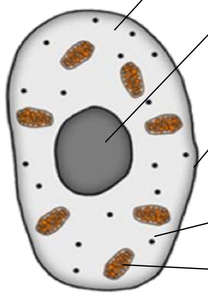
B1 You and your genes What is the genome?



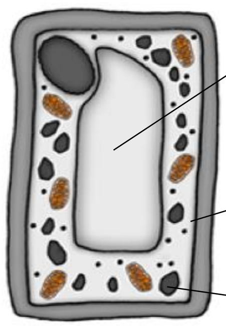
cytoplasm	*site of chemical reactions in the cell*	gel like substance containing enzymes to catalyse the reactions
nucleus	*contains **genetic material***	controls the activities of the cell and codes fro proteins
cell membrane	*semi permeable*	controls the movement of substances in and out of the cell
ribosome	*site of protein synthesis*	mRNA is translated to an amino acid chain
mitochondrion	*site of respiration*	where energy is released for the cell to function

animal cell

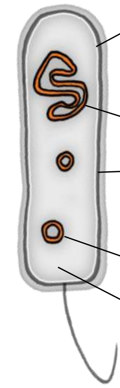
plant cell

Eukaryotes complex organisms

contains all the parts of animal cells plus extras



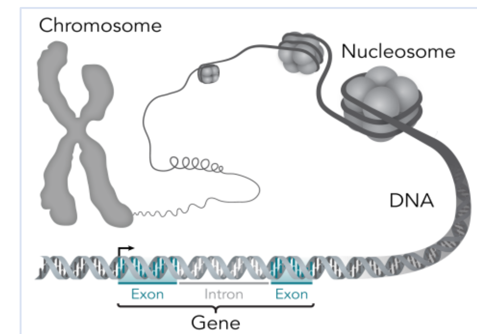
permanent vacuole	*contains cell sap*	keeps cell turgid, contains sugars and salts in solution
cell wall	*made of cellulose*	supports and strengthens the cell
chloroplast	*site of photosynthesis*	contains chlorophyll, absorbs light energy

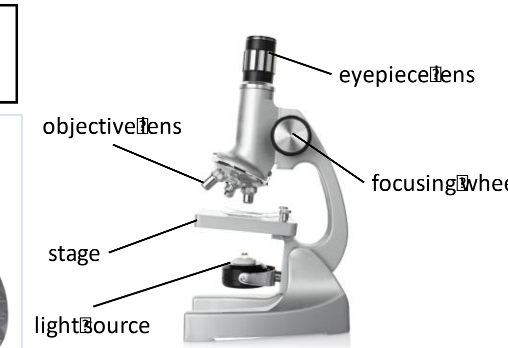


cell membrane	*site of chemical reactions in the cell*	gel like substance containing enzymes to catalyse the reactions
bacterial DNA	*not in nucleus floats in the cytoplasm*	controls the function of the cell
cell wall	***NOT** made of cellulose*	supports and strengthens the cell
plasmid	*small rings of DNA*	contain additional genes
cytoplasm	*semi permeable*	controls the movement of substances in and out of the cell

Bacterial cells are much smaller than plant and animal cells

Prokaryotes simpler organisms



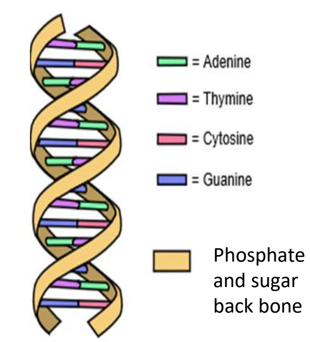


DNA and the genome

Genetic material in the nucleus is composed of a chemical called DNA.

The genome is the entire genetic material of an organism.

DNA structure
Polymer made up of two strands forming a double helix.
Contained in structures called chromosomes. A gene is a small section of DNA on a chromosome. Each gene codes for a sequence of amino acids to make a specific protein.



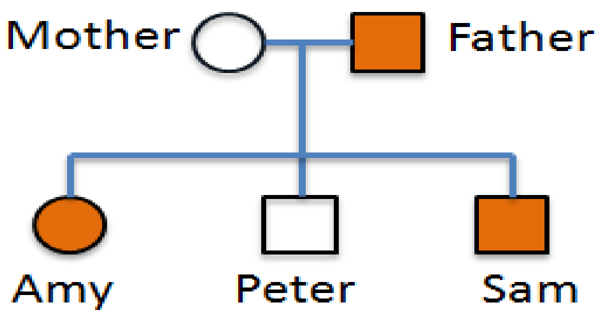
DNA codes for proteins. Proteins are important molecules which can be structural (e.g. collagen) or functional (e.g. enzymes). Proteins are polymers that are made from amino acids. They can be arranged in different sequences to make all the proteins in our bodies.
A sequence of 3 bases is the code for a particular amino acid. The order of bases controls the order in which each amino acid is assemble to produce a specific protein.

Define terms linked to genetics

Gamete	Sex cells produced in meiosis.
Chromosome	A long chain of DNA found in the nucleus.
Gene	Small section of DNA that codes for a particular protein.
Allele	Alternate forms of the same gene.
Dominant	A type of allele – always expressed if only one copy present and when paired with a recessive allele.
Recessive	A type of allele – only expressed when paired with another recessive allele.
Homozygous	Pair of the same alleles, dominant or recessive.
Heterozygous	Two different alleles are present 1 dominant and 1 recessive.
Genotype	Alleles that are present for a particular feature e.g. Bb or bb
Phenotype	Physical expression of an allele combination e.g. black fur, blonde hair, blue eyes.

Variation: difference in the characteristics of individuals in a population may be due to	***Genetic causes (inheritance)***	There is usually extensive genetic variation within the population of a species e.g. hair colour, skin colour, height that can also be affected by environment e.g. nutrition, sunlight.
	Environmental causes (condition they have developed in)	
	A combination of genes and environment	

B1 You and your genes: How is genetic information inherited?



Key
- Female without disorder
- Female with disorder
- Male without disorder
- Male with disorder

Using a family tree: If the father was homozygous dominant then all of the offspring would have the disorder. He must be heterozygous

Inherited disorders

Some disorders are inherited. They are caused by the inheritance of certain alleles

Polydactyly	*Cystic fibrosis*
Caused by inheriting a dominant allele.	Caused by inheriting a recessive allele (both parents have to at least carry it).
Causes a person/animal to have extra toes or fingers.	A disorder of the cell membrane. Patients cannot control the viscosity of their mucus.

Sex determination

Ordinary human body cells contain 23 pairs of chromosomes

One pair of chromosomes carry the genes that determine sex

Female	*Male*
XX	XY

Gametes	X	Y
X	XX	XY
X	XX	XY

The probability of a male of female child is 50%. The ratio is 1:1

Gametes	b	b
B	Bb	Bb
B	Bb	Bb

Gametes join at fertilisation to restore the number of chromosomes

Gametes are made in reproductive organs (in animals ovaries and testes)	*Cells divide by meiosis to form gametes*	Copies of the genetic information are made.
		The cell divides twice to form four gametes each with single set of chromosomes.
		All gametes are genetically different from each other.

egg	B	*contains female chromosomes*	Large food (energy) store for developing embryo.
sperm	b	*fertilise an egg*	streamlined with a long tail acrosome containing enzymes large number of mitochondria

Genetic inheritance

Some characteristics are controlled by a single gene e.g. ear wax, colour blindness.

The alleles present, or genotype operate at a molecular level to develop characteristics that can be expressed as a phenotype.

Most characteristics are as a result of multiple genes interacting.

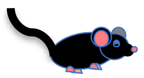
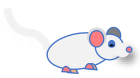
The concept of probability in predicting results of a single gene cross.

Dominant and recessive allele combinations

Dominant	*Recessive*
Represented by a capital letter e.g. B.	Represented by a lower case letter e.g. b.

3 possible combinations:
Homozygous dominant BB
Heterozygous dominant Bb
Homozygous recessive bb

Using a punnet square (using mouse fur colour as an example)

Parent phenotype	Black fur 	White fur 
Parent genotype	BB	bb
What gametes are present	In each egg: B, B	In each sperm: b, b

The probability of black fur offspring phenotype is 100%. All offspring genotypes are heterozygous (Bb).

