Biology Paper 1 (Triple)

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3. Eukaryotic and prokaryotic cells
4. Animal specialised cells
5. Plant specialised cells
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8. Transport in and out of cells – diffusion
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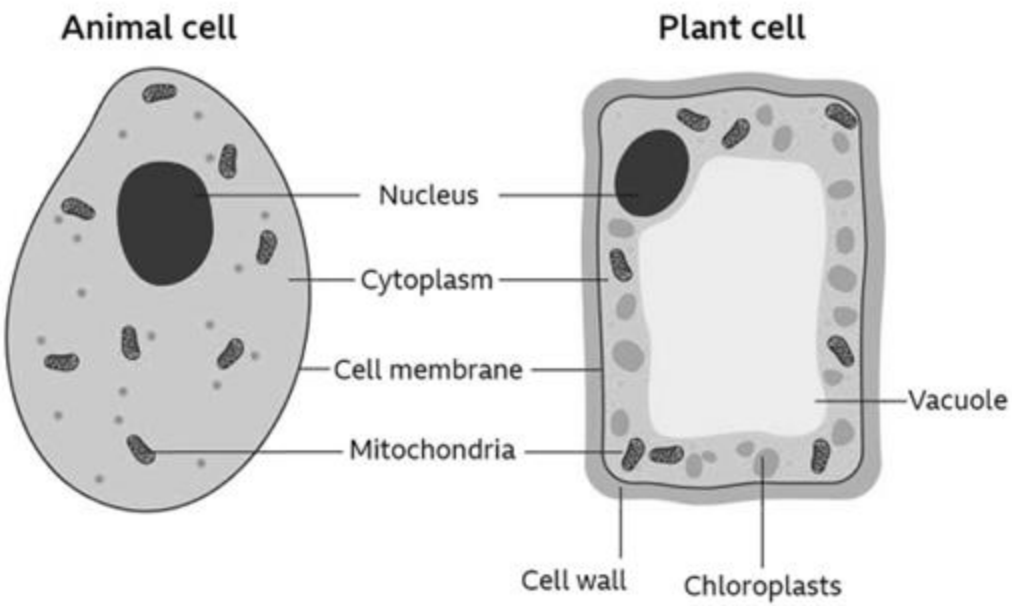
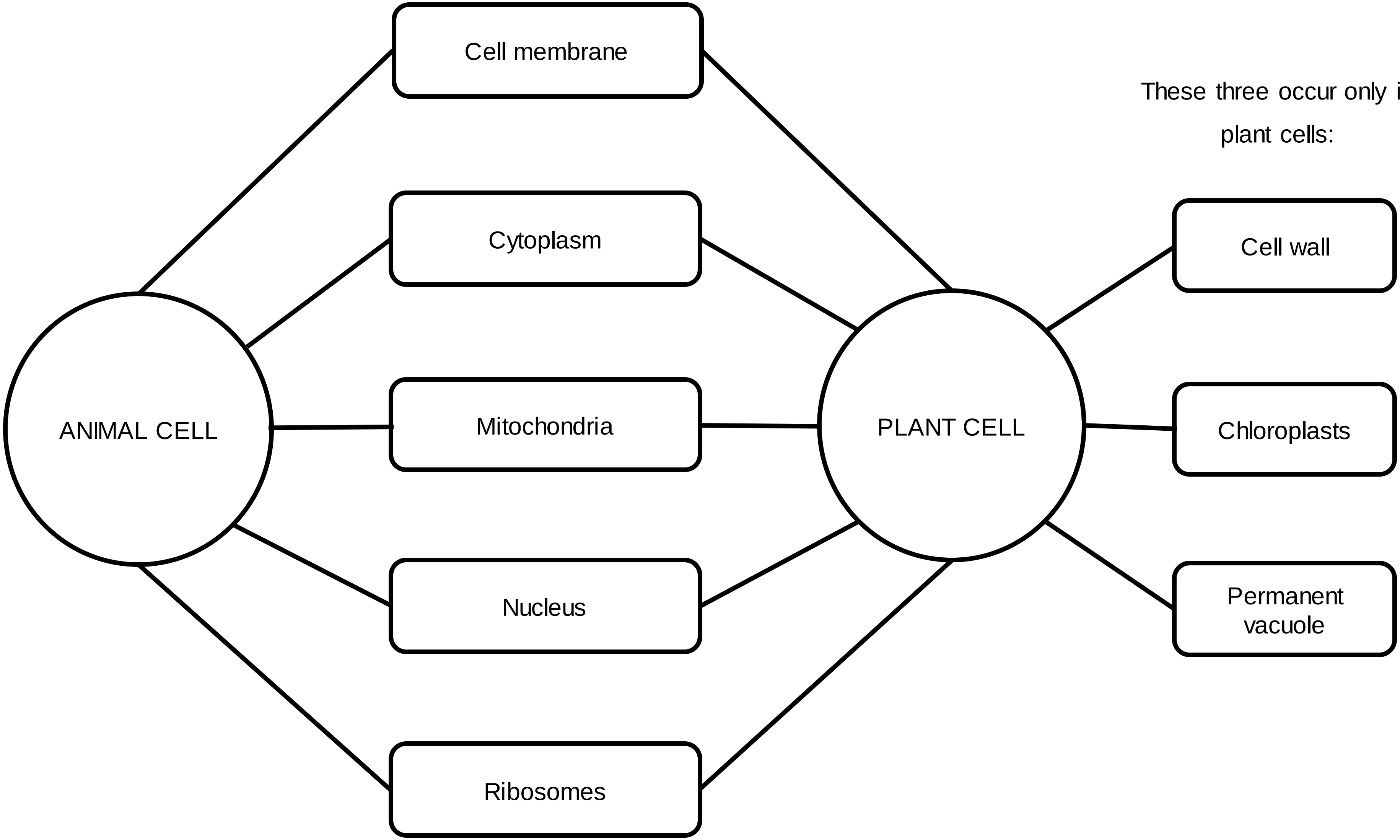
1. Cells



Both animal and plant cells contain a nucleus, cytoplasm, cell membrane, mitochondria and ribosomes. Plant cells also contain a cell wall, chloroplasts, and a permanent vacuole.

Cell organelle	**Description**
Cell membrane	Controls what enters and leaves the cell.
Cell wall	Made of cellulose, to strengthen the cell.
Chloroplast	The site of photosynthesis.
Cytoplasm	The site of chemical reactions.
Mitochondria	To release energy during respiration.
Nucleus	Contains **chromosomes** made of DNA molecules. Each chromosome carries a large number of genes.
Permanent vacuole	Filled with cell sap (a weak solution of sugars and salts).
Ribosomes	The site of protein synthesis (where proteins are made).

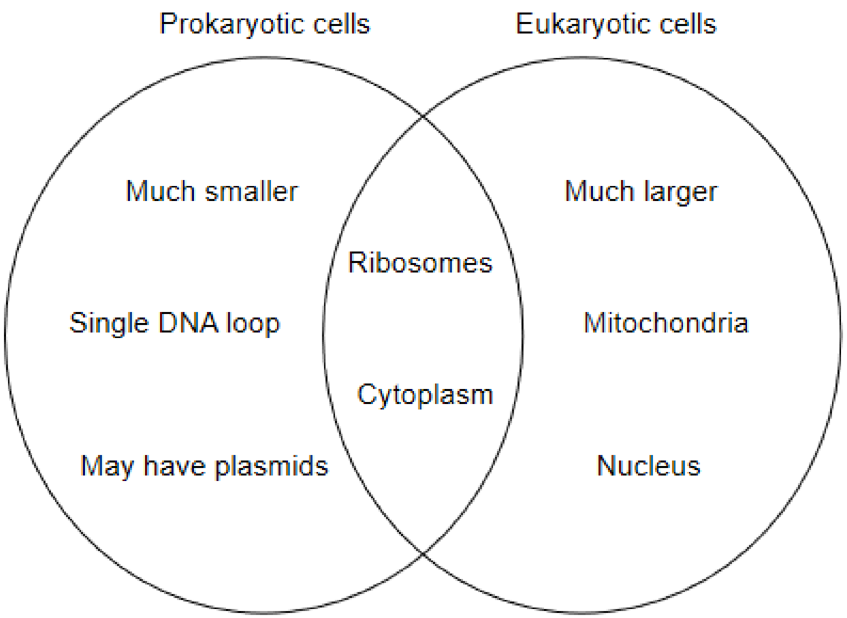
2. Organisation of Cells



3. Eukaryotic and prokaryotic cells

Eukaryotic cells contain a nucleus.

Plant cells and animal cells are eukaryotic.

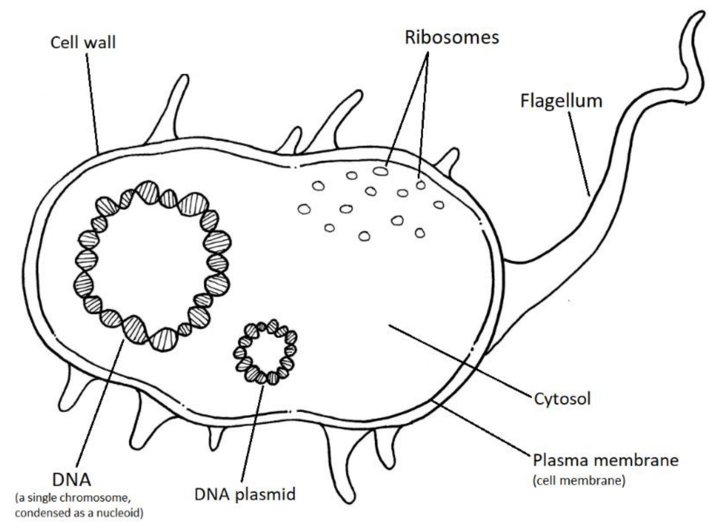


Prokaryotic cells (bacteria) are much smaller than eukaryotic cells.

They do not have a nucleus.

They do not have mitochondria but do have ribosomes.

They have a single DNA loop and may also have small rings of DNA called plasmids.



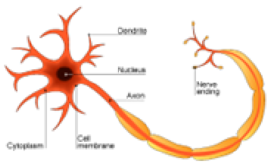
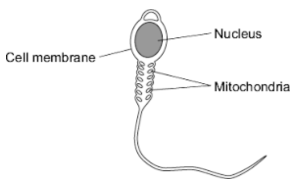
1000nm (nanometres) = 1μm

1000μm (micrometres) = 1mm

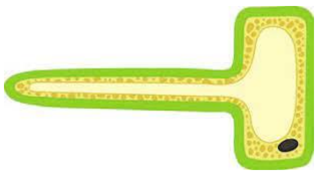
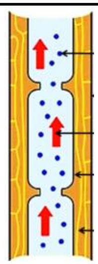
1000mm (millimetre) = 1m

10mm = 1cm (centimetre)

4. Animal Specialised Cells

Type of specialised cell	Function	Adaptations
Nerve cell 	Carry electrical impulses around the body	Lots of dendrites to make connections to other cells A very long axon that carries the electrical impulse from one place to another Contain lots of mitochondria to provide the energy needed to make special transmitter molecules, to carry impulses across gaps (synapses) between one nerve cell and the next
Muscle cells 	Contract and relax to allow movement	Contain special fibres that can slide over one another to allow the muscle to contract and relax Contain lots of mitochondria to provide energy for contraction Store glycogen which can be converted into glucose for respiration
Sperm cells 	Fertilise an egg cell	A tail for movement Middle section full of mitochondria to provide energy for tail to move Digestive enzymes in acrosome to digest a pathway into the egg A large nucleus containing half the genetic information needed to make an organism

5. Plant Specialised Cells

Specialised cell	**Function**	**Adaptations**
Root hair cell 	Absorb water and mineral ions	Large surface area available for water to move into cell by osmosis Large permanent vacuole that speeds up osmosis Lots of mitochondria that carry out respiration to provide the energy needed for active transport of mineral ions
Xylem cells 	Transport water and mineral ions from the roots to the highest leaves and shoots - always upwards.	When first formed xylem cells are alive but due to build-up of lignin the cells die and form long hollow tubes (vessels). The lignin makes the xylem vessels very strong and helps them withstand the pressure of water moving up the plant.
Phloem cells 	Transport sugars up and down the plant	End walls between cells break down to form sieve plates that allow water carrying dissolved sugars to move up and down the phloem. Neighbouring companion cells are packed with mitochondria to provide their energy needs.

