, here they stay dividing (binary fission) in ideal conditions, and releasing toxins damage our cells.
How Viruses make us ill: They enter our cells, reproduce inside them before bursting the host cell to be released and spread more.
Measles is a very infectious disease caused by a virus. Its most common symptom is the rash.
HIV (Human immunodeficiency virus) is a virus transmitted through bodily fluids. After some time the infected host will develop AIDS which attacks their immune system. There is no cure for HIV/AIDS however a patient can be treated with antiviral medicines.
TMV or tobacco mosaic virus affects plant's chloroplasts and their ability to photosynthesize.
Gonorrhoea is a sexually transmitted disease (STD) caused by a bacterium.Gonorrhoea causes a burning pain when urinating.
Salmonella is a genus of bacteria that causes food poisoning. It causes vomiting and diarrhea.

Both can be treated with antibiotics.
Malaria is spread by mosquitoes that carry the Plasmodium protist. They suck blood from infected people and inject it into other people but do not get ill themselves and so are called vectors. The symptoms of malaria include fever, sweats and chills, headaches, vomiting, and diarrhea. It can be prevented by limiting the bites from vectors.
Rose black spot is caused by a fungus that infects roses. It infects leaves and causes black or purple spots on the leaves. It affects the plant's ability to photosynthesize.

Transmission of pathogens:

Type	Examples
Direct contact	This can be sexual contact during intercourse or non-sexual contact, like shaking hands.
Water	Dirty water can transmit many diseases, such as the cholera bacterium.
Air	When a person who is infected by the common cold sneezes, they can spray thousands of tiny droplets containing virus particles to infect others.
Unhygienic food preparation	Undercooked or reheated food can cause bacterial diseases like Escherichia coli which is a cause of food poisoning.
Vector	Any organism that can spread disease is called a vector. Many farmers think tuberculosis in their cattle can be spread by badgers.

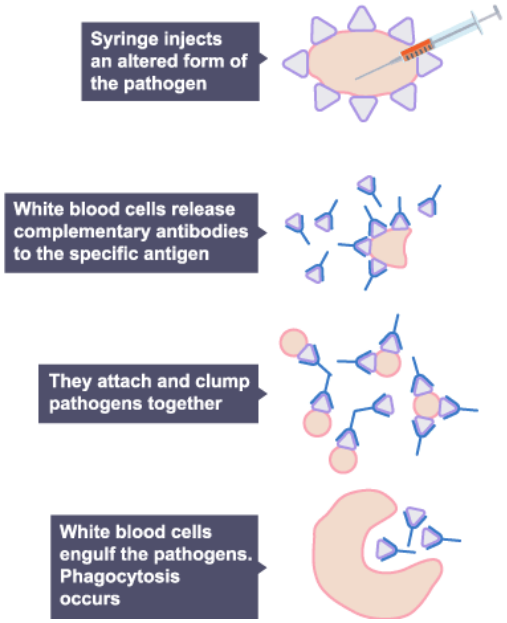
There are various non-specific human defenses against disease, these include:

- **Skin** - The skin prevents infection from disease and pathogens by acting as a physical barrier that can heal itself if cut or grazed.
- **Nose** - Cells in the nose produce mucus. This traps pathogens before they can enter the lungs. Also hairs in the nose act as a barrier against pathogens.
- **Trachea and bronchi** - these have ciliated cells and mucus that trap pathogens and move them up to the throat to be swallowed.
- Stomach - Hydrochloric acid in the stomach kill bacteria.

White blood cells are part of the bodies Immune system that kills pathogens, there are two types of white blood cells:

- **Phagocytes** - Phagocytes surround any pathogens in the blood and engulf them. They are attracted to pathogens and bind to them. Once engulfed Phagocytes expose the pathogen and release enzymes that break the pathogen down. They are **non-specific.**
- **Lymphocytes** - Lymphocytes are another type of white blood cell. They recognize proteins on the surface of pathogens called **antigens**. Lymphocytes detect that these are foreign not naturally occurring within your body and produce **antibodies**. Lymphocytes can also make antitoxins and are called **Specific**

During the primary infection, the antibodies slowly increase, peak at around ten days, and then gradually decrease. A second exposure to the same pathogen causes the memory white blood cells to respond quickly in order to produce lots of the relevant antibodies, which prevents infection.