Crossing two heterozygous mice (Bb)

Gametes	B	b
B	BB	Bb
b	Bb	bb

The probability of black fur is 75% and white fur 25%. The ratio of black to white mice is 3:1

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B1 You and your genes
How can and should gene technology be used?

Embryo screening

Embryo screening issues		
	Economic	Costly and not 100% reliable.
	Social	Not available to everyone (due to cost).
	Ethical	Should only ‘healthy’ embryos be implanted following screening.

Embryo screening:
Chorionic villus testing: Cells are taken from the developing placenta removed to check for presence of faulty genes.
Amniocentesis: Cells are taken from the amniotic fluid to check for presence of faulty genes.

Embryo screening and may alleviate suffering

Pre-implantation genetic diagnosis (PGD): A cell is taken from embryos created by IVF check for presence of faulty genes. Only healthy embryos are implanted into the mother’s uterus.

Personalised medicine

Genetic sequencing can be used to make healthcare personal.

Whole genome sequencing is when the complete sequence of somebody's DNA is worked out. Patterns in the data can then be linked to their medical histories and use of medicines.

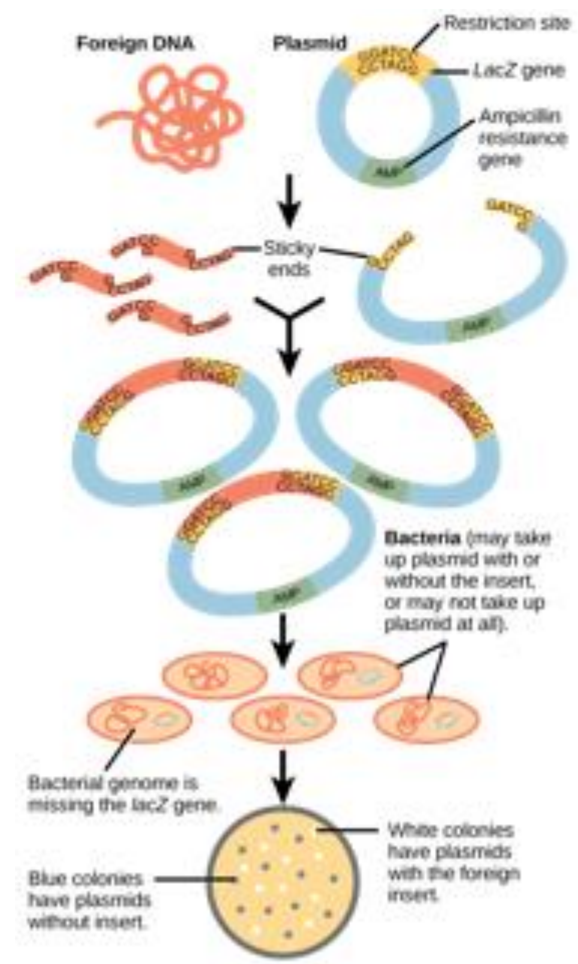
It can be used to help people understand the risks of passing on genetic diseases to their children.

It can also be used to inform people who are likely to develop a genetic disease later in life.

Pros:
Treatments can be started earlier for certain diseases.
People can make informed choices.
We can check that medicines are suitable for people before they are given.

Cons:
People should have a right to privacy.
Who should be told of the results? Family, friends, employers, insurance companies and banks may all want to know.
It would cost a lot of money for everyone to be tested.

Genetic engineering



Concern: effect of GMO on human health not fully explored

Concern: effect of GMO on wild populations of flowers and insects.

Genes from the chromosomes of humans or other organisms can be ‘cut out’ and transferred to the cells of other organisms.

Modern medical is exploring the possibility of GM to over come inherited disorders e.g. cystic fibrosis

Genetic engineering process (HT only)
1. Enzymes are used to isolate the required gene.
2. Gene is inserted into a vector – bacterial plasmid or virus.
3. Vector inserts genes into the required cells.
4. Genes are transferred to plants/animals/microbes at an early stage of development so they develop the required characteristics.

Genetically modified crops (GMO)		
	Crops that have genes from other organisms	To become more resistant to insect attack or herbicides.
		To increase the yield of the crop.

B2 Keeping Healthy What are the causes of disease?

Health

The World Health Organisation (WHO) describes health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

The presence of one disease can lead to a higher susceptibility to other diseases.		
	Damage to immune system	HIV compromises the immune system meaning tuberculosis (TB) can infect.
	Damage to DNA	HPV can cause damage to DNA in cells leading to cervical cancer.

Communicable and non communicable diseases

Communicable	*Non-communicable*
Caused by pathogens. They can be passed from person to person.	Caused by a fault in genes or by the way we live (lifestyle)

Detection and identification of plant diseases

Detection	Identification
Stunted growth	Reference using gardening manual or website, laboratory test for pathogens, diagnostic testing for DNA or antigens from the disease causing organism.
Spots on leaves	
Area of decay	
growths	
Malformed stem/leaves	
Discolouration	
Presence of pests	

Pathogens

Pathogens are microorganisms that cause infectious disease

Bacteria may produce toxins that damage tissues and make us fell ill

Viruses	Bacteria (prokaryotes)	Protists (eukaryotes)	Fungi (eukaryotes)
e.g. cold, influenza, measles, HIV, tobacco mosaic virus	*e.g. tuberculosis (TB), Salmonella, Gonorrhoea*	*e.g. dysentery, sleeping sickness, malaria*	*e.g. athlete's foot, thrush, rose black spot*
DNA or RNA surrounded by a protein coat	No membrane bound organelles (no chloroplasts, mitochondria or nucleus). Cell wall. Single celled organisms	Membrane bound organelles. Usually single celled.	Membrane bound organelles, cell wall made of chitin. Single celled or multi-cellular

Communicable diseases

Pathogens may infect plants or animals and can be spread by direct contact, water or air

Human disease examples

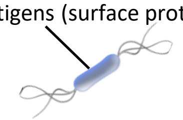
Plant disease examples

Pathogen	*Disease*	Symptoms	Method of transmission	Control of spread
Bacteria	*Salmonella*	Food poisoning- sickness and diarrhoea.	Contaminated food or water is ingested.	Proper cooking and cleaning of food and treatment of water.
Fungi	*Athletes foot*	White, flaky patches on feet.	Skin touches a contaminated surface.	Cleaning of surfaces. Keep feet dry and clean.
Protists	*Malaria*	Recurrent fever. Damage to blood and liver.	By an animal vector (mosquitoes).	Prevent breeding of mosquitoes. Use of nets to prevent bites.
Virus	*Influenza*	Coughing and fever.	Contact with bodily fluids of an infected person.	Isolation of infected person. Vaccination.
Virus	*HIV*	Initially flu like systems, serious damage to immune system.	Sexual contact and exchange of body fluids.	Anti-retroviral drugs and use of condoms.
Bacteria	*crown gall disease*	Knobbly swelling on roots/stem.	Bacteria in soil.	Destroy infected plants.
Fungus	*Ash dieback*	Brown patches on bark.	Spread by spores carried by the wind and movement of contaminated plant material.	Disinfecting of plant material. Destroying infected plants.
Virus	*Tobacco mosaic virus*	Brown/yellow patches on leaves.	Direct contact and contaminated seeds.	Destruction of infected plant crop.

B2 Keeping Healthy
How do organisms protect themselves from pathogens?

Pathogens are identified by white blood cells by the different proteins on their surfaces **ANTIGENS.**

Antigens (surface protein)



The result of changes in DNA that lead to uncontrolled growth and division

Immune system

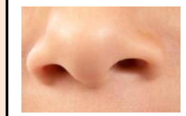
Specific immune system

a. Exposure to pathogen	Pathogens are identified by white blood cells by the different proteins on their surfaces **ANTIGENS.**
b. Antigens trigger an immune response	Trigger causes the production of antibodies.
c. Production of memory lymphocytes	Antigens also trigger the production of memory lymphocytes (a type of white blood cell). These cells can produce the specific antibody for a pathogen.
d. Secondary response	Memory lymphocytes can produce specific antibodies much more quickly if the same pathogen returns.