6. Nucleus

Nucleus is found in animal and plant cells. → Chromosomes in the **nucleus** are made of DNA molecules. → **Chromosomes** are long strands of DNA that have been tightly wound together. → A **gene** is a section of DNA that codes for a protein. Proteins make up all parts of our cells

The nucleus contains **chromosomes** made of DNA molecules.
Each chromosome carries a large number of genes.

Gametes (sperm and egg cells) only have 1 set of chromosomes, so they have 23 chromosomes.

When human gametes come together in fertilisation, they form a zygote (fertilised egg cell) with 23 pairs of chromosomes (46 chromosomes).
Human body cells contain 23 pairs of chromosomes.

Biological structures in size order

Smallest ↓ Largest

- Gene
- Chromosome
- Nucleus
- Cell
- Tissue
- Organ

7. Stem Cells and Microscopes

Use the EVERY model to complete calculations:

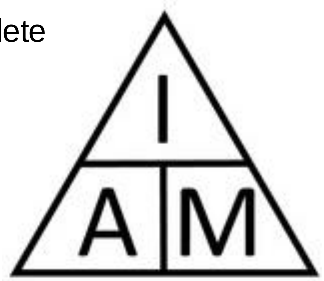
E = equation

V = values

E = enter results

R = result

Y = units



$$\text{Magnification} = \frac{\text{size of image}}{\text{size of real object}}$$

Magnification increases the size of the image.

Resolution increases the detail of the image.

Electron microscopes have higher magnification and higher resolution than **light microscopes.**

They have allowed scientists to study cells in much finer detail.

They have increased our understanding of sub-cellular structures such as mitochondria.

Type	Description
Adult stem cells	Adult cells which can form many types of cells, including blood cells.
Embryonic stem cells	Stem cells from embryos which divide and differentiate into specialised cells.
Differentiation	Specialisation of cells
Stem cells	Undifferentiated cells, capable of dividing to make lots of cells, and of differentiating to form specialised cells.
Meristem tissue	Tissue made up of stem cells in plants. It can differentiate into any type of plant cell, throughout the plant's life. Can be used to produce plant clones quickly and economically. Can be used to clone rare species. Can be used to clone plants with useful features, e.g. disease resistance.
Therapeutic cloning	Scientists can use embryo stem cells to make different types of human cells. The cells are not rejected by the patient's body, but some people have ethical or religious concerns.

8. Transport in and out of cells - diffusion

Diffusion: The overall movement of particles from high concentration to low concentration – they spread out.

Examples

Oxygen and carbon dioxide diffuse in and out of cells in **gas exchange.**

Urea moves out of cells into the blood plasma. It is a waste product. It goes to the kidney to be excreted.

Factors that affect the rate of diffusion

- The bigger the difference in concentrations, the faster diffusion is.
- The higher the temperature, the faster diffusion is.
- The bigger the surface area of the membrane, the faster diffusion is.

Diffusion and single celled organisms

Single celled organisms have a large surface area compared with their volume.

Diffusion is enough to get them all the molecules that they need.

Diffusion and larger organisms

Larger organisms have a small surface area compared to their volume.

They need exchange surfaces and transport systems to allow them to absorb enough oxygen and move it around the body.

Exchange surfaces in plants have:

1. a large surface area.
2. thin membranes, to provide a short diffusion path.

Exchange surfaces in animals have:

1. a large surface area
2. thin membranes, to provide a short diffusion path.
3. a good blood supply
4. good ventilation (they breathe)

9. Levels of organisation

Organism → Organ system → Organ → Tissue → Cell

Examples:
human
cat
ladybird
oak tree
aphids
sparrowhawk
tiger

Examples:
digestive system
immune system
nervous system
reproductive system
excretory system

Examples:
stomach
heart
lungs
liver
pancreas
small intestine
root (plant)

Examples:
epithelial tissue
endothelial tissue
muscle tissue

Examples:
sperm cell
egg cell
liver cell
epithelial cell
nerve cell
root hair cell
leaf palisade cell

Basics of organisation

Cells are the building blocks of all organisms.

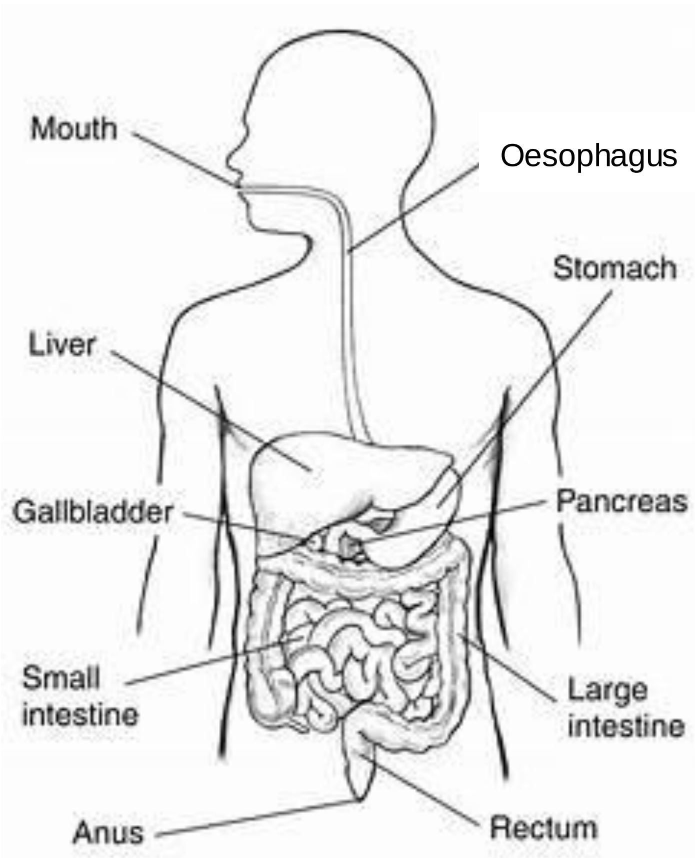
A tissue is a group of cells with a similar structure and function.

An organ is a group of tissues performing similar functions.

An organ system is a group of organs, which work together to perform a particular function.

10. Organisation of cells in the digestive system

The **human digestive system** is an example of an organ system in which several organs work together to digest and absorb food.

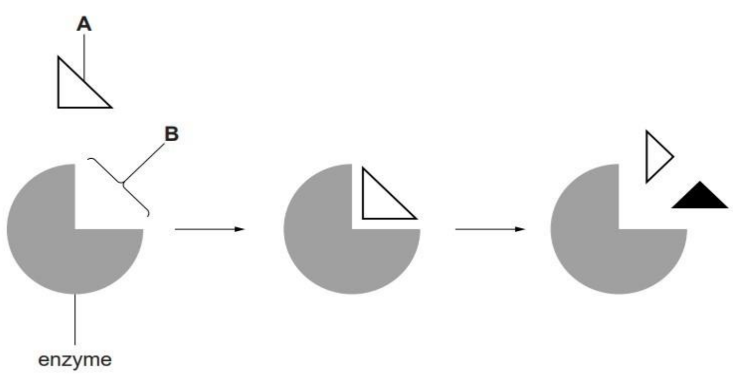


Organ	Function
Mouth	First stage of digestion, teeth break up food with mechanical digestion and salivary amylase breaks down food in chemical digestion.
Oesophagus	Transports food from the mouth to the stomach.
Stomach	Churns food and adds acid.
Small intestine	Adds digestive enzymes (amylase, lipase, and protease) and absorbs nutrients from the food.
Large intestine	Absorbs water, producing waste.
Rectum	Stores waste.
Anus	Waste passes out of the anus.
Liver	Produces bile. Bile neutralises stomach acid and emulsifies fats. Food does not pass through here.
Gall bladder	Stores bile which has been produced in the liver. Food does not pass through here.
Pancreas	Produces digestive enzymes: amylase, lipase, and protease. Food does not pass through here.

11. Enzymes in the digestive system

Digestive enzymes break down food into small soluble molecules that can be absorbed into the blood stream.

Digestive Enzyme	**Produced by**	**Converts…**	**Into…**
Amylase (carbohydrase)	Mouth, small intestine, pancreas	Starch (carbohydrates)	Sugar
Lipase	Small intestine, pancreas	Lipid (fat)	Glycerol + fatty acid
Protease	Stomach, small intestine, pancreas	Protein	Amino acids



Enzymes are **specific.**

They have a specific shape (**the active site**) which works on a specific substrate – like a lock and key.

If the active site changes shape, it no longer works. Changes in pH and temperature can **denature** – change the shape of the active site - so that it no longer works.

The products of digestion are used to build new carbohydrates, lipids and proteins.

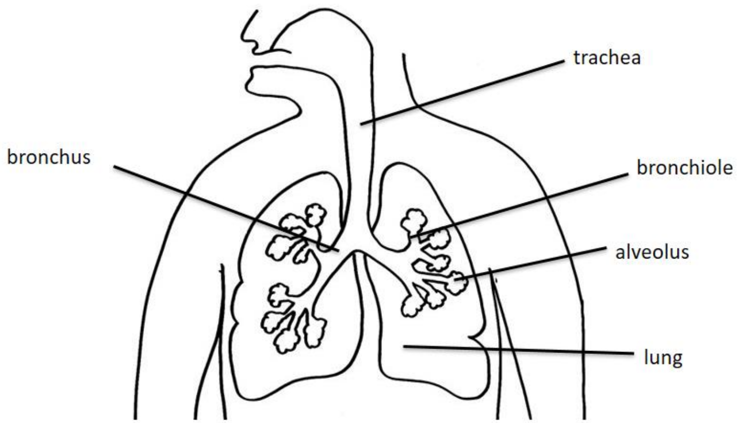
Glucose can also be respired.

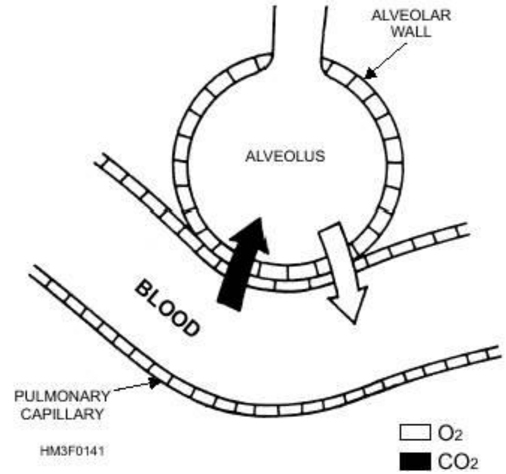
Bile is made in the liver and is stored in the gall bladder.

It is alkaline and neutralises the hydrochloric acid from the stomach.

It emulsifies fat to form small droplets, increasing the surface area. This makes fat digestion quicker.

12. The breathing system





The lungs provide a good exchange surface for oxygen:

1. **Large surface area** provided by alveoli.
2. **Thin walls** of alveoli (one cell thick) and blood supply (capillary), providing a short diffusion distance.
3. **Good blood supply** to transport the oxygen away from the lungs.
4. **Well ventilated** to supply more oxygen.

Air enters the body through the **mouth** and **nose**.

⇩

Air enters the **trachea**.

⇩

The trachea divides into two **bronchi**.
One **bronchus** enters each lung.

⇩

Each bronchus branches out into smaller tubes called **bronchioles**.
Air travels through these bronchioles.