Herd immunity is when the majority of the population is vaccinated and thus the chance of people coming into contact with specific pathogens before they are able to be vaccinated and protects the vulnerable in society.

Antibiotics are substances that kill bacteria or prevent their growth. They do not work against viruses.

Over time, bacteria can become resistant to certain antibiotics: this is an example of natural selection. In a large population of bacteria, there may be some that are not affected by the antibiotic (because of mutations). These survive and reproduce, creating more bacteria that are not affected by the antibiotic.
Different antibiotics kill different types of bacteria, so it's important patients are treated with the right ones.
Painkillers block nerve impulses from the part of the body experiencing pain.
Traditionally drugs were extracted from plants and microorganisms like penicillin and aspirin from willow bark.
Most new drugs are synthesized by chemists in the pharmaceutical industry. However, the starting point may still be a chemical extracted from a plant
Drugs developed must be safe, effective, stable, and have a known dose.
Stages of drug development:

1. Preclinical - Done in labs using cells and tissues.
2. If it is not toxic it will then be tested on living organisms and animals. This is still considered preclinical.
3. Clinical - Using humans. It is tested on a small number of healthy volunteers, then a large number of healthy volunteers, then on patients suffering from the target illness.

Placebos substances are given to volunteers that have no active ingredients but have psychological effects. They test if it is the drug that is working or the psychological effect. In a double-blind trial, the developers may not know who is on the trial either, this is to eliminate conclusion biases.

3.2 Monoclonal antibodies

Monoclonal antibodies are identical copies of one type of antibody.

Formation of monoclonal antibodies

1. An antigen is injected into a mouse
2. The mouse naturally produces lymphocytes, which produce antibodies specific to the antigen
3. Spleen cells that produce the lymphocytes are removed during a small operation
4. The spleen cells are fused with human cancerous white blood cells called myeloma cells to form hybridoma cells which divide indefinitely
5. These hybridoma cells divide and produce millions of monoclonal antibodies specific to the original antigen

Pregnancy test kits use monoclonal antibodies. These have been designed to bind with a hormone that is found only in the urine of pregnant women.

Cancerous cells have antigens. Monoclonal antibodies can be designed to bind specifically with these antigens. When injected into a person's body, the monoclonal antibodies will bind with these cancer cells and clump them together. This makes it easier to identify a cancerous tumor, which can then be treated or removed.

3.3 Plant disease

Plant pathogens kill or reduce the growth of many plants, which in turn can reduce biodiversity.

Common symptoms of these diseases are discolored leaves and wilting.

Plants can be infected by a range of viral, bacterial, and fungal pathogens as well as by insects (aphids)

Plants can be damaged by a range of ion deficiency conditions for example nitrate and magnesium deficiencies. Nitrogen is used to make proteins, which are used for growth and repair. Seedlings grown without magnesium will appear yellow and will be smaller. Magnesium is used to make chlorophyll, which is essential for photosynthesis.

Physical defenses

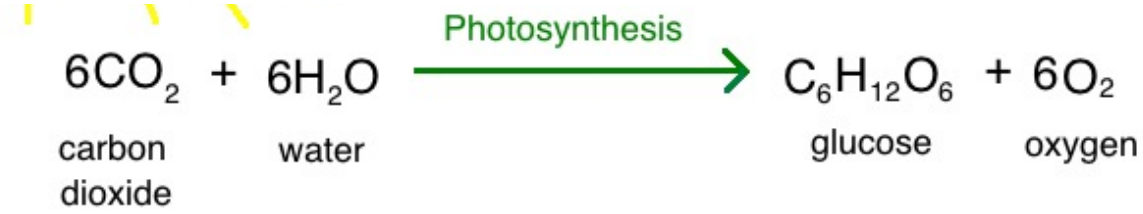
- thick bark - This is an external layer of dead cells that forms a physical barrier against infection.
- cellulose cell wall - acts as another barrier against infection.
- waxy cuticle - which also stops leaves cells from becoming infected.

Chemical defenses

- Production of antibacterial chemicals -These limit the spread of bacteria that were not stopped by physical defenses.
- stinging nettles have developed poisons to stop themselves from being eaten by herbivores. These do not defend plants from infection by pathogens.

Mechanical defense adaptations include drooping leaves, thorns and hairs.