Phagocytes	*Phagocytosis*	Phagocytes engulf the pathogens and digest them.
Lymphocytes	*Antibody production*	Specific antibodies destroy the pathogen. This takes time so an infection can occur. If a person is infected again by the same pathogen, the lymphocytes make antibodies much faster.
Platelets	*Blood clotting*	Fragments of cells. Can seal damaged blood vessels or form a scab over a wound.

Non-specific immune systems

The human body has several chemical and physical ways of providing protection from pathogens

	*Nose*	Nasal hairs, sticky mucus and cilia prevent pathogens entering through the nostrils.
	*Trachea and bronchus (respiratory system)*	Lined with mucus to trap dust and pathogens. Cilia move the mucus upwards to be swallowed.
	*Stomach acid*	Stomach acid (pH1) kills most ingested pathogens.
	*Skin*	Hard to penetrate waterproof barrier. Glands secrete oil which kill microbes.
	*Lysozymes in tears*	Breaks down the cell wall of some bacteria.

Vaccines

Vaccines are used to immunise a large proportion of the population (herd immunity) to prevent the spread of a pathogen

Vaccination

Small amount of dead or inactive form of the pathogen	*1st infection by pathogen*	White blood cells detect pathogens in the vaccine. Antibodies are released into the blood.
	Re-infection by the same pathogen	White blood cells detect pathogens. Antibodies are made much faster and in larger amounts.

Vaccination

Disadvantages	A very small number of people (eg 1 in 900000 for MMR) a person may have a bad reaction to a vaccine and therefore cannot be immunised.
Advantages	Almost everyone can be immunised (herd immunity) which protects those people who cannot have vaccines. Spread of a pathogen in a population is prevented.

Protecting plants from disease

Regulating the movement of plant material	This stops diseases spreading. It includes seeds, timber and soil as well as whole plants.
Monoculture	If there is no variation between individual plants diseases can spread quickly and they are all vulnerable to the same infections.
Chemical or biological control	WE can use spray chemicals to control plant diseases or introduce a species that preys on the insect pest.

Medicines

antibiotics	Kill infective bacteria inside the body.
antivirals	Inhibit development of new viruses
antiseptic	Kill a wide range of microbes

Human genome

Using patients DNA to predict the likelihood of developing a particular disease and developing treatment tailored to their genome.

Aseptic technique

Aseptic technique		
Autoclave	*Sterile inoculating loops*	*Covered petri dishes and culture vials*
Sterile growth medium and agar plates are sterilized by subjecting them to high pressure steam.	Sterilized before transferring microorganis ms so that sample isn't contaminated.	Covered to avoid contaminatio n by other microorganis ms in the air.

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B2 Keeping Healthy
How can lifestyle effect health?

Non-communicable diseases

Non-communicable diseases are caused by the interaction of a number of factors

Disease	Interacting factors
Cardiovascular disease	Diet, obesity, smoking, drinking alcohol, lack of exercise, genetics.
Cancer	
Lung disease	
Liver disease	
Malnutrition	

Lifestyle factors and their effects on non-communicable disease locally and globally

Disease	lifestyle factors
Obesity and malnutrition	Lack of exercise and consuming too many/too few calories through an unbalanced diet. Schools meals are balanced to combat this in young people.
Liver disease	Large amounts of alcohol taken over a long period of time can lead to liver disease e.g. cirrhosis. The NHS spends over £500 million a year treating liver disease.
Cardiovascular disease	Smoking leads to damage and blocking of arteries supplying the heart with oxygenated blood. WHO estimates that 6 million people die globally as a result of smoking related illnesses.

Treating CHD

Evaluating different treatments for cardiovascular disease (CHD)		
Life long medication	*Surgical procedures*	*Lifestyle changes*
Medicines to reduce blood pressure and cholesterol. Statins for lowering cholesterol carry a small risk of developing diabetes.	A stent can be surgically inserted into blocked blood vessel. Blocked blood vessels can be bypassed with inserted blood vessels. This treatment requires life long medication.	Giving up smoking, drinking excess alcohol and taking more exercise can reduce the risk of CVD. Some patients may not stick to lifestyle changes.

Discovery of new drugs

Drugs (including antibiotics) have to be tested and trialled before to check they are safe and effective

New drugs are extensively tested for:

Efficacy	Make sure the drug works
Toxicity	Check that the drug is not poisonous
Dose	The most suitable amount to take

Preclinical trials - using cells, tissues and live animals - must be carried out before the drug can be tested on humans.

Clinical trials use healthy volunteers and patients

Stage 1	Stage 2	Stage 3	Stage 4
Healthy volunteers try small dose of the drug to check it is safe record any side effects	A small number of patients try the drug at a low dose to see if it works	A larger number of patients; different doses are trialled to find the optimum dose	A double blind trial will occur. The patients are divided into groups. Some will be given the drug and some a placebo.

Double blind trial: patients and scientists do not know who receives the new drug or placebo until the end of the trial. This avoids bias.

A placebo can look identical to the new drug but contain no active ingredients

Antibiotic resistance

How antibiotic resistance develops

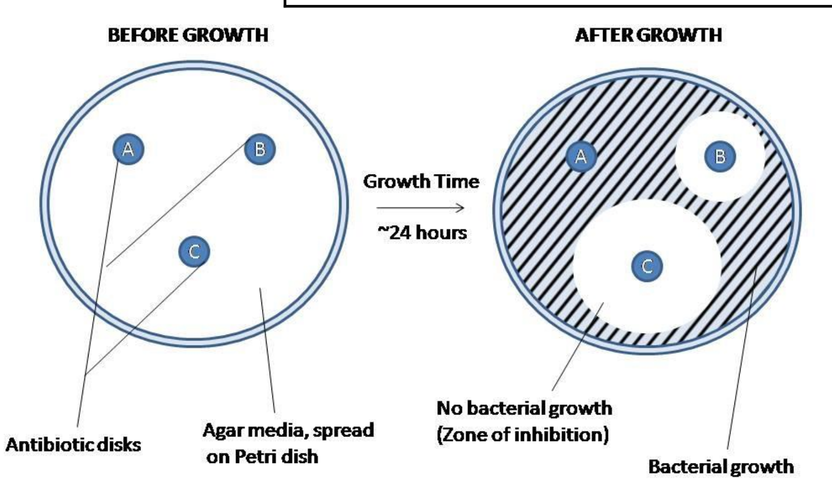
1. A mutation in one bacteria makes it resistant to the antibiotic.
2. Part way through the treatment most of the bacteria have been killed (except the resistant ones).
3. The person feels better and stops taking the antibiotics.
4. With no competition for space or food the resistant bacteria reproduce quickly.
5. The while population is now resistant to the antibiotic.

Testing for antibiotic resistance

We can see which antibiotic is the most effective by growing the bacteria in the laboratory on agar plates.

Paper discs with antibiotic on are places on the agar and the clear zones are measured.

The clear zone with the biggest area is the most effective antibiotic.

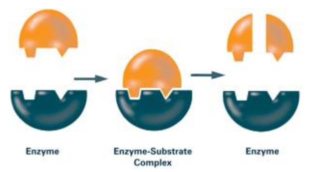


B3- Living together Food and ecosystems

Enzymes

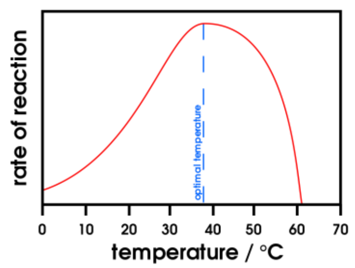
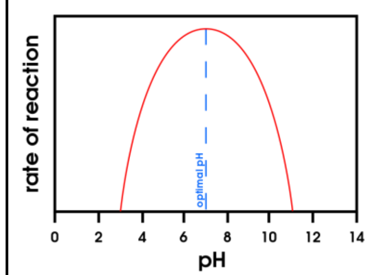
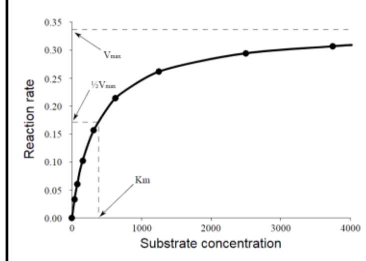
Enzymes catalyse (increase the rate of) specific reactions in living organisms