⇩

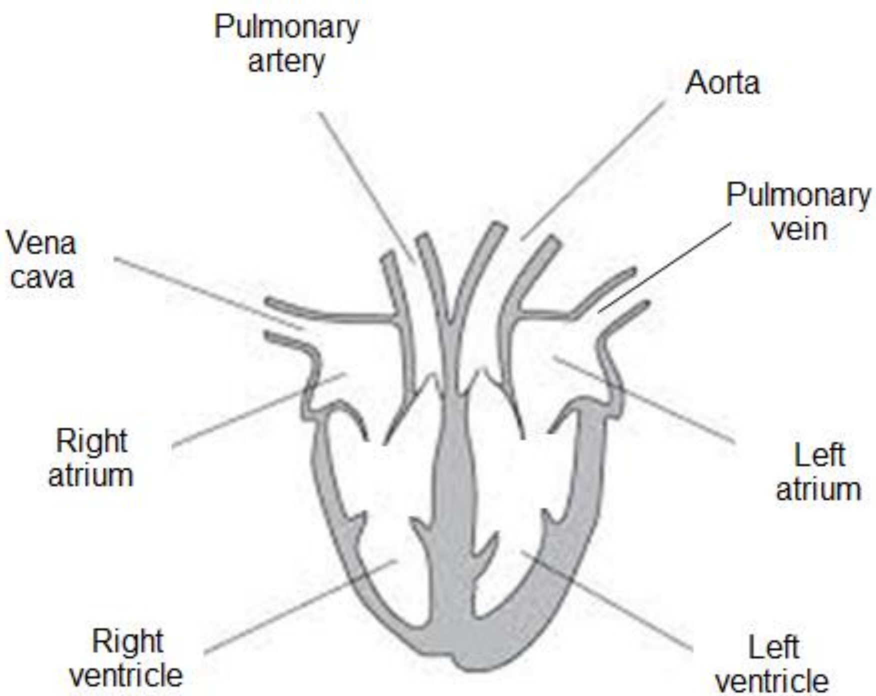
At the end of the bronchioles, the air enters one of the many millions of **alveoli** where gaseous exchange takes place

13. Organisation of cells in the circulatory system 1

The heart is an **organ**.

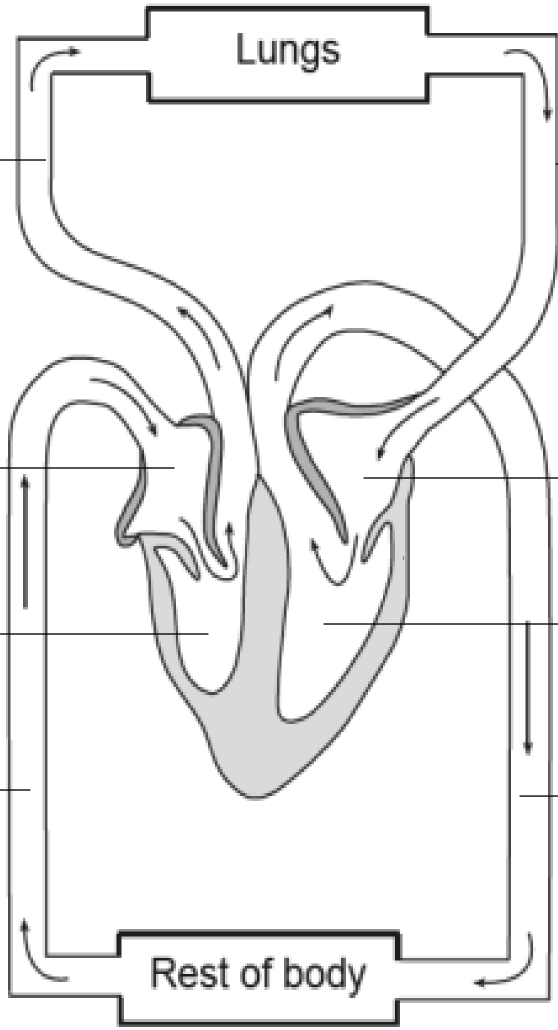
The function of the heart is to pump blood around the body.

Humans have a **double circulatory system**, which means that blood must pass through the heart **twice** to complete a full circuit of the body.



Organ	Function
Heart	Organ that pumps blood around the body in a double circulatory system.
Vena cava	Vein which brings blood from the body to the right atrium of the heart.
Right ventricle	Chamber which pumps blood to the lungs where gas exchange takes place.
Pulmonary artery	Artery takes blood from the right ventricle to the lungs.
Left ventricle	Chamber which pumps blood around the rest of the body
Pulmonary vein	Vein which brings blood from the lungs to the left atrium of the heart.
Aorta	The aorta takes blood from the left ventricle to the body.
Pacemaker	In the wall of the right atrium, controls heart rate.

14. Organisation of cells in the circulatory system 2

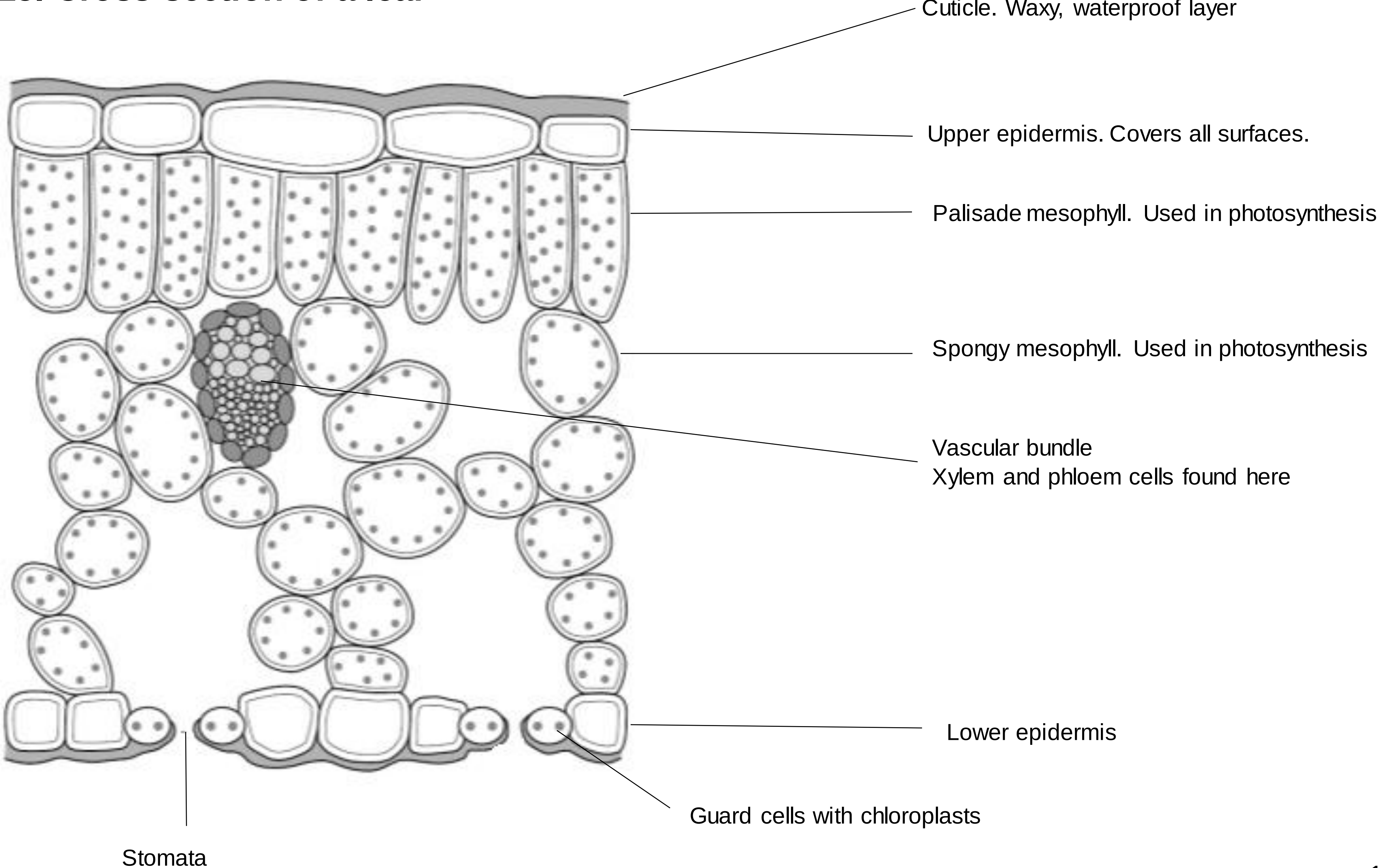


The blood is a tissue.

Blood component	Role
Plasma	Solution in which cells are suspended; carries dissolved food and hormones around the body
Red blood cells	Carry oxygen
White blood cells	Involved in immune response to fight pathogens
Platelets	Involved in blood clotting

Blood vessel	Role	Description
Artery	Carry blood away from heart	Walls contain lots of strong elastic tissue to withstand pressure
Capillary	Allow substances to diffuse into and out of the blood	Walls are one cell thick and include small holes to allow substances to move in and out easily
Vein	Carry blood to the heart	Have valves to keep blood flowing in one direction only

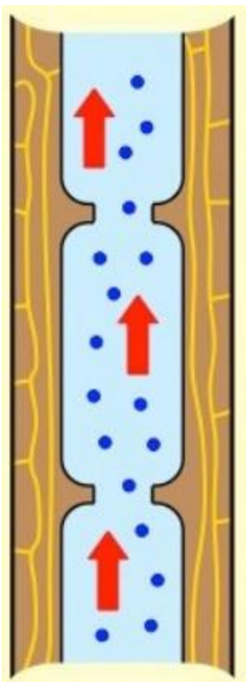
15. Cross section of a leaf



16. Organisation of cells in plants

Water is absorbed (by osmosis) by **root hair cells** that have a large surface area.
The root hair cells also absorb mineral ions (by active transport).

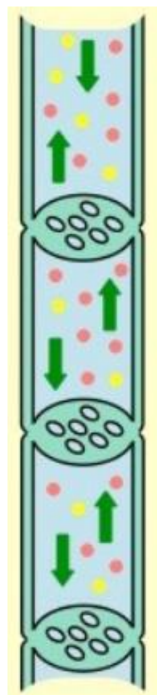
Xylem Cells



Transports water and mineral ions from the roots to the stems and leaves.
Made of hollow tubes, strengthened by lignin.

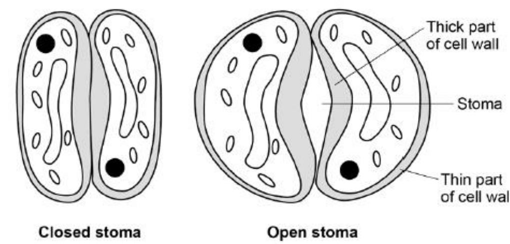
Transpiration is the transport of water and minerals up the xylem of a plant, and the evaporation of water through the stomata.
Transpiration is increased by
- Increased temperature
- Increased air movement
- Increased light intensity
- Decreased humidity

Phloem Cells



Translocation is the transport of sugars in the phloem, to all parts of the plant.
The leaves make sugars through photosynthesis.
The **phloem** transports dissolved sugars from the leaves to the rest of the plant for respiration or for storage of starch.
Phloem is made of tubes of elongated cells.
Cell sap (dissolved sugars) moves from one phloem cell to the next through pores in the end walls.

Stomata and Guard Cells



The **stomata** (small holes in the underside of the leaf) are needed for gas exchange in the leaf.
Water is also lost to the surroundings through the stomata.
To reduce water loss, **guard cells** can change the size of the stomata.