4.1 Photosynthesis



The energy comes from the sun.
Three main factors affect light concentration, carbon dioxide concentration, and temperature. These are limiting factors. This means that if these were increased then more photosynthesis could take place.
To increase yield farmers may grow crops in warm greenhouses with large amounts of Co2 and lots of sunlight.
Plants use their glucose from photosynthesis for Respiration, making fruits, making cell walls, making proteins, storing in seeds, and storing as starch.
Plants use nitrates as a supply of nitrogen, which is needed to make proteins for healthy growth.

4.4.2 Respiration
Aerobic respiration (occurs in the mitochondria)
glucose + oxygen → carbon dioxide + water + energy released
$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy released

Anaerobic respiration (occurs in the cytoplasm when the lungs and heart in unable to provide sufficient oxygen for aerobic respiration)
glucose → lactic acid + energy released
$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$ + energy released
Glucose is not completely broken down, so much less energy is released than during aerobic respiration.
Glucose in yeast cells is converted to carbon dioxide and ethanol, which we refer to simply as 'alcohol' (this process is called fermentation):
glucose → ethanol + carbon dioxide + energy released
$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

Reactions which transfer energy to the environment are exothermic reactions.
Organisms need energy to perform functions such as growth and repair, reproduction, movement and defense.
Lots of aerobic respiration causes muscle fatigue due to buildup of lactic acid.
Oxygen debt

When a period of exercise is over, lactic acid must be removed. The body's tolerance of lactic acid is limited.
Lactic acid is taken to the liver by the blood, and either:

- oxidized to carbon dioxide and water, or
- converted to glucose, then glycogen - glycogen levels in the liver and muscles can then be restored

These processes require oxygen. This is why, when the period of activity is over, a person's breathing rate and heart rate do not return to normal straight away.
The amount of oxygen required to remove the lactic acid, and replace the body's reserves of oxygen, is called the oxygen debt.
Metabolism is the sum of all the chemical processes in a cell or the body.
The energy transferred by respiration in cells is used by the organism for the continual enzyme-controlled processes of metabolism that synthesize new molecules.

Tests for substances:
Starch: Add a few drops of iodide solution. A bluish-black color develops if starch is present.
Benedict's test for sugars: Benedict's solution turns from blue to orange-red if sugars are present
Proteins: add buirets solution to the solution. It turns from light blue to purple in the presence of protein.

Paper 2

4.5.1 Homeostasis
Homeostasis is the maintenance of a constant internal environment.
Homeostasis is the regulation of conditions in the body such as temperature, water content, and blood glucose levels.
Automatic control systems may involve nervous responses or chemical responses.
Receptors are parts of the body that detect changes in the environment.
Coordination center, such as the brain, spinal cord, or pancreas, which receives and processes information from receptors around the body.
Effectors bring about responses, which restore optimum levels these include muscles and glands.

5.2 The human nervous system
A neuron's function is to transmit electrical impulses across the nervous system quickly.
A neuron is adapted for this function in the following ways:

- The cell body contains the cytoplasm and nucleus

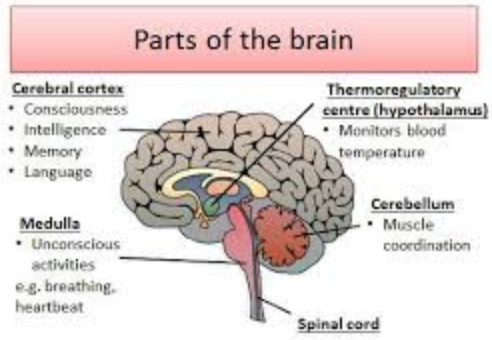
- The axon is a long extension of the cytoplasm (can be up to 1m). This means nerve impulses can be transmitted to the extremities by one cell.
- The myelin sheath is a fatty layer that surrounds the axon. The sheath acts as an insulator and speeds up nerve impulses.
- The branched ends of the axon and the smaller branches coming from the cell body allow the neuron to make connections with many other neurons.