The 'lock and key theory' is a simplified model to explain enzyme action



Enzymes catalyse specific reactions in living organisms due to the shape of their active site

Digestive enzymes speed up the conversion of large insoluble molecules (food) into small soluble molecules that can be absorbed into the bloodstream

The activity of enzymes is affected by changes in temperature, pH and substrate concentration		
Enzymes activity has an optimum temperature	*Enzyme activity has an optimum pH*	*Increasing substrate concentration increases rate (limited by number of active sites)*
		

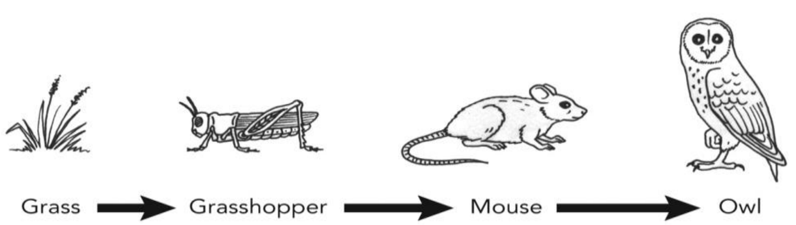
Large changes in temperature or pH can stop the enzyme from working (denature)	
Temperature too high	*pH too high or too low*
Enzyme changes shape (denatures) the substrate no longer fits the active site.	

Investigations into enzymatic reactions	
Starch and amylase, using iodine to test for qualitatively for the amount of starch.	*Catalase and hydrogen peroxide (liver or potato) testing for the amount of oxygen produced*

Levels of organisation

Photosynthetic organisms are the producers of biomass for life on Earth

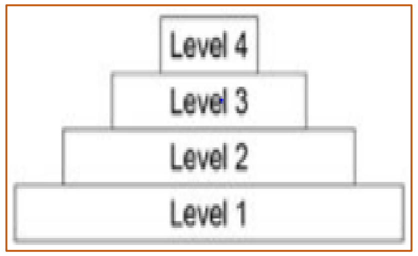
Food chains			
Feeding relationships in a community			
Producer	Primary consumer	Secondary consumer	Tertiary consumer
All food chains begin with a producer e.g. grass that is usually a green plant or photosynthetic algae.		Consumers that kill and eat other animals are predators and those eaten are prey.	



Transport in cells

Diffusion <u>No</u> energy required	*Movement of particles in a solution or gas from a higher to a lower concentration*	E.g. O_2 and CO_2 in gas exchange, urea in kidneys. Factors that affect the rate are concentration, temperature and surface area.
Osmosis <u>No</u> energy required	*Movement of water from a dilute solution (high water potential) to a more concentrated solution*	E.g. Plants absorb water from the soil by osmosis through their root hair cells. Plants use water for several vital processes including photosynthesis and transporting minerals.
Active transport ***<u>ENERGY</u>*** required	*Movement of particles from a dilute solution to a more concentrated solution*	E.g. movement of mineral ions into roots of plants and the movement of glucose into the small intestines.

Trophic levels and biomass



Trophic levels can be represented by numbers and biomass in pyramids.	
Trophic levels are numbered sequentially according to how far the organisms is along the food chain.	
Level 1	Plants and algae.
Level 2	Primary consumers.
Level 3	Secondary consumers.
Level 4	Tertiary consumers.

Abiotic and biotic factors.

Abiotic	Biotic
Non-living factors that affect a community	*Living factors that affect a community*
Living intensity.	Availability of food.
Temperature.	
Moisture levels.	New predators arriving.
Soil pH, mineral content.	
Wind intensity and direction.	New pathogens.
Carbon dioxide levels for a plant.	One species outcompeting so numbers are no longer sufficient to breed
Oxygen levels for aquatic organisms.	

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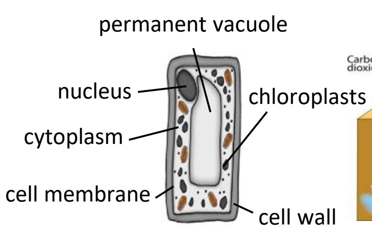
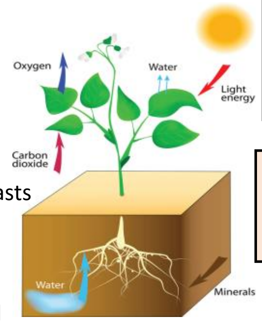




Photosynthetic organisms are the main producers of food and therefore biomass for life on Earth.

Plants use the glucose produced in photosynthesis in a variety of ways

Photosynthetic reaction

The plant manufactures glucose from carbon dioxide and water using energy transferred from the environment to the chloroplasts by light

Photosynthesis		
	Plants make use of light energy from the environment (ENDOTHERMIC) to make food (glucose)	Carbon dioxide + Water $\xrightarrow{\text{light}}$ Oxygen + Glucose
		$CO_2 + H_2O \xrightarrow{\text{light}} O_2 + C_6H_{12}O_6$

The rate of photosynthesis is affected by temperature, light intensity, carbon dioxide concentration, and the amount of chlorophyll

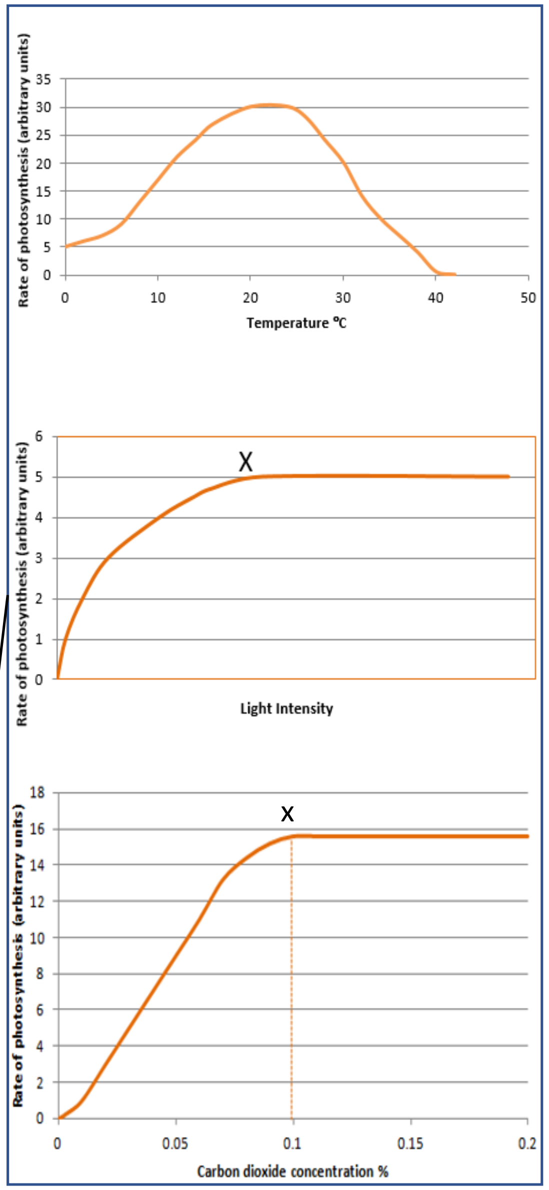
Factors affecting the rate of photosynthesis

Factor	How the rate is affected	Limiting factors (why the rate stops going up)
Temperature	*As the temperature of the environment the plant is in increases rate of photosynthesis increases (up to a point) as there is more energy for the chemical reaction.*	Photosynthesis is an enzyme controlled reaction. If the temperature increases too much, then the enzymes become denatured and the rate of reaction will decrease and stop
Light intensity	*Light intensity increases as the distance between the plant and the light sources increases. As light intensity increases so does the rate of photosynthesis (up to a point) as more energy is available for the chemical reaction.*	At point X another factor is limiting the rate of photosynthesis. This could be carbon dioxide concentration, temperature or the amount of chlorophyll
Carbon dioxide concentration	*Carbon dioxide is needed for plants to make glucose. The rate of photosynthesis will increase when a plant is given higher concentrations of carbon dioxide (up to a point).*	At point X another factor is limiting the rate of photosynthesis. This could be light intensity, temperature or the amount of chlorophyll

Investigating photosynthesis		
	Experiments to investigate photosynthesis	Light intensity – measure the amount of oxygen produced by pond weed (elodea) when light intensity if changed (distance to lamp).
		Carbon dioxide – measure the biomass of plants grown in different concentrations of carbon dioxide

B3- Living together
Food and ecosystems

Rate of photosynthesis



Light intensity obeys the inverse square law. This means that if you double the distance between the plant and the light source you quarter the light intensity

Rate of photosynthesis

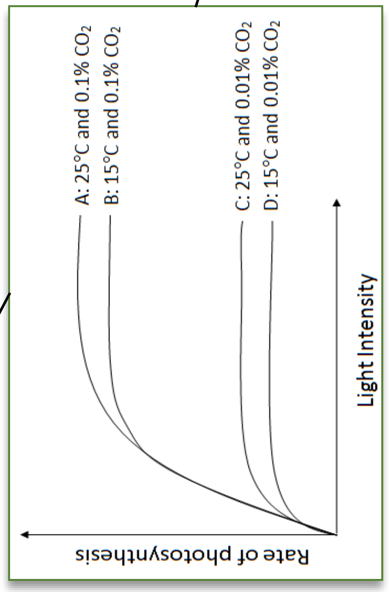
Graph lines C and D: If temperature is increased by 10°C then a slight increase in rate of photosynthesis occurs.