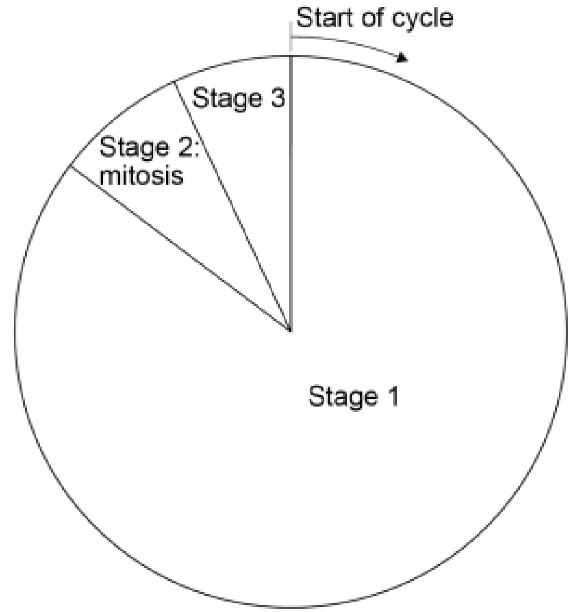
17. Coronary Heart Disease

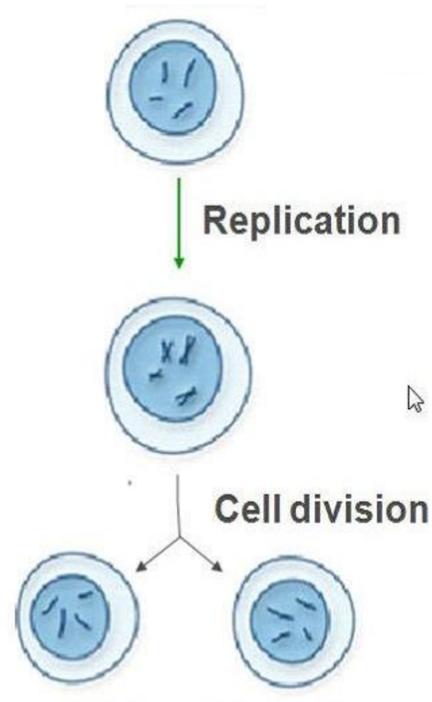
Term	Definition
Disease	dis-ease (not at ease; something in our body or mind is not working correctly)
Coronary Heart Disease	a non-communicable disease (you can't catch it)
Coronary arteries	supply the heart muscle with oxygen and glucose
Coronary heart disease	The coronary arteries have layers of fatty material building up in them. They get narrower. Less blood can flow through the coronary arteries, so the heart muscle lacks oxygen.

Treatment	Description
Statins	Tablets used to reduce blood cholesterol. They slow down the rate of fatty material build up.
Stents	Used to keep the coronary arteries open.
Heart valve replacement	Valves keep blood flowing through the heart in the right direction. Sometimes the valves don't open fully or become leaky. This prevents blood flowing through the heart properly. The patient becomes out of breath and lacks energy. Faulty heart valves can be replaced with new biological valves (from a donor) or mechanical valves.
Heart failure	Can be treated with a new heart and lungs. The heart would come from a donor. Mechanical hearts can be used to keep the patient alive whilst waiting for a heart transplant.

18. Cell Cycle: Mitosis

Stage of the cell cycle	Events
1	The cell grows. The DNA replicates to form two copies of each chromosome. New mitochondria and ribosomes are made.
2	**Mitosis**: one set of chromosomes is pulled to each end of the cell. The nucleus divides.
3	The cytoplasm and cell membranes divide. There are now two identical cells.





Uses of cell division by mitosis

1. Growth
2. Repair of tissues
3. Asexual reproduction

19. Cell Cycle: Mitosis and Cancer

Stage of the cell cycle	**Events**
1	The cell grows. The DNA replicates to form two copies of each chromosome. New mitochondria and ribosomes are made.
2	Mitosis: one set of chromosomes is pulled to each end of the cell. The nucleus divides.
3	The cytoplasm and cell membranes divide. There are now two identical cells.

Uses of cell division by mitosis

1. Growth
2. Repair of tissues
3. Asexual reproduction

Cancer is the result of uncontrolled growth and division of cells. This is caused by a change in the genetic material of the cell.

Benign tumours are growths of abnormal cells.
They are contained in one area, usually within a membrane. They do not invade other parts of the body.

Malignant tumour cells are cancers.
They invade neighbouring tissues and spread around the body in the blood, where they form secondary tumours.
Lifestyle factors and genetic factors can be risk factors for cancers.

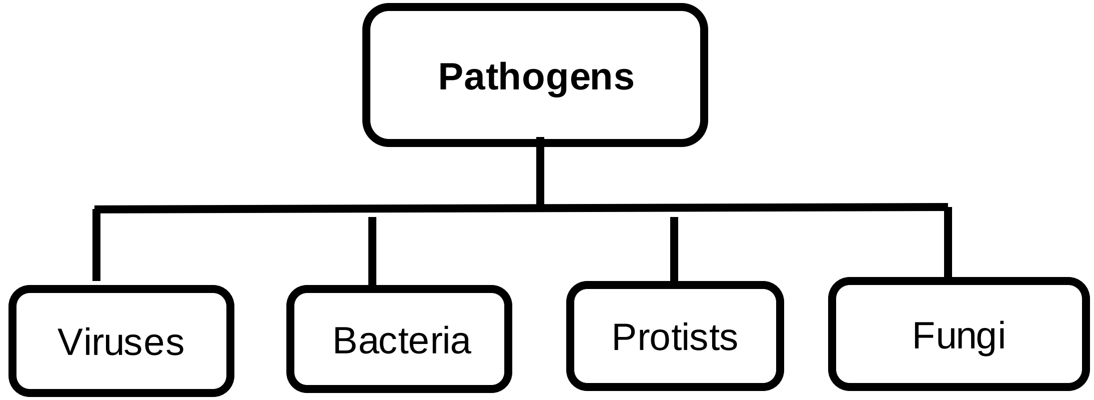
20. Communicable diseases: pathogens

Communicable diseases are diseases caused by pathogens – they can spread from one organism to another.

Pathogens are organisms that cause infectious disease.
They can be viruses, bacteria, protists or fungi.
Pathogens may infect plants or animals.
Pathogens can spread by direct contact, water or by air.

Bacteria reproduce rapidly inside the body.
Bacteria produce poisons/toxins that damage tissues and make us feel ill.

Viruses reproduce rapidly inside the body.
Viruses live and reproduce inside cells, causing cell damage.



21. Communicable diseases: viruses

Pathogen	Disease	Transmission	Symptoms	Treatment or prevention
Virus	Measles	Sneezing and coughing produces droplets containing the virus; these droplets can be inhaled by others.	Fever and red skin rash. It can be fatal if there are complications.	Most young children are vaccinated against measles.
Virus	HIV/AIDs	Sexual contact or exchange of body fluids such as blood.	Flu-like illness, which then attacks the body's immune cells. Late stage HIV, known as AIDS, happens when the immune system is so damaged that it cannot deal with infections or cancers	treated with antiretroviral drugs.
Virus	Tobacco mosaic virus (TMV)	By direct contact	A distinctive mosaic pattern of discoloration on the leaves. The leaves can't photosynthesise as well, which affects the growth of the plant.	Remove infected plants; wash hands when handling plants to prevent transfer from one to another

22. Communicable diseases: bacteria, fungi and protists

Pathogen	Disease	Transmission	Symptoms	Treatment or prevention
Bacterium	Salmonella (food poisoning)	Undercooked chicken, or contamination of surfaces from raw chicken	Fever, abdominal cramps, vomiting and diarrhoea, caused by the bacteria and the toxins from the bacteria.	Poultry (chicken, turkey and ducks) are vaccinated against salmonella to control the spread
Bacterium	Gonorrhoea	sexually transmitted disease	Thick yellow or green discharge from the vagina or penis; as well as pain when urinating.	Antibiotics, although there are many resistant strains. Barrier methods of contraception can reduce the spread.
Fungus	Rose black spot	by wind or water	Purple or black spots develop on leaves. The leaves turn yellow and drop off. The leaves don't photosynthesise well, which affects the growth of the plant.	Fungicides and removing and destroying the affected leaves.
Protist	Malaria	Spread by mosquito bites.	Recurrent (repeating) episodes of fever. It can be fatal.	Prevented by stopping mosquitos from breeding, and by avoiding being bitten e.g. with a mosquito net.

23. Human defences against pathogens

Humans have several **non-specific defences** against pathogens.

These defences are general i.e. they work on most pathogens.

Skin is a physical barrier.

Nose, trachea, bronchi contains mucus and hairs to trap pathogens.

Stomach contains acid which kills pathogens.

If a pathogen enters the body, the **immune system** tries to destroy it.

White blood cells kill pathogens by:

1. Phagocytosis (absorbing the pathogen and destroying it)
2. Antibody production (they make pathogens stick together)
3. Antitoxin production

A **vaccine contains** small quantities of dead or inactive pathogen, which are injected into the body

↓

Stimulates the white blood cells to produce antibodies.

↓

Memory cells remain in the body.

↓

If the same pathogen re-enters the body, the white blood cells produce antibodies **quickly and in greater numbers**, preventing infection.
The person shows no symptoms.

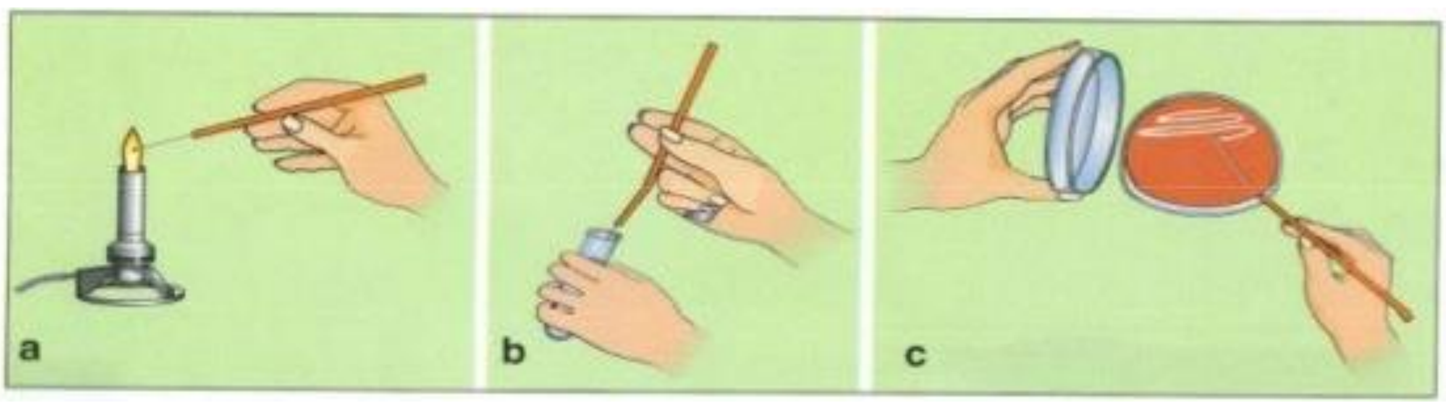
Benefits of Vaccinations:

Prevent infection in individuals (see above).

Prevent the spread of infection from one person to another.

24. Preparing uncontaminated cultures of bacteria

1. Sterilise Petri dishes and culture media before use.
2. Sterilise an inoculating loop by passing through a flame.
3. Dip the cool inoculating loop into the bacterial culture.
4. Lift the lid of the dish as little as possible and for as short a time as possible.
5. Zigzag the loop over the surface of the agar in the Petri dish.
6. Secure the lid with adhesive tape in strips (not all the way around). This allows oxygen into the plate for aerobic bacteria. It also discourages the growth of harmful anaerobic bacteria.
7. Incubate upside down (to prevent condensation) at 25^0C (to prevent growth of microbes harmful to people).



25. Medical Drugs

Antibiotics are medicines that help to cure bacterial disease. They kill infectious bacteria inside the body. An example is penicillin. It is important that the right antibiotic is used for the right bacteria. Antibiotics cannot be used to kill viruses. Resistant strains of bacteria have evolved – e.g. MRSA – these are not affected by antibiotics.

Painkillers do not kill pathogens, but they do treat the symptoms of disease.

Antivirals are difficult to produce. They tend to damage body tissues as well as kill the virus.

Drug	Source	Purpose
Digitalis	Foxgloves	Heart disease
Aspirin	Willow	Painkiller
Penicillin	Penicillium mould	Antibiotic (discovered by Alexander Fleming)

New drugs

Traditional drugs came from plants and microorganisms.

New drugs are synthesised by chemists in the pharmaceutical industry. However, the starting point may still be a chemical extracted from a plant.

Testing new drugs

New medical drugs must be tested and trialled to check that they are safe and effective.