There are 3 types of neurons:

- Motor Pathway: Coordinator → Effector (muscles or glands)
- Sensory Receptor → Coordinator
- Relay Sensory → motor (these neurons are inside of the CNS)

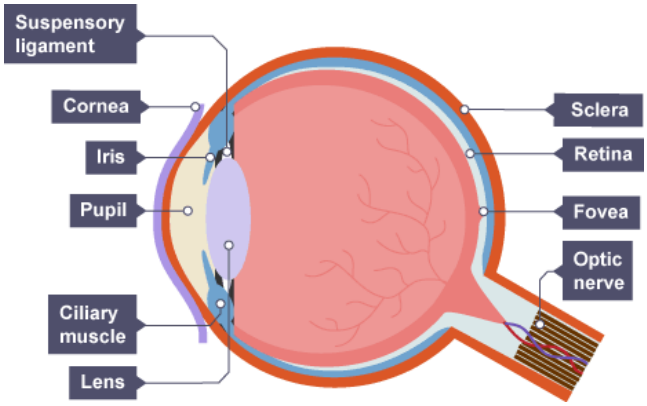
A coordinator is the brain or the spinal cord (CNS)

A receptor detects stimuli.
Synapses are the junctions between two neurons. Neurons cannot touch each other.
Reflex reactions are automatic and rapid because they pass through the spinal cord instead of the brain.



Ways we investigate brain functions include:

- MRI scans
- Studying patients with brain damage
- Electrically stimulating the brain



Structure	Function
Cornea	Refracts light - bends it as it enters the eye
Iris	Controls how much light enters the pupil
Lens	Further refracts light to focus it onto the retina
Retina	Contains the light receptors

Optic nerve	Carries impulses between the eye and the brain
Ciliary muscle/body	Alters the shape of the lens so that the eye can focus
Suspensory ligament	Attaches the ciliary muscle to the lens

Myopia is short-sightedness (image is formed before the retina) treatment: decreasing focusing power of the eye
Hyperopia is farsightedness (image is formed after the retina) Treatment: increasing the focusing power of the eye.

5.3 Hormonal Coordination in humans
Hormones are chemical messengers sent in the bloodstream.
The endocrine system is a group of glands which secrete hormones into the bloodstream.
The following glands are all part of the endocrine system:

- Pituitary (master gland) - Located in the head, releases LH, ADH, FSH
- Thyroid - Located in the neck, releases Thyroxine responsible for your metabolic rate
- Pancreas - Located in the Belly, releases insulin responsible for blood glucose levels
- Adrenal gland - Located in the belly, releases adrenaline responsible for “fight or flight”
- Testes - Produces testosterone which controls puberty and sperm production
- Ovaries - Produces oestrogen which is involved in the menstrual cycle

Hormonal responses are slower and last longer than nervous responses

Insulin is used by the body to convert soluble glucose into insoluble glycogen so that it can be stored. (Glucagon converts glycogen into glucose when it needs to be repaired).
People with type 1 diabetes have pancreases that create no or very little amounts of insulin. This means that glucose is not converted into glycogen by the liver and blood glucose levels are not kept at a safe level. You can get insulin injections to treat type 1 diabetes.
Type 2 diabetes occurs when a person becomes resistant to their own insulin. This can be controlled by eating a carbohydrate-controlled diet and getting regular exercise.

Negative feedback = once normal is achieved correction mechanism is turned off.
The kidney is involved in regulating the water and ion content of the blood.

1. Blood enters the kidney through the renal artery
2. Blood enters a bundle of capillaries
3. Blood is filtered through pores in the capillary walls. The small molecules leave e.g. Glucose, water, ions, and Urea (ultrafiltration) blood cells too big to fit
4. A filtrate is formed
5. Selective reabsorption of useful substances back into the blood e.g. All glucose, some water and ions, and all urea. This is now called urine.
6. Urine travels to the bladder where it is stored before it is excreted.

ADH is responsible for water reabsorption into the blood in the kidney. More ADH more water reabsorbtion
People with kidney failure can be kept alive using a dialysis machine or a kidney transplant.
A dialysis machine works like this:
Blood from the patient is sent down a tube with partially permeable membranes. Dialysis fluid with the same concentrations of ions and glucose is moved around the tube and substances transfer back and forth until the patient have the correct levels of ions, glucose and urea are present in the blood.

During puberty, reproductive hormones cause secondary sex characteristics to develop.
The menstrual cycle has four stages:

- Stage 1 - Day 1 Menstruation starts and the uterus lining breaks down for about 4 days
- Stage 2 - Day 4 to 14 The uterus lining builds up again to prepare for an egg
- Stage 3 - Day 14 Ovulation an egg develops and is released
- Stage 4 - Day 14 to 28 The uterus lining is maintained but breaks down if no egg implants.