Explain graphs of two or three factors and decide which is the limiting factor

Graph lines A and D: If carbon dioxide concentration and temperature are increased the rate of photosynthesis increases significantly up to a point.

Graph Lines A and B: If carbon dioxide concentration is increased from 0.01% to 0.1% then a large increase in rate occurs up to a point.

Graph line A: Rate could be limited by temperature and/or amount of chlorophyll. Plant tissue can be damaged when carbon dioxide concentrations exceed 0.1%

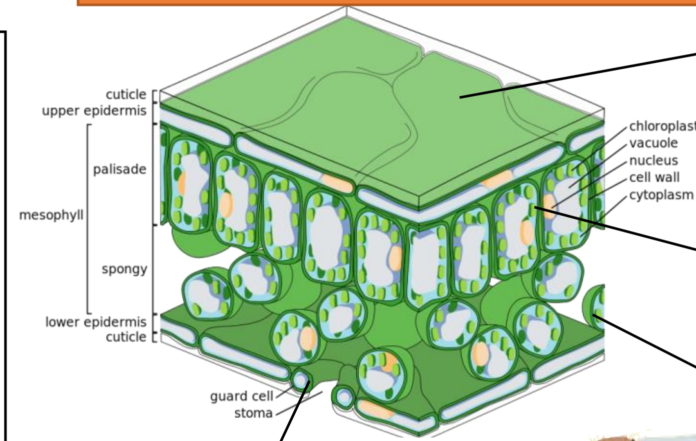


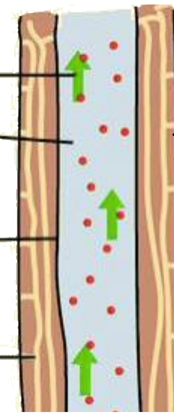
Plant organ systems

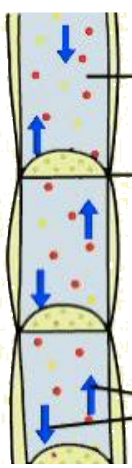
B3- Living together
Food and ecosystems

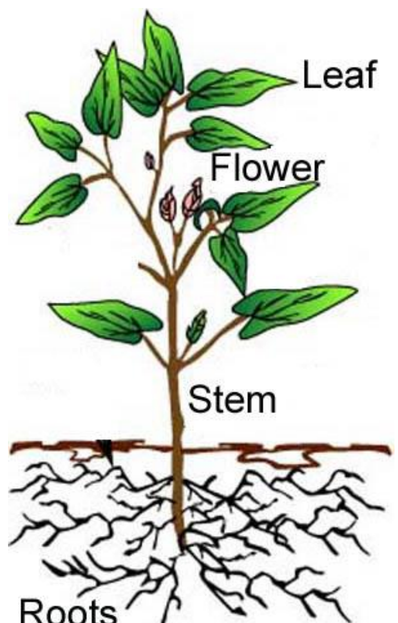
The roots, stem and leaves form a plant organ system for transport of substances around the plant

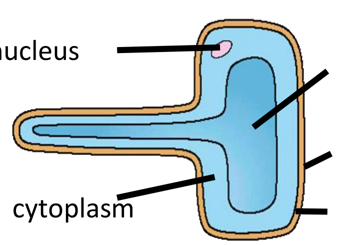
In extreme conditions (high temperature, low water) plants have adapted by reducing the size of the leaf to reduce surface area and have fewer stomata to reduce water loss

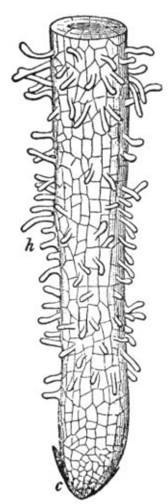










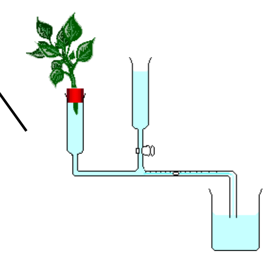


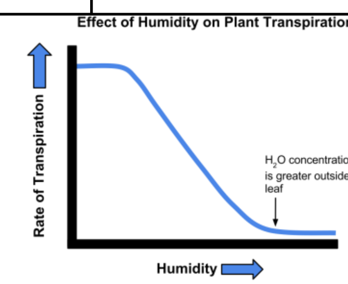
Root hair cells have an increased surface area for absorbing water and mineral ions.

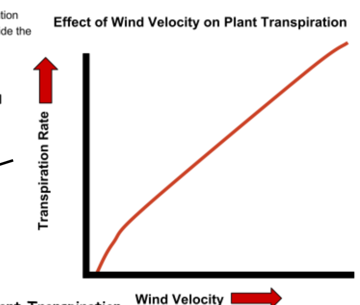
Plant tissues

Epidermal tissues	*Waxy cuticle (top layer of the leaf)*	Reduces water loss from the leaf
	Guard cells and stomata	Guard cells open and close the stomata to control water loss and allow for gas exchange (oxygen and carbon dioxide).
Palisade mesophyll	*Palisade cells*	Cells near the top surface of the leaf that are packed with chloroplasts that contain chlorophyll. Both adaptations maximize photosynthesis.
Spongy mesophyll	*Air spaces in the leaf between cells*	Increased surface area for gas exchange so that carbon dioxide can diffuse into photosynthesising cells.
xylem	*Hollow tubes strengthened by lignified dead cells adapted for the transportation of water and mineral ions through the plant in the transpiration stream*	Allows transport of water and mineral ions from the roots to the stem and the leaves.
Phloem TRANSLOCATION	*Cell sap moves from one phloem cell to the next through pores in the end walls*	Transports dissolved sugars from the leaves to the rest of the plant for immediate use or storage (translocation).
Meristem tissue	*New cells (roots and shoot tips) are made here including root hair cells*	Root hair cells have an increased surface area for the uptake of water by osmosis, and mineral ions by active transport.

A potometer is used to measure the amount of water lost over time (rate of transpiration)

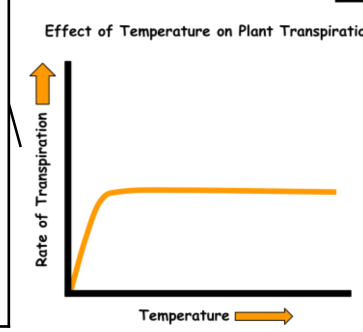






Transpiration

Transpiration	*The rate at which water is lost from the leaves of a plant. The transpiration stream is the column of water moving through the roots, stem and leaves*	Temperature, humidity, air movement and light intensity affect the rate of transpiration.