They are tested for **toxicity**, **efficacy** (does it work**)**, and **dose.**

Preclinical trials use cells, tissues and animals

Clinical trials use healthy volunteers and patients

1.Very low doses are given at the start.

2.If it is safe, further clinical trials are done to find the optimum dose.

3.In double blind trials, some patients are given a placebo.

A **placebo** looks like the drug but contains no drug.

In a **double blind trial**, neither the scientist nor the patient knows if they have been given the drug, or the placebo.

26. Monoclonal Antibodies

What are monoclonal antibodies?

Monoclonal antibodies are produced from a single clone of cells.

The antibodies are specific to one binding site on one protein antigen, and so are able to target a specific chemical or specific cells in the body.

To produce monoclonal antibodies

1. A protein antigen is injected into a mouse.
2. The mouse produces lymphocytes (a type of white blood cell), which make antibodies against this particular antigen.
3. The lymphocytes are extracted from the mouse.
4. The lymphocyte is fused with a tumour cell to make a hybridoma cell.
5. Single hybridoma cells are cloned to make large numbers of identical cells, making identical antibodies.
6. A large quantity of antibody can then be collected and purified.

Problems:

They create more side effects than expected, so have not yet been used as widely as everyone hoped.

How monoclonal antibodies work in the body

1. Monoclonal antibody is specific to the antigen e.g. HIV
2. Monoclonal antibodies attach to the (HIV) antigens
3. Virus (HIV) genetic material cannot enter cell

Uses of monoclonal antibodies

- In pregnancy testing
- To measure the levels of hormones and other chemicals in blood
- To locate or identify specific molecules in a tissue or a cell, by binding them with a fluorescent dye
- To treat some diseases – for cancer, the monoclonal antibody can be bound to a radioactive substance, a toxic drug or a chemical, which stops cells growing and dividing. It delivers the substance to the cancer cells, without harming other cells.

27. Health Issues

Health is the state of physical and mental wellbeing.
Health may be affected by diet, stress and life situations.

Diseases often interact:

Defects in the immune system increase the chance of infectious disease.

Viruses living in cells can trigger cancers.

Pathogens can cause immune reactions; the immune reactions can then trigger allergies, such as asthma and skin rashes.

Severe physical illness can lead to mental illness e.g. depression.

Lifestyle has an effect on some non-communicable diseases
Many diseases are caused by the interaction of a number of risk factors.

Examples include:

- Poor diet, smoking and lack of exercise are risk factors for cardiovascular disease.
- Obesity is a risk factor for type 2 diabetes.
- Alcohol can affect liver and brain function.
- Smoking is a risk factor for lung disease and lung cancer.
- Smoking and alcohol have effects on unborn babies.
- Carcinogens, including ionising radiation, are risk factors for cancer.

28. Plant diseases

Causes of plant disease

Viruses, bacteria, fungi, insects

Nitrate deficiency causes stunted growth (as nitrate ions are needed to make amino acids, and amino acids are needed to make proteins. Proteins are needed for growth)

Magnesium deficiency causes chlorosis (yellow leaves) as they are needed to make chlorophyll

Detection of plant disease

Stunted growth

Spots on leaves

Areas of decay (rot)

Growths

Malformed stems or leaves

Discolouration

Presence of pests

Identification of a disease

Refer to a gardening manual or website

Take infected plant to a lab to identify the pathogen

Using testing kits that contain monoclonal antibodies

Plant defence responses

Physical defences

Cellulose cell walls

Tough waxy cuticle on leaves

Layers of dead cells around stems (bark on trees) which fall off

Chemical defences

Antibacterial chemicals

Poisons to deter herbivores

Mechanical adaptations

Thorns and hairs deter animals

Leaves which droop or curl when touched

Mimicry to trick animals

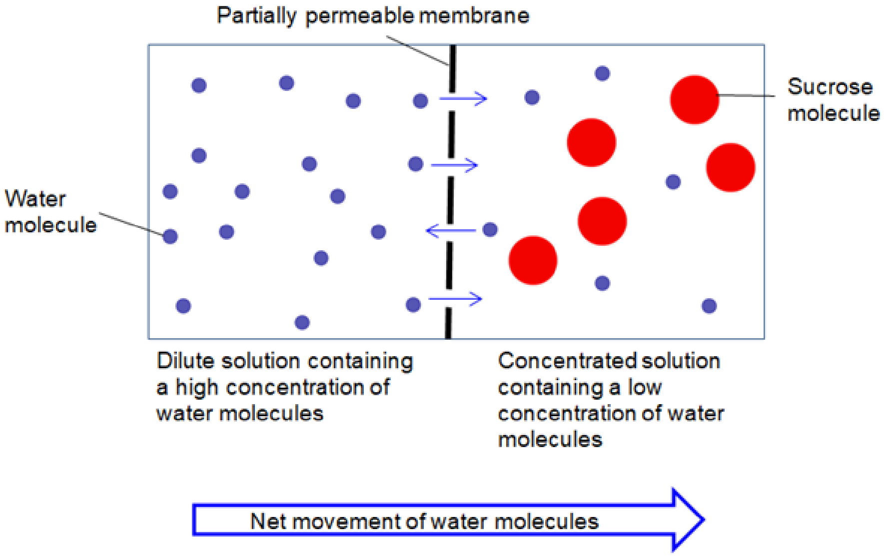
29. Transport across membranes – osmosis and active transport

Osmosis is the **diffusion** of **water** through a partially permeable membrane.

Water moves from a **dilute solution to a concentrated solution.**

Cell membranes are partially permeable.

This means that they allow some things to cross e.g. water, but not other things e.g. sugar.

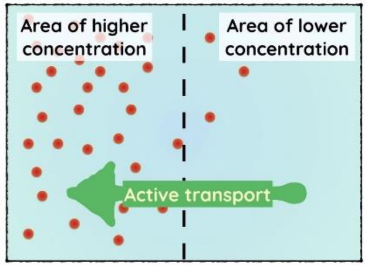


Active Transport is the movement of substances from a **low concentration to a high concentration.**

This is the opposite of diffusion.

Active transport needs **energy** from respiration.

This is because it moves substances against the concentration gradient; from **low to high** concentration.



Active transport is used by plant root hairs to move mineral ions from the soil to the plant. The mineral ions are needed for growth.

Active transport is used in the small intestine to move sugar molecules into the blood. Sugar molecules are used for cell respiration.

30. Photosynthesis

Photosynthesis

carbon dioxide + water → glucose + oxygen

We remember it as COW → GO

$6CO_2 + 6H_2O \rightarrow C_6H_{12}0_6 + 6O_2$

Light is needed to provide the energy for photosynthesis.

Photosynthesis is endothermic.

During photosynthesis, energy is transferred from the environment to chloroplasts.

Rate of photosynthesis

The rate of photosynthesis is **increased** when:

1. The light intensity increases
2. The carbon dioxide concentration increases
3. The amount of chlorophyll increases
4. The temperature increases*

*if the temperature increases too much, enzymes that control photosynthesis are denatured, and the rate decreases.

Uses of glucose from photosynthesis

The glucose produced in photosynthesis may be:

Used for **respiration**

Converted into insoluble **starch** for storage

Used to produce amino acids for **protein** synthesis

Used to produce **cellulose**, to strengthen the cell wall

Used to produce **fat** or oil for storage

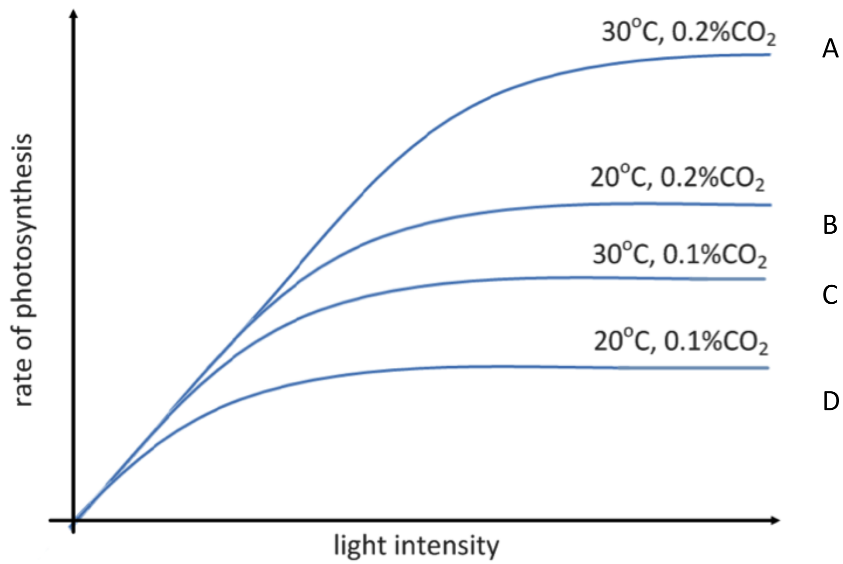
(RSPCF)

To produce amino acids, plants also use nitrate ions.

Nitrate ions are absorbed from the soil.

They are absorbed by root hair cells by active transport.

31. Limiting Factors in Photosynthesis: Higher only



Why does this matter?

Limiting factors are important in the economics of enhancing the conditions in greenhouses to gain the maximum rate of photosynthesis while still maintaining profit.

Carbon dioxide concentration, temperature, light intensity and the amount of chlorophyll all affect the rate of photosynthesis.

Any of these factors may be the factor that limits the rate of photosynthesis. For example, if there is plenty of carbon dioxide, but light intensity is low, then light intensity will be the limiting factor.

You will need to be able to tell from a graph which factor is the limiting factor.

At first, as light intensity increases, the rate of photosynthesis increases, meaning that light intensity is the limiting factor.

Then, light intensity continues to increase, but photosynthesis does not. This means that there is another limiting factor.

By comparing line C and D, or line A and B, we can see that when the temperature increases, the rate of photosynthesis increases. This means that temperature is a limiting factor.

By comparing line A and C, or line B and D, we can see that when the concentration of carbon dioxide increases, the rate of photosynthesis increases. This means that concentration of carbon dioxide is a limiting factor.

32. Respiration

Cellular respiration happens continuously in living cells.

It is exothermic.

It transfers all the energy needed for living processes.

It can be aerobic (using oxygen) or anaerobic (without oxygen).

Organisms need energy for

- Chemical reactions to build larger molecules
- Movement
- Keeping warm

Aerobic respiration

Glucose + oxygen → carbon dioxide + water

Remember it as GO → COW

$C_6H_{12}0_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Anaerobic respiration in muscles

Glucose → lactic acid

Anaerobic respiration transfers much less energy than aerobic respiration, as oxidation is incomplete.

Anaerobic respiration in plants and yeast cells

Glucose → ethanol and carbon dioxide

Anaerobic respiration in yeast cells is called fermentation.

It is important in the manufacture of bread and alcoholic drinks.

33. Response to exercise and metabolism

Response to exercise

During exercise, the body needs more energy.

The heart rate, breathing rate, and breath volume increase to supply the muscles with more oxygenated blood.

If muscles do not get enough oxygen, anaerobic respiration occurs.

Problems:

Incomplete oxidation of glucose means that less energy is released.

Lactic acid is produced.

An oxygen debt is caused.

Muscles become fatigued and stop contracting efficiently.

After exercise (Higher only)

Lactic acid is transported by the blood from the muscles to the liver

It is converted back to glucose

This conversion requires oxygen.

The amount of oxygen required to convert the lactic acid back to glucose is called the **oxygen debt.**

Metabolism

Metabolism is the total of all the reactions in a cell, or in the body.

The energy transferred by respiration in cells is used by the organism for the constant enzyme-controlled reactions that synthesis new molecules. These reactions are known as metabolism.