FSH - Released from the pituitary gland, causes an egg to mature and for the ovaries to produce oestrogen
Oestrogen - Released from the ovaries, causes uterus lining to grow and stimulates the release of LH, and inhibits release of FSH
LH - Released from the pituitary gland, causes release of egg on day 14
Progesterone- Released from ovaries, maintains uterus lining, inhibits the release of LH and FSH
Oestrogen can be used to prevent release of an egg, can be taken as a pill that can cause side effects.

4.5.4 Plant hormones

Auxin is a plant hormone produced in the tip that controls growth in the shoots and root of plants. In shoots auxin causes the cells to elongate as a geotropism or phototropism response.
Gibberellins stimulate plant stems to grow
Ethene stimulates the ripening of fruit

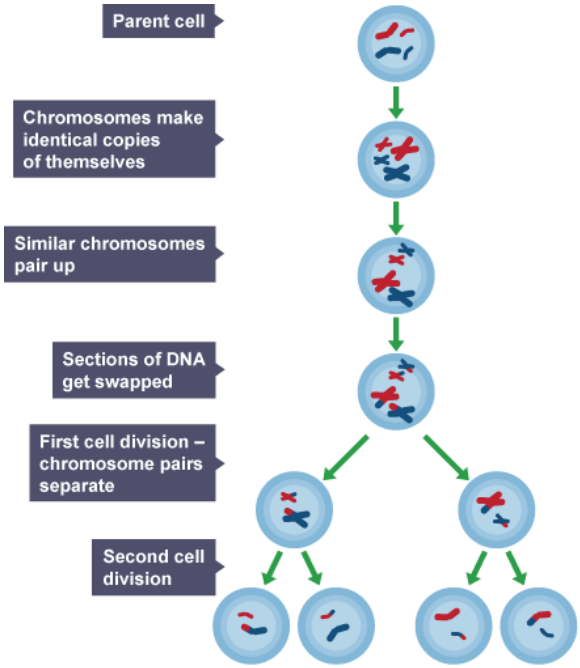
4.6.1 Reproduction

Sexual reproduction combines the genetic material from two parents in their offspring
advantages: Offspring show variation (This allows for adaptation, drive natural selection, and allows for selective breeding to occur)
Asexual reproduction produces offspring genetically identical to one parent.
advantages: One parent needed only, More cost-effective when growing plants as the process is quick, many offspring can be produced at one time (in controlled conditions)

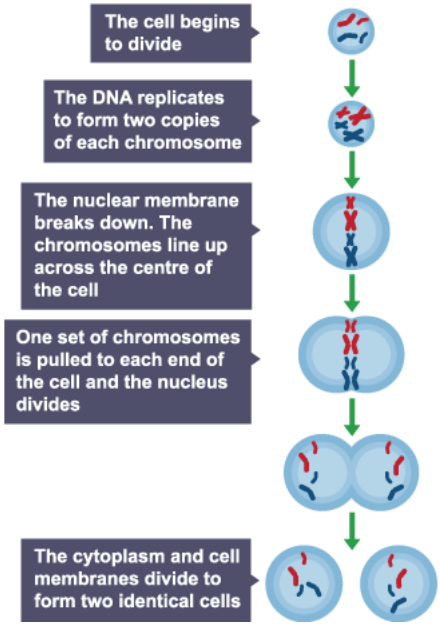
Gametes are the human sex cells (sperm and egg)
Plant sex cells are the stamen and ovary.

Meiosis occurs in the testes of men and ovaries of women.
Meiosis and mitosis differ because:

- mitosis is a form of cell division which produces two identical, diploid body cells
- meiosis is a form of cell division which produces four non-identical, haploid sex cells or gametes (sperm and ova in humans)



^Meiosis^



^Mitosis^

A human has 42 Chromosomes in 23 pairs.
The genetic material in the nucleus of a cell is composed of a chemical called DNA. It carries the genetic code, which determines the characteristics of a living organism.