The shape of the graph for light intensity is the same for temperature (energy)

KS4 Biology
B4 Using Food and Controlling Growth

Additional keywords: exothermic, aerobic respiration, anaerobic respiration, interphase, mitosis, meiosis, ATP, microscopy, magnification, light microscope, electron microscope, image size, actual size, micrometre, nanometre, stem cells, meristems, differentiation, specialised, embryo, zygote, haploid, diploid, fertilisation, gamete

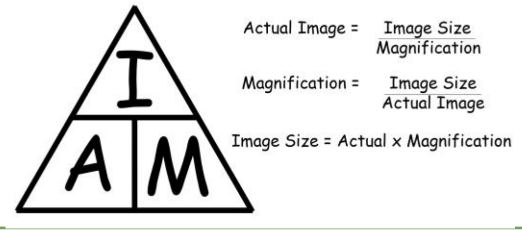
Respiration - Cellular respiration is an **exothermic** reaction which is continuously occurring in all living cells.

	Aerobic	**Anaerobic**
Conditions	Oxygen present	Not enough oxygen present
Inputs	Glucose and oxygen	Glucose
Outputs	Carbon dioxide and water	In animals and some bacteria – lactic acid In plants and some microorganisms (e.g. yeast) – ethanol and carbon dioxide
ATP yield	High – 32 ATP made per molecule of glucose	Much lower – 2 ATP made per molecule

Anaerobic respiration - ***Respiration when oxygen is in short supply. Occurs during intensive exercise.*** Glucose → lactic acid

Aerobic respiration - ***Respiration with oxygen. Occurs inside the mitochondria continuously.*** Glucose + oxygen → carbon dioxide + water.

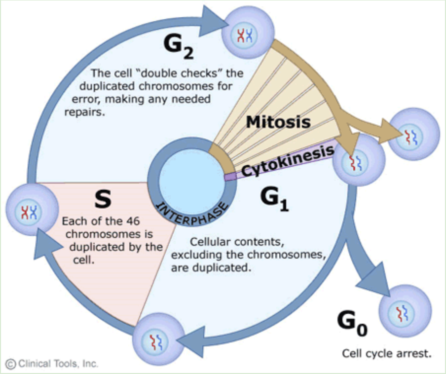
$C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$



The Cell Cycle - new cells are needed for growth and repair. The cell cycle has two main parts:

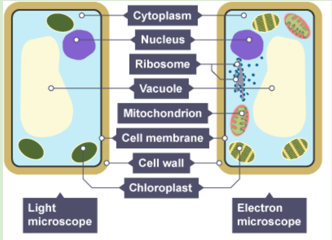
1) Interphase – *the cell grows.* It increases the amount of cellular structures. It copies its DNA, so there's one copy for each cell. The DNA forms X-shaped chromosomes.

2) Mitosis – *this is when a cell reproduces itself.* The chromosomes line up at the centre and get pulled to opposite ends. Membranes form around the chromosomes and become nuclei. The cytoplasm divides. The two cells are identical to the parent cell.



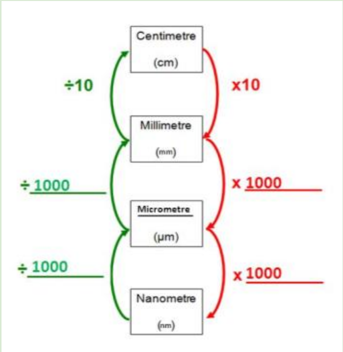
Microscopy

Electron microscopes can make specimens look bigger and show more detail than **light microscopes.**



Magnification – *how many times bigger the image is*

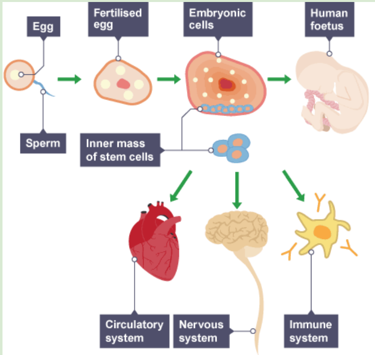
Total magnification = eyepiece lens magnification x objective lens magnification



Stem cells

Stem cells are cells that have not undergone **differentiation**. A cell which has not yet become **specialised** is called **undifferentiated**.

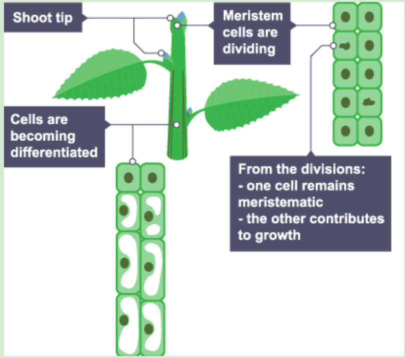
All cells in an embryo start off identical and can form any type of cell.



Advantages	Disadvantages
• Can be used to treat medical conditions and disease (e.g. type 1 diabetes, MS, paralysis) • No rejection • No need to find a donor • No need for tissue typing • Can be used to grow whole organs • Can be used in medical research	• No guarantee how successful treatment will be • Ethical issues with using embryonic stem cells (at what stage is an embryo a life?) • Culture stem cells could be contaminated with viruses which would be transferred to a patient • Difficulty obtaining and storing a patient's embryonic stem cells

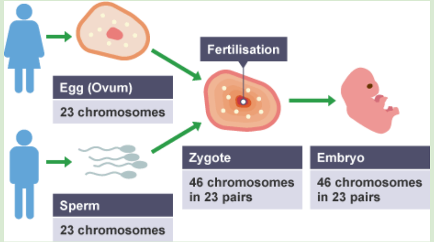
Stem cells in plants

Cell division in plants occurs in regions called **meristems.** Cells divide by mitosis and produce **unspecialised** cells.



Sexual Reproduction

Two parents are needed. The nuclei of the male and female gametes (sex cells) are fused to create a **zygote**. This is called **fertilisation**. Offspring are genetically different to each other and the parents.

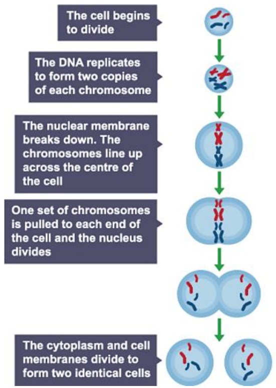


Meiosis vs Mitosis

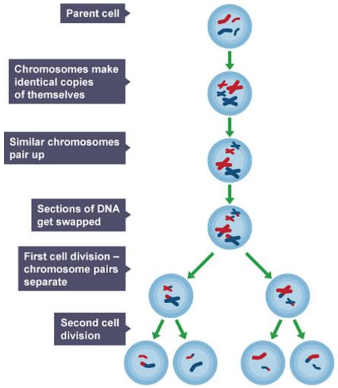
Mitosis	Meiosis
Diploid cells made	Haploid cells made
Used for growth and repair	Used for sexual reproduction
Cells made are genetically identical to starting cell and each other	Cells made are genetically different to starting cell and each other
Two cells are produced	Four cells are produced
One division occurs	Two divisions occur
Interphase happens before cell division	Interphase happens before cell division

Meiosis – A type of cell division that produces four **gametes**. Each gamete has only one copy of each chromosome, and is genetically different. Half the chromosomes come from the organism's father and half have come from the organism's mother.

Mitosis



Meiosis



KS4 Biology
B5 The Human Body – Staying Alive

Additional keywords: diffusion, surface area, volume, concentration gradient, gas exchange, red blood cell, white blood cell, platelet, haemoglobin, biconcave, arteries, veins, capillaries, lumen, receptor, effector, stimulus, neuron, reflex arc, CNS, circulator system, pulmonary circulation, system circulation, atrium, ventricle, aorta, testosterone, oestrogen, menstrual cycle, homeostasis,

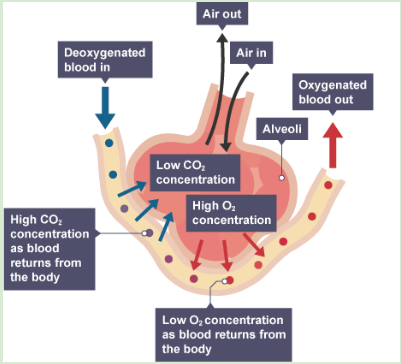
Exchange of materials

Diffusion – *The random, net movement of particles from an area of high concentration to an area of low concentration.* Diffusion moves substances in and out of cells in a leaf, in the lungs and in liver cells. Diffusion is limited by the **surface area to volume ratio** of the organism.

Multicellular organisms need specialised exchange surfaces because they have a small surface area to volume ratio, so can't exchange enough substances across their outside surface alone.

Adaptations of exchange surfaces to maximise exchange:

- A **large surface area to volume ratio** (e.g. alveoli in the respiratory system, villi in the digestive system)
- A **short distance** required for diffusion to and from cells, when the cell membrane is very thin (e.g. walls of blood capillaries, epithelia of alveoli and the villi in the small intestine are one cell thick)
- **Efficient blood supply** to transport molecules to and from the exchange surface (e.g. network of blood capillaries surrounding each alveolus in the lungs and each villus in the small intestine)

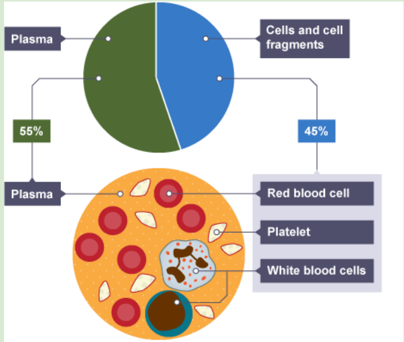


Gas exchange in the alveoli in the lungs:

Oxygen from the air passes into the bloodstream in the lungs through structures called alveoli. It diffuses to a region of lower concentration in the bloodstream.

Blood – flows around the body transporting substances to and from cells. It is composed of **red blood cells, white blood cells and platelets**.

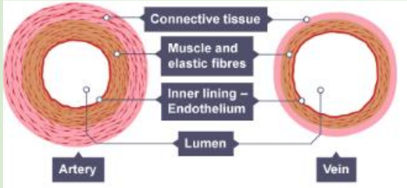
Component	Function(s)
Plasma	Transporting carbon dioxide, digested food molecules, urea and hormones; distributing heat
Red blood cells	Transporting oxygen
White blood cells	Ingesting pathogens and producing antibodies
Platelets	Involved in blood clotting

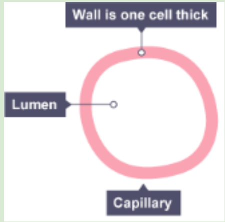


Adaptations of red blood cells for oxygen transport:

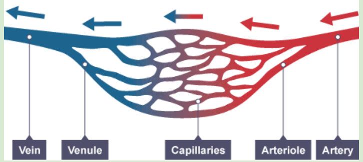
- Contain haemoglobin – combines with oxygen
- No nucleus – carry more haemoglobin
- Small and flexible – fit through narrow capillaries
- Biconcave shape – maximise surface area for diffusion
- Thin – short distance for oxygen to diffuse

Blood vessels





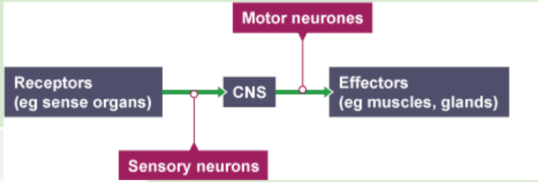
Arteries	Veins
Always carry blood **away** from the heart	Always carry blood **to** the heart
Carry oxygenated blood, except for the pulmonary artery	Always carry deoxygenated blood, except for the pulmonary vein
Carry blood under high pressure	Carry blood under low or negative pressure
Have thick muscular and elastic walls to pump and accommodate blood	Have thin walls - have less muscular tissue than arteries
A type of supporting tissue called connective tissue provides strength	Have less connective tissue than arteries
The channel in the blood vessel that carries blood - the **lumen** - is narrow	Have a wide lumen



The nervous system – Allows an organism to respond quickly to changes in the internal or external environment. The responses to the **stimuli** are short lasting.

Receptors are a group of specialised cells that detect a change in the environment **(stimulus)**. Sense organs (skin, tongue, nose, eye, ear) contain groups of receptors and respond to certain stimuli e.g. temperature, chemicals, light, sound and pain. **Effectors** include muscles and glands, that produce a specific response to a detected stimulus.

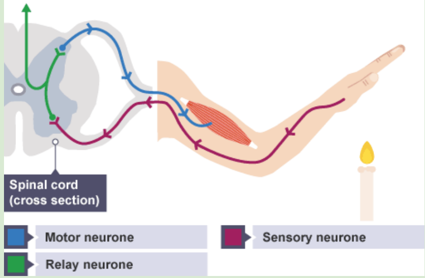
Receptors are connected to effectors as follows:

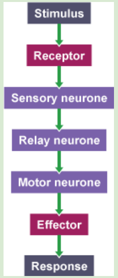


Sensory receptors	These detect the changes in the environment (stimulus)
Sensory neurons	Nerve cells that send a signal from the sensory receptors to the CNS
CNS	The central nervous system (CNS), which is the brain and the spinal cord. This coordinates a response and sends a signal down a motor neuron.
Motor neurons	Nerve cells that receive a signal from the CNS and transfer it to the effector
Effectors	The muscles or glands that produce a response to the stimulus

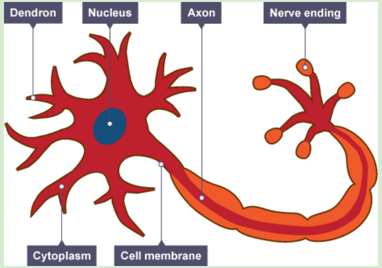
Reflex arc – the nerve pathway followed by a reflex action.

1. Receptor in the skin detects a stimulus (the change in temperature).
2. Sensory neuron sends electrical impulses to a relay neuron, which is located in the spinal cord of the CNS. Relay neurons connect sensory neurons to motor neurons.
3. Motor neuron sends electrical impulses to an effector.
4. Effector produces a response (muscle contracts to move hand away).





Neuron



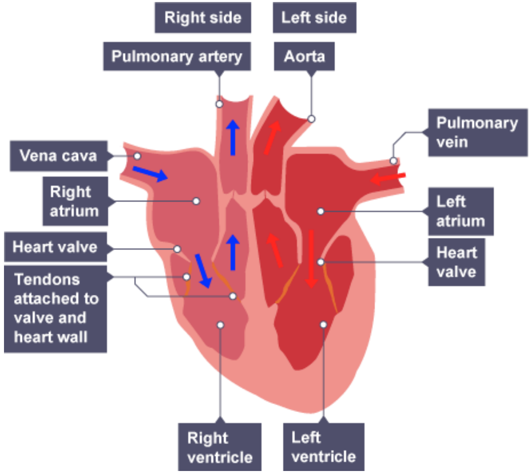
The Circulatory System

The **heart** is an organ made of cardiac muscle tissue and pumps blood around the body by contracting. **Veins** go into the heart, **arteries** go away from the heart. Humans have a **double circulatory system** – the **pulmonary circulation** and the **systemic circulation**.

Pulmonary circulation	Systemic circulation
• Transports blood to the lungs • Under low pressure	• Transports oxygen and nutrients around the body • Transports carbon dioxide and other waste away from cells • Under high pressure

Circulating blood:

- Deoxygenated blood from the body enters the right atrium
- Blood passes from the right atrium to the right ventricle, then to the lungs
- Oxygenated blood from the lungs enters the left atrium
- Blood passes into the left ventricle, through the aorta and into the body



Hormones in reproduction

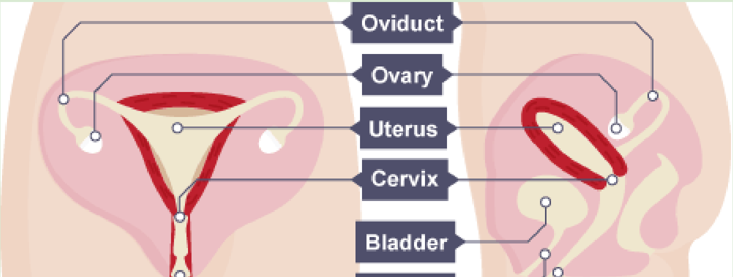
A hormone is a chemical substance, produced by a gland and carried by the blood, which alters the activity of specific target organs.

Testosterone – a hormone produced by the testes, controls the development of male secondary sexual characteristics e.g. facial hair. **Oestrogen** – a hormone produced by the ovaries, controls the development of female secondary sexual characteristics e.g. breast development.

The **menstrual cycle** is a process lasting around 28 days where the lining of the uterus is prepared for pregnancy and occurs in females after puberty. Several hormones control the menstrual cycle:

Hormone	Produced by	Role
FSH (follicle stimulating hormone)	Pituitary gland	Causes an egg to mature in an ovary.
Oestrogen	Ovaries	Repairs, thickens and maintains the uterus lining.
LH (luteinising hormone)	Pituitary gland	Triggers ovulation in the ovary (the release of a mature egg).
Progesterone	Ovaries	Maintains the lining of the uterus during the middle part of the menstrual cycle and during pregnancy.

Human female reproductive system



Contraception

Hormonal methods:

- Oral contraceptives (the pill) contain oestrogen or progesterone and inhibit production of FSH
- Contraceptive injections, implants or skin patches with slow-release progesterone inhibits the release of eggs

Benefits – more than 99% effective, can reduce the risk of certain cancers
Risks – possible side effects e.g. changes in mood, weight and blood pressure, does not protect against sexually transmitted communicable diseases

Non-hormonal methods:

- Physical barrier methods (condoms, diaphragms)
- IUD/coil prevent implantation of an embryo
- Spermicidal agents – kill or disable sperm
- Abstaining from intercourse when egg may be in oviduct
- Surgical methods or male and female sterilisation e.g. vasectomy

Benefits – condoms quick and easy to use, IUDs can be left in positive for up to 10 years
Risks – condoms can tear or rip, diaphragms need to be left in for several hours afterwards, IUDs need to be fitted by a health professional and can cause an ectopic pregnancy, allergic reactions to condoms, surgical methods cant be

Homeostasis

Homeostasis - *The regulation of internal conditions of a cell or organism to maintain optimum conditions for function.* Controls in the human body: blood glucose concentration, body temperature, water levels.

Having Diabetes means you can't control your blood sugar level. There are two types:

Type 1 Diabetes – pancreas stops making insulin, so a person's blood glucose level can rise to a level that can kill them. Treatment includes insulin injections several times a day.

Type 2 Diabetes – A person's cells don't respond properly to insulin, or their pancreas doesn't produce enough insulin. Treatment includes eating a healthy diet, taking regular exercise and losing weight.

Blood glucose concentration	
Monitored and controlled by the pancreas	
Too high	Too low
Pancreas produces the hormone insulin, glucose moves from the blood into the cells. In liver and muscle cells excess glucose is converted to glycogen for storage.	Pancreas produces the hormone glucagon that causes glycogen to be converted into glucose and released into the blood.

KS4 Triple Biology
B6 Life on Earth – past, present and future

Additional keywords: Variation, characteristics, mutation, Charles Darwin, Alfred Wallace, natural selection, evolution, species, fossils, antibiotic resistance, classification, selective breeding, kingdom, phylum, class, order, family, genus, species, binomial

Evolution

Variation is the differences in the **characteristics** of organisms. A **mutation** is a random change in DNA which affects a gene and/or chromosome.

Charles Darwin and **Alfred Wallace** made observations on variation in plants, animals and fossils and proposed a theory of **natural selection** and how this drives the **evolution** of new **species**. The 'On the Origin of Species' (1859) was slowly accepted as it challenged creation theory (God), there was insufficient evidence at the time and the mechanism of inheritance was not yet known. Other theories e.g. **Lamarckism** are based on the idea that changes occur in an organism during its lifetime which can be inherited. We now know that this cannot occur.

The process of natural selection:
Individual organisms within a particular species show a wide range of variation for a characteristic. Individual most suited to the environment are more likely to breed successfully. Characteristics enable individuals to survive are then passed on to the next generation.

Evidence for evolution – rock fossils

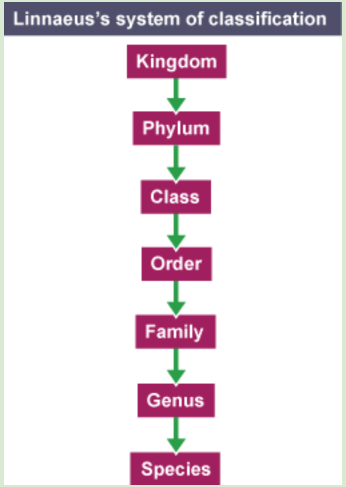
A **fossil** is the preserved remains of a dead organism from millions of years ago. There are gaps in the fossil record because many early forms of life were soft-bodied.

A fossil can be formed by:

- Hard body parts (e.g. bones, shells) do not decay easily or are replaced by minerals as they decay
- Parts of organisms that have not decomposed because the conditions needed for decay are absent (e.g. in ice, in amber)
- Preserved traces of organisms (e.g. footprints) get covered by layers of sediment, which eventually become rock

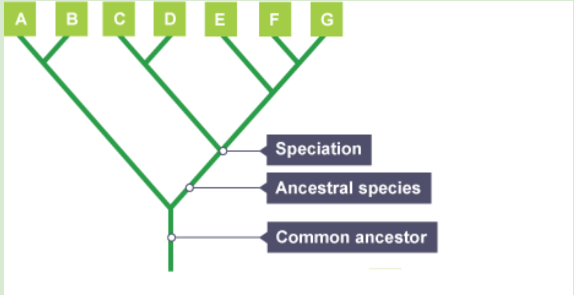
Classification

Living organisms are classified into groups depending on their characteristics. The system was developed by Carl Linnaeus.

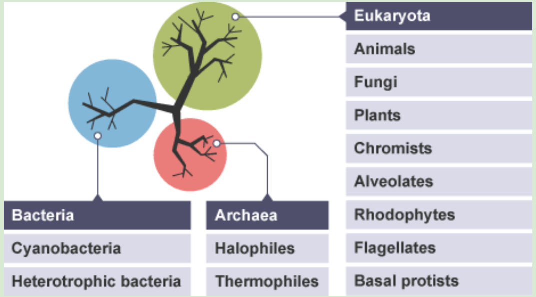


There are 5 kingdoms – animals, plants, fungi, protists and Prokaryotes.

Evolutionary trees are used to represent the relationships between organisms. Branches show places where speciation has occurred, and a new species has evolved.



Classification systems have continued to be developed by other scientists. Carl Woese developed the three-domain system.
This system is based on evidence now available from analysing organisms on the molecular level.



Selective Breeding – The process by which humans breed plants/animals for particular genetic characteristics.

Selective breeding

Choosing parents with the desired characteristics from a mixed population

Chosen parents are bred together.

⇩

From the offspring those with desired characteristics are bred together.

⇩

Repeat over several generations until all the offspring show the desired characteristics.

Desired characteristics are chosen for usefulness or appearance:

- Disease resistance in food crops
- Animals which produce more meat or milk
- Domestic dogs with a gentle nature
- Large or unusual flowers

Benefits	**Risks**
• New varieties may be economically important e.g. drought resistance crops • Animals can be selected that cannot cause harm e.g. cattle without horns	• Reduced genetic variation can lead to attack by specific insects or disease • Unknowingly selecting for rare disease genes when selecting for another positive trait e.g. a high percentage of Dalmatian dogs are deaf • Creating physical problems in specific organisms e.g. large dogs can hips that haven't formed correctly

Modern evidence for evolution

The development of antibiotic resistance in bacteria gives more evidence to support the theory of natural selection leading to evolution. Bacteria can evolve quickly because they reproduce at a fast rate. Mutations in the DNA of bacteria can produce new characteristics – e.g. some bacteria might become resistance to certain antibiotics, such as penicillin.

The main steps in the development of resistance are:

1) a random mutation occurs in a gene of an individual bacterial cell
2) the mutation protects the bacterial cell from the effects of the antibiotic - it becomes antibiotic resistant
3) bacteria without the mutation die or cannot reproduce when the antibiotic is present
4) antibiotic resistant bacteria can reproduce with less **competition** from non-resistant bacterial strains - this is an advantage for them and these bacteria survive
5) the genes for antibiotic resistance are passed to the offspring
6) over time the whole population of bacteria becomes antibiotic resistant because the antibiotic resistant bacteria are best suited to their environment

MRSA

The number of resistant strains has increased, partly due to the misuse of antibiotics. This has resulted in more infections that are difficult to control. MRSA is methicillin-resistant *Staphylococcus aureus*. It is a very dangerous type of bacteria because it is resistant to most antibiotics, so if someone gets infected with MRSA they cannot be treated easily.