Metabolism includes:

respiration

glucose → starch/ glycogen/ cellulose

glucose + nitrate ions → amino acids → proteins

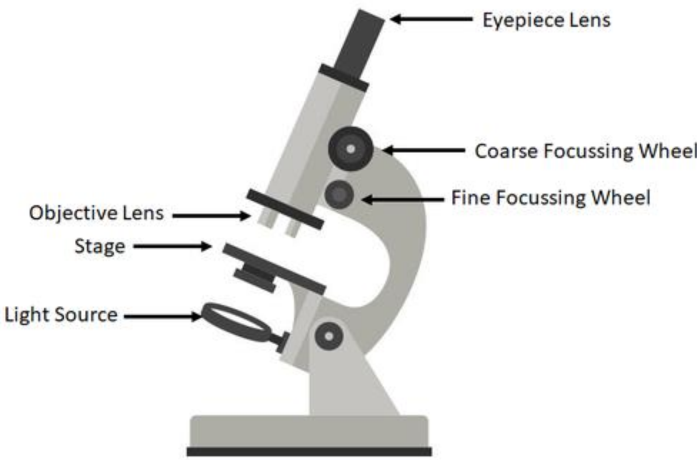
glycerol + fatty acids → lipids

breakdown of excess proteins → urea for excretion

34. Required Practicals 1 – Microscopy and Food Tests

Using a Microscope

1. Light on
2. Platform (stage) high
3. Lowest magnification objective lens first
4. Coarse focus first, then fine focus



Rules for Biological Drawings

- Sharp pencil
- Smooth lines
- Ruler for label lines
- No arrowheads
- Add magnification (multiply eyepiece lens by objective lens)

Food tests

Food	Test	Positive result
Starch	add iodine solution	turns black
Sugars	add Benedict's solution → heat	makes (orange) precipitate
Protein	add Biuret solution	turns purple
Fats (lipids)	add ethanol → shake → add water → shake	cloudy white emulsion

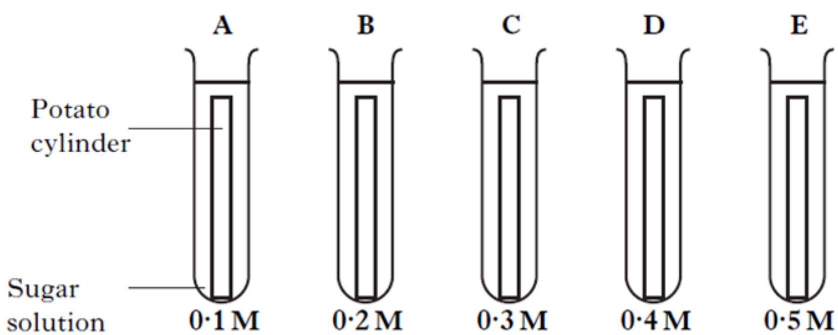
35. Required Practical 2 - Osmosis

Investigate the effect of concentration of salt or sugar solutions on mass of potato

IV: concentration of salt (or sugar) solution (need at least 5 different concentrations)

DV: change in mass of potato cylinders

CV: volume of salt solution; surface area of potato; time in solution; all potato skin removed; method of drying the potato



Method

1. Use a cork borer to cut 5 pieces of potato; make them the same length.
2. Place a known volume of each salt solution into each of 5 boiling tubes.
3. Weigh each potato cylinder.
4. Add one potato to each boiling tube, recording the mass for each.
5. After 30 minutes, remove each piece of potato; dry by rolling three times on a paper towel.
6. Reweigh each potato piece.
7. Calculate the change in mass of the potato and the % change in mass.
8. Plot a graph of salt concentration against % change in mass.

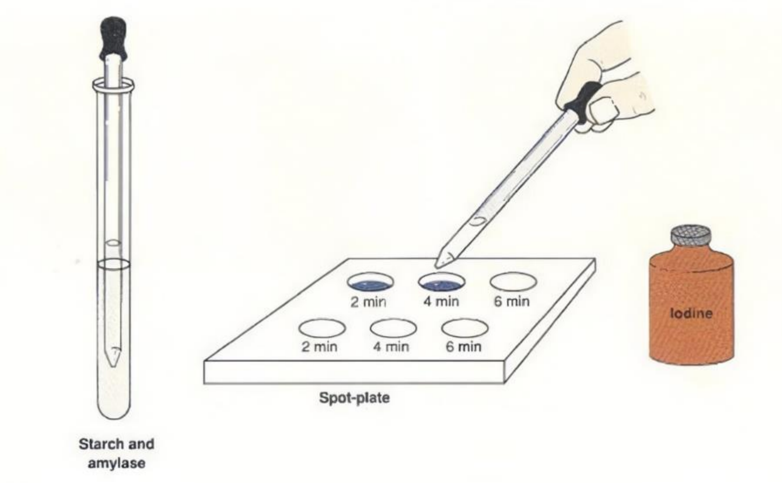
36. Required Practical 3 - Enzymes

Investigate the effect of pH on the reaction of amylase enzyme

IV: pH (change using at least 5 different buffer solutions)

DV: time taken to digest starch (measured as the time it takes for a sample of the mixture **not** to turn black when mixed with iodine solution)

CV: volume and concentration of amylase solution; volume and concentration of starch solution; temperature; time for samples



Method:

1. Place known volume of starch solution into a boiling tube.
2. Place known volume of amylase solution into the boiling tube.
3. Stir using a glass rod.
4. Take a sample of mixture and place onto a spot tile.
5. Add a drop of iodine solution to the spot tile; repeat every 30s; record the time taken for the mixture not to turn black.
6. Repeat steps 1 – 5 for at least 5 different pHs.

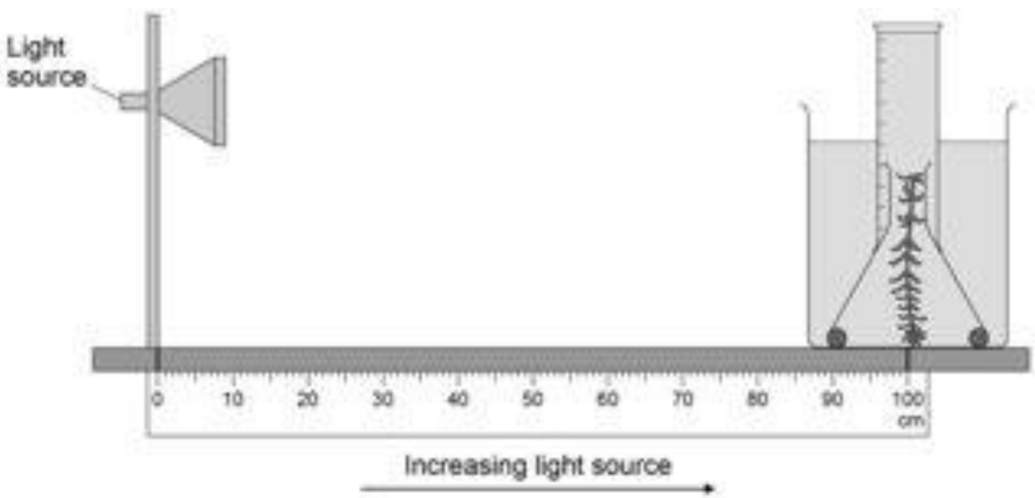
37. Required Practical 4 - Photosynthesis

Investigate the effect of light intensity on the rate of photosynthesis

IV: light intensity (using at least 5 different distances from lamp to pondweed)

DV: number of bubbles released from pondweed per minute

CV: concentration of carbon dioxide; power of the bulb; no background light; time; length of pondweed



Method:

1. Cut a piece of pondweed, with a diagonal cut.
2. Place cut end uppermost into a boiling tube.
3. Immerse in water or a dilute solution of sodium hydrogen carbonate (to provide carbon dioxide).
4. Place a lamp 10cm away from the boiling tube; turn off all other lights.
5. When bubbles appear, start to count bubbles for one minute.
6. Using same pondweed, repeat the experiment, increasing the distance from the lamp by 10cm each time, for at least 5 distances.
7. Plot a graph of distance from the lamp against number of bubbles produced per minute.

38. Required Practical 5: Microbiology

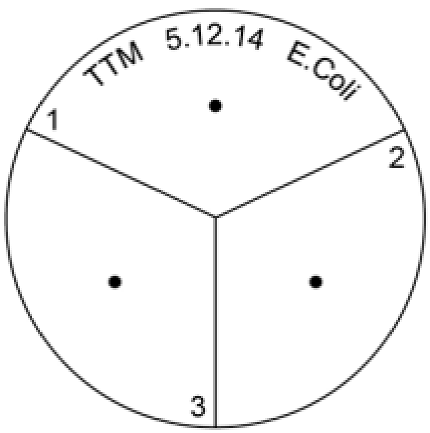
Preparation of Uncontaminated Cultures of Bacteria

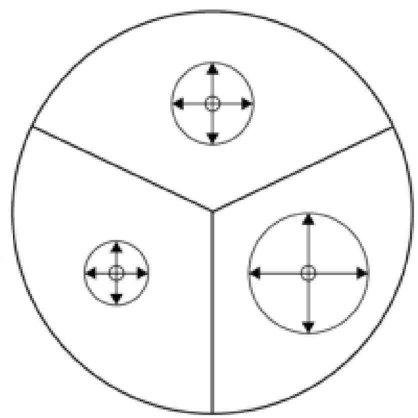
1. Sterilise Petri dishes and culture media before use.
2. Sterilise an inoculating loop by passing through a flame.
3. Dip the cool inoculating loop into the bacterial culture.
4. Lift the lid of the dish as little as possible and for as short a time as possible.
5. Zigzag the loop over the surface of the agar in the Petri dish.
6. Secure the lid with adhesive tape in strips (to allow oxygen into the plate, whilst ensuring that other contaminants can't enter).
7. Incubate upside down (to prevent condensation) at 25^{0}C (to prevent growth of microbes harmful to people).

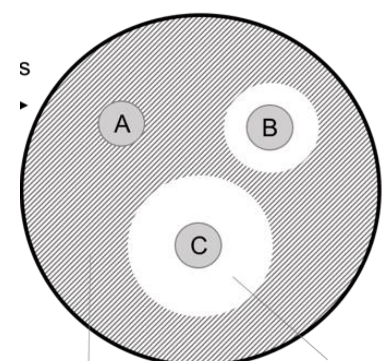
Effectiveness of Antibiotics

1. Prepare an uncontaminated plate of bacteria.
2. Sterilise forceps by dipping in ethanol, then passing through a flame.
3. Allow to cool, then pick up a disc pre-soaked in antibiotic.
4. Place the disc on the agar; repeat for two other antibiotics and a disc dipped in sterilised water (a control).
5. Incubate at 25^{0}C for 48 hours.
6. Measure diameter of the clear area around the disc.

The larger the clear zone, the more effective the antibiotic for that type of bacteria.







Biology Paper 2 (Triple)

39. Homeostasis
40. Reflex actions
41. Endocrine System
42. The Brain
43. The eye
44. Accommodation in the eye
45. Correction of eye problems
46. Control of blood glucose
47. Diabetes
48. Control of body temperature
49. Adrenaline, thyroxine
50. Control of water and nitrogen balance 1
51. Control of water and nitrogen balance 2
52. Hormones in human reproduction
53. Hormones to treat infertility
54. Contraception
55. Plant hormones
56. Adaptation and independence
57. Competition
58. Organisation of an ecosystem
59. Trophic levels in an ecosystem
60. Recycling materials: carbon
61. Recycling materials: water, and decomposition
62. Biodiversity and human interaction 1
63. Biodiversity and human interaction 2
64. Food production
65. Variation
66. Chromosomes
67. DNA
68. Coding for proteins
69. Cell division: mitosis
70. Cell division: meiosis
71. Reproduction: asexual and sexual
72. Genetic crosses: definitions and inheritance
73. Genetic crosses: Punnett squares
74. Evolution
75. Speciation
76. Evidence for evolution: fossils, extinction, resistant bacteria
77. History of ideas – Darwin and Wallace
78. History of ideas – Mendel
79. Selective breeding
80. Cloning
81. Genetic engineering
82. Classification
83. Required practical 6: Human reaction time
84. Required practical 7: Plant responses
85. Required practical 8: Decay
86. Required practical 8: Field investigations 1
87. Required practical 8: Field investigations 2
88. Maths in Science 1
89. Maths in Science 2

39. Homeostasis

Homeostasis is maintaining constant internal conditions, so that cells can survive.

Cells in the body can only survive within narrow physical and chemical limits. Outside of these limits, enzyme action and all cell functions stop.

Homeostasis maintains optimal conditions.
This includes
Blood glucose concentration
Body temperature
Water levels.

Homeostasis is **automatic.**
There are two automatic control systems in the body.
1. The nervous system
2. The endocrine system (chemicals called hormones).

The nervous system enables humans to react to changes in surroundings and to coordinate behaviour.
Automatic control systems have three parts.

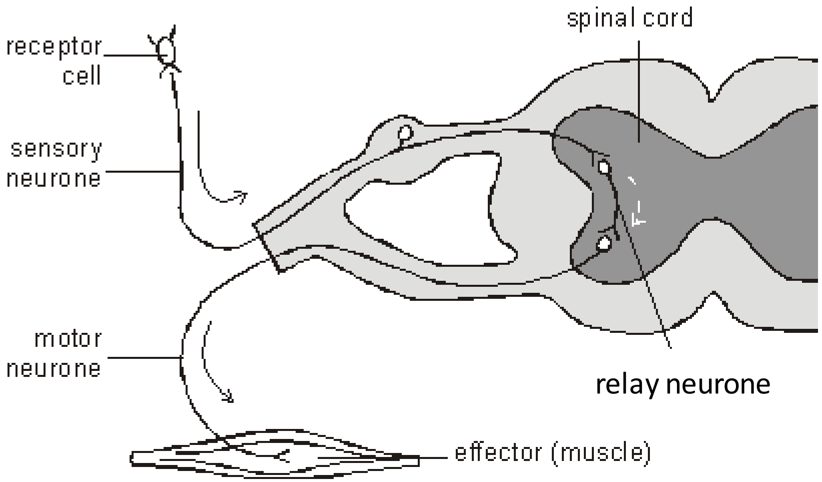
1. **Receptors**: cells that detect stimuli, and pass this information along neurones as electrical impulses.
2. **Coordination centre** is the central nervous system, which receives and processes information from receptors. The CNS sends instructions to…
3. **Effectors** that make changes to restore optimum levels, e.g. muscles or glands.

40. Reflex Actions

Reflexes are quick and short lasting.

They do not involve the conscious part of the brain.

Gaps between neurones are called synapses.



stimulus

⬇

receptor

⬇

sensory neurone

⬇

synapse

⬇

relay neurone

⬇

synapse

⬇

motor neurone

⬇

effector

⬇

response

41. The Endocrine System

Examples of endocrine glands

Pituitary gland

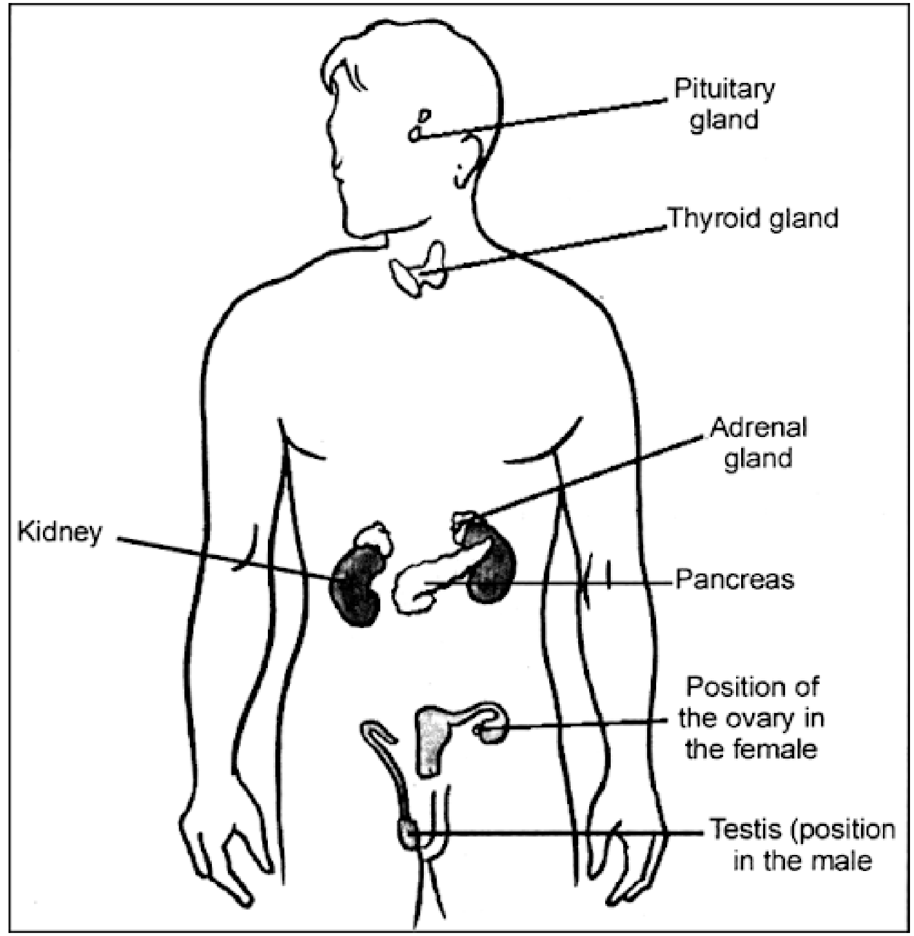
Thyroid

Pancreas

Adrenal gland

Ovary

Testes



The Endocrine System

The endocrine system is made of glands.

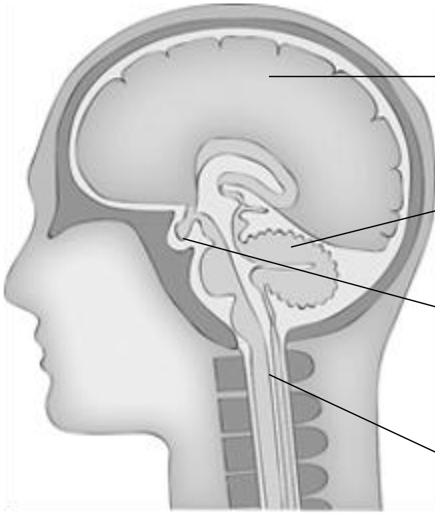
Glands secrete (release) chemicals called hormones.

Hormones are secreted straight into the blood stream.

The blood carries the hormone to a target organ where it produces an effect.

Compared to the nervous system, the effects are slower but last longer.

42. The Brain



Part of brain	function
Cerebral cortex	Thought, language
Cerebellum	Movement
Pituitary gland	The ‘master gland’. Secretes several hormones into the blood in response to body conditions. These hormones act on other glands. These glands release other hormones, bringing about more effects.
Medulla	Involuntary control of breathing, swallowing, digestion

The Brain

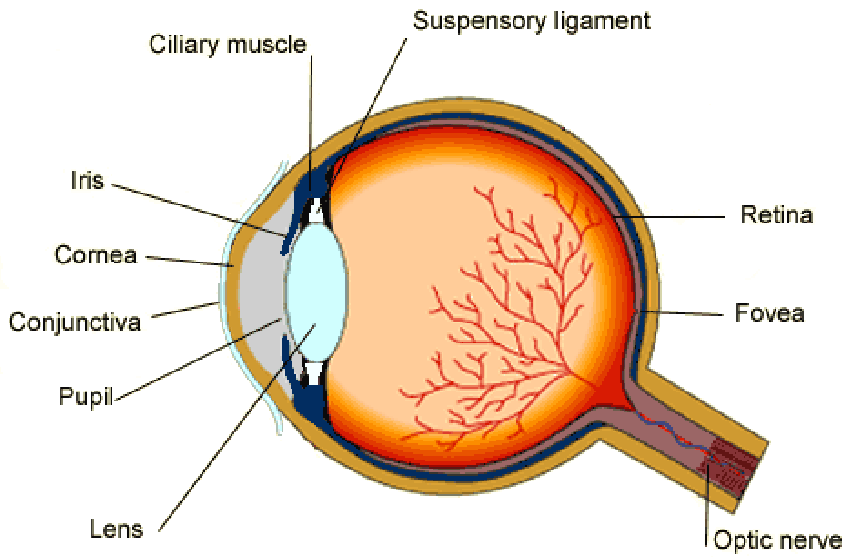
Made of billions of interconnected neurones that control complex behaviour.

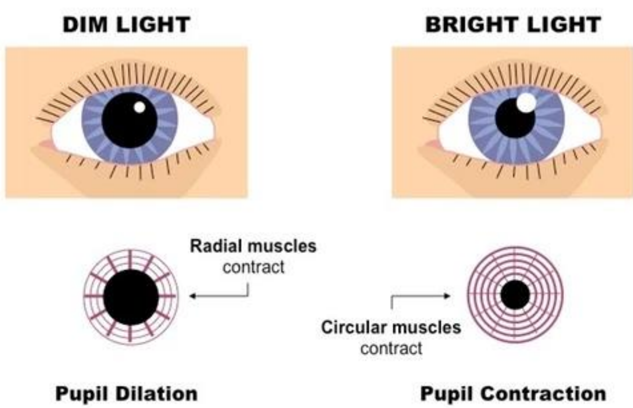
Neuroscientists map regions to functions by studying patients with brain damage, electrically stimulating parts of the brain, using MRI scanning.

The complexity makes investigation and treatment difficult.

43. The Eye

The eye is a sense organ containing receptors to light intensity.





Part	Role
cornea	transparent layer at the front of the eye; refraction occurs here
Iris	coloured part of eye; contains radial and circular muscles
pupil	gap which allows light into the eye
lens	refracts the light onto the retina
ciliary muscles	control the shape of the lens
suspensory ligaments	support the lens
retina	contains receptors; rods detect light, cones detect colour
optic nerve	sensory neurones that transmit impulses from eye to brain
sclera	tough outer covering

Adaptation to different light conditions uses the muscles of the iris

Dim light: radial muscles contract, circular muscles relax, pupil gets bigger

Bright light: radial muscles relax, circular muscles contract; pupil gets smaller.

44. Accommodation in the eye

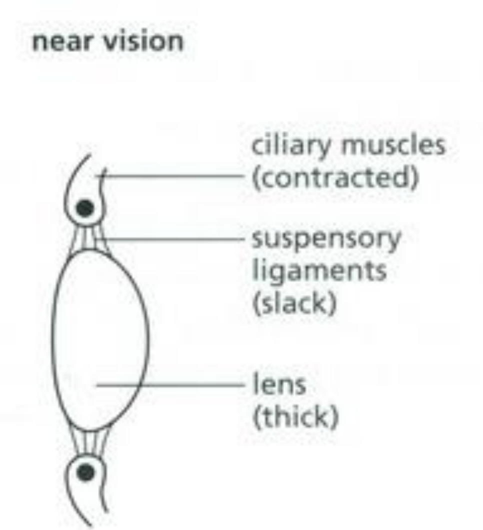
Accommodation: changing the shape of the lens to focus on near or distant objects.

Near objects:

Ciliary muscles contract

Suspensory ligaments loosen

Lens is thicker and refracts light more strongly

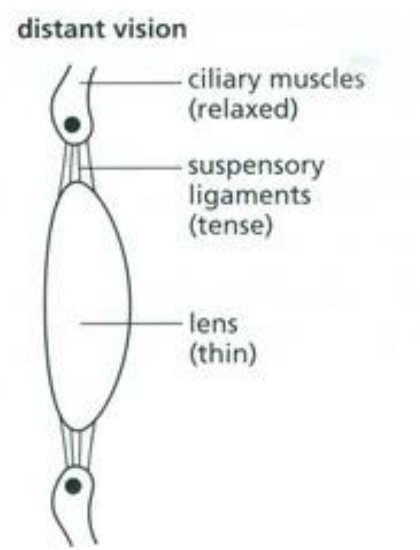


Distant objects:

Ciliary muscles relax

Suspensory ligaments are pulled tight

Lens is thinner and refracts light less strongly

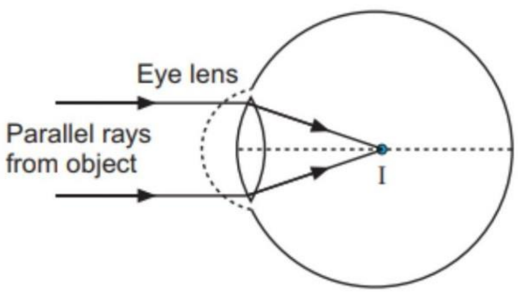


45. Correction of eye problems

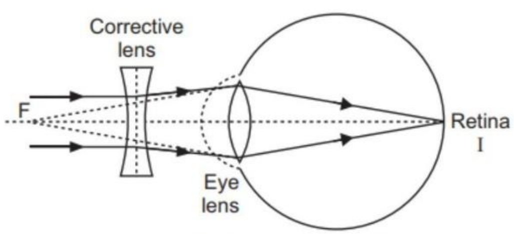
Correction of myopia (short sightedness)

Problem: light rays focus before the retina (for example the eyeball is too long)

Solution: use concave spectacle lenses to refract the light outwards before the cornea.



(a) Image formation by myopic eye

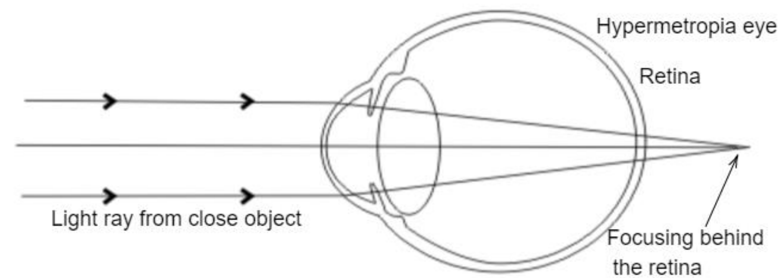


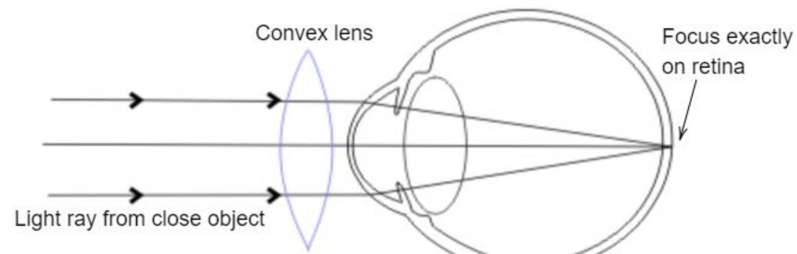
(b) Corrected myopia

Correction of hyperopia (long sightedness)

Problem: light rays focus after the retina (for example the eyeball is too short)

Solution: use convex spectacle lenses to refract the light inwards before the cornea.





Corrected hypermetropia eye

New technologies include:

Hard and soft contact lenses

Laser surgery to change the shape of the cornea

Replacement lenses in the eye

46. Control of blood glucose

Negative feedback: when the body responds to a change in a factor (temperature, glucose concentration, salt concentration) by correcting it**.**

Blood glucose concentration is monitored and controlled by the pancreas.

*Glucagon is higher only

Steady blood glucose concentration

Pancreas detects high blood glucose concentration

Pancreas releases **insulin**

Insulin causes glucose to move from blood into cells

Insulin causes liver and muscle cells to convert glucose into glycogen

Blood glucose levels fall again

Steady blood glucose concentration

Pancreas detects low blood glucose concentration

Pancreas releases **glucagon***

Glucagon causes glycogen (which was stored in cells) to be converted into glucose

Glucose is released into the blood

Blood glucose levels rise again

Steady blood glucose concentration

47. Diabetes

Type 1 diabetes is a disorder.

The pancreas does not produce enough insulin.

People with type 1 diabetes have uncontrolled high blood glucose levels.

Type 1 diabetes is treated with insulin injections.

Type 2 diabetes is a disorder.

Cells do not respond to insulin.

Obesity is a risk factor for type 2 diabetes.

Type 2 diabetes is treated with a carbohydrate-controlled diet (e.g. starch rather than sugar) and exercise regimes.

48. Control of body temperature

The regulation of body temperature is another example of negative feedback.

The skin contains temperature receptors and sends impulses to the **thermoregulatory centre in the brain.** →

The thermoregulatory centre also contains receptors sensitive to the temperature of the blood.

↗ Body temperature gets **too high**

There must be an increased transfer of energy from the skin to the environment.

1. Blood vessels dilate (vasodilation)
2. Sweat glands produce sweat; as the sweat evaporates it cools the body.

↘ Body temperature gets **too low**

There must be a decreased transfer of energy from the skin to the environment.

1. Blood vessels constrict (vasoconstriction)
2. Sweating stops
3. Skeletal muscles contract

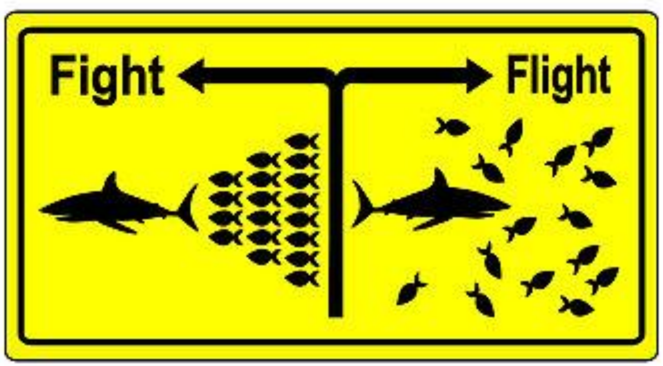
Blood temperature returns to **normal**

49. Adrenaline and thyroxine

Adrenaline is produced by the adrenal glands.

Adrenaline is produced in times of fear or stress.

Adrenaline increases the heart rate.
It increases the delivery of oxygen and glucose to the brain and muscles, preparing the body for fight or flight.



Thyroxine is produced by the thyroid gland.

Thyroxine stimulates the basal metabolic rate.

Thyroxine plays an important role in growth and development.

When thyroxine levels increase, signals sent to the thyroid gland turn off thyroxine production, so that levels decrease again.
This is another example of negative feedback.

50. Control of water and nitrogen balance in the body 1

If the blood plasma becomes **too dilute**, water will move by osmosis from the plasma into the cells; they might burst.

If the blood plasma becomes **too concentrated**, water will move by osmosis from the cells into the plasma; they might shrivel.

Excess amino acids are **deaminated** in the liver to make ammonia. Ammonia is toxic and so it is immediately converted into urea.

Water leaves the body via the lungs during exhalation.

Water, ions and urea are lost from the skin in sweat.

There is no control over the loss of water, ions or urea by the skin or the lungs.

Excess water, ions and urea are removed via the kidneys in the urine.

The kidneys make urine by:

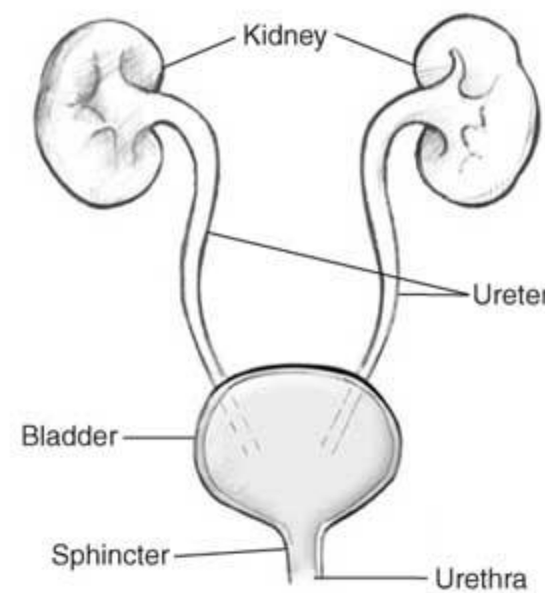
Filtering the blood

Reabsorbing **all** of the glucose

Reabsorbing as much water and ions as needed.

Excreting all of the urea

Urine contains excess water, excess ions and urea.



51. Control of water and nitrogen balance in the body 2

Effect of ADH (anti-diuretic hormone)
The water level in the body is controlled by the hormone ADH.

ADH is released by the pituitary gland when the blood is too concentrated.

ADH makes the kidney tubules more permeable to water.

ADH causes more water to be reabsorbed back into the blood from the kidney tubules.

This is controlled by negative feedback.

Kidney failure is treated by organ transplant or by kidney dialysis.

If someone has an **organ transplant**:
the tissue type must match
all operations have some risk of infection
the patient must take immunosuppressant drugs for the rest of their life to reduce the risk of rejection.

If someone is on **dialysis**:
it is very time consuming and requires many hours of hospital treatment every week.

52. Hormones in Human Reproduction

Secondary sex characteristics include the changes that take place at puberty.

During puberty reproductive hormones cause secondary sex characteristics to develop.

Testosterone is the main male hormone.

It is produced by the testes.

It stimulates sperm production.

Female hormone	Produced by	Function
Follicle stimulating hormone (FSH)	pituitary gland	causes an egg in the ovary to mature
Luteinising hormone (LH)	pituitary gland	causes the mature egg to be released into the oviduct – **ovulation**
Oestrogen	ovary	involved in thickening the lining of the uterus inhibits FSH
Progesterone	ovary	involved in maintaining the thickened lining of the uterus

53. Hormones to treat infertility

The use of hormones to treat infertility

The woman may be given a ‘fertility drug’.

This drug contains FSH and LH.

She may become pregnant in the normal way.

The couple may have **IVF treatment (in vitro fertilisation**).

1. The woman is given FSH and LH to stimulate the maturation of several eggs.
2. The eggs are collected from the mother and fertilised by sperm from the father in the laboratory.
3. The fertilised eggs develop into embryos.
4. When they are tiny balls of cells, one or two embryos are inserted into the mother’s uterus (womb).

Positives of fertility treatment

Gives a woman/couple a chance to have a baby of her/their own.

Negatives of fertility treatment

It is very emotionally and physically stressful.

The success rate is not high.

It can lead to multiple births, which are a risk to the babies and mother.

54. Contraception

Contraception can be used to control fertility.

Contraceptives may be classified as hormonal or non-hormonal.

Type	Method	How it works
Hormonal	Oral contraceptives	contain hormones to inhibit FSH production, so that no eggs mature
	Injection, skin patch or implant of slow-release progesterone	inhibit the maturation of eggs for a number of months or years
	Intrauterine devices (IUD)	prevent the implantation of an embryo or release a hormone
Non-hormonal	Barrier methods such as condoms and diaphragms	prevent the sperm reaching an egg
	Spermicidal agents	kill or disable sperm
	Abstaining from intercourse when an egg may be in the oviduct	prevents fertilisation
	Surgical methods of male and female sterilisation	eggs cannot move along oviduct; sperm cannot move along sperm ducts

55. Plant Hormones

Plants produce hormones to coordinate and control growth and responses to light (**phototropism**) and gravity (**geotropism or gravitropism**).

Unequal distribution of auxin causes unequal growth rates in plant roots and stems.

Positive Phototropism in stems

Auxin is produced from the stem tip.

Auxin diffuses down the stem, causing cells to elongate and divide (by mitosis).

In uniform light, auxin remains evenly distributed in the stem, so growth is uniform.

In unidirectional light (light from one side only), auxin moves to the shaded side of the stem, so the shaded side grows more quickly; the stem bends towards the light.

Positive Geotropism in roots

If a root is horizontal, auxin accumulates on the lower side.

Auxin restricts cell division in roots.

The lower side of the root grows more slowly than the upper surface of the root, so the root grows downwards.

Auxins are used in agriculture and horticulture:

As weed killers

As rooting powders

For promoting growth in tissue culture

Gibberellins are important in initiating (starting) seed germination.

Gibberellins are used in agriculture and horticulture:

To end seed dormancy

Promote flowering

Increase fruit size

Ethene controls cell division and ripening of fruits.

Ethene is used in the food industry to control ripening of fruit during storage and