The cell's nucleus contains chromosomes. These are long threads of DNA, which are made up of many genes.
A gene is a small section of DNA in a chromosome that codes for a specific protein.
The genome of an organism is the entire genetic material of that organism.
DNA is a chemical found in the nucleus that carries genetic code. Its structure is a double helix held together by complementary base pairs.
Each strand of DNA is made of chemicals called bases. (T-A) (C-G)
How genes make proteins:

1. A gene is unwound + unzipped from the chromosome. A copy of the gene called MRNA can leave the nucleus.
2. When in the cytoplasm a Ribosome binds to the MRNA
3. A triplet is exposed in the ribosome and a molecule carrying a specific amino acid binds to the complementary triplet.
4. The amino acids are joined by enzymes to form peptide bonds

5. The ribosome then shifts along 1 triplet continuing to form the chain of amino acids until it reaches the stop triplet where the ribosome and the MRNA break apart and the new-made protein is released.

Different proteins have different orders of amino acids (which are determined by the order of bases). They, therefore, fold into different 3D structures. The shape of the protein is vital for its function e.g. active site shape in enzymes
If a Mutation changes the order of bases then the protein may not function properly. However, whilst mutations occur simultaneously most do not alter the protein.
Not all parts of DNA code for proteins so some variation in these areas may not affect how genes are expressed.

Genotype is what alleles an organism has.
Phenotype is the visible characteristic an organism displays as a result of its genes.
Dominant means that the allele will be expressed if it is present. A recessive allele is only expressed in the absence of a dominant allele.
Homozygous is when an organism has two of the same alleles.
Heterozygous is when an organism has two different alleles.
Many characteristics e.g. eye color are a result of multiple genes interacting.

Punett squares work as follows:
R is a dominant allele for having spots on a dog
Phenotype : spots x plain
Genotype : Aa aa
Gametes (A)(a) (a)(a)

Plain/ spots	a	a
A	Aa	Aa
a	aa	aa

F1 ratio 1 spot: 1 plain

Polydactyly is a addition of one or more fingers caused by a dominant allele.
Cystic fibrosis is a disease-causing respiratory problems caused by a recessive allele.
Sex is determined by the 23rd pair of chromosomes (humans have 46)
XX = Female XY= Male

6.2 Variation and evolution
Variation is the difference shown between humans.
Variation can be genetic- caused by the genes you inherit e.g. eye colour

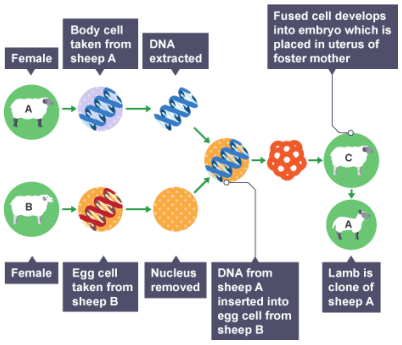
Variation can also be environmental - caused by external factors e.g. getting a scar
How evolution works:
All organisms show variation and all organisms overproduce babies. Therefore, only the offspring that are better suited to their environment due to variation will survive and reproduce in order to pass on their genetics (are variations). Over time this will cause the population to evolve.
Selective breeding is when humans breed plants or animals for particular genetic characteristics: e.g. disease resistance or grain yield in wheat
Inbreeding reduces the variation of alleles in the gene pool this means the is an increased chance in inbred organisms suffering from recessive genetic illnesses and from organisms dying from diseases due to lack of variation (and possible resistance).

Genetic modification (GM, also called genetic engineering) involves taking a gene from one species and putting it into another species. It involves these steps:

1. selection of the desired characteristic
2. isolation of the gene responsible for the characteristic
3. insertion of the gene into another organism e.g. bacterium cell
4. replication of the transgenic organism

Genetic modification can be used to produce plants that improve food production or make insulin from a bacterium with the human gene for insulin inserted into them.
Concerns about GM crops include:

- It may harm people when consumed
- It may cause an allergic reaction in some
- It has moral issues involved (should we be making new life forms)



You can clone plants buy placing cuttings e.g. a tree branch in damp compost and use plant hormones to encourage new roots to develop.
Another way of cloning plants is to buy tissue culture. A tissue sample can be taken from a parent plant are placed in an agar growth medium containing auxin. Eventually, the sample will develop into tiny plantlets which can then be planted.

4.6.3 The development of understanding of genetics and evolution
Charles Darwin's theory of evolution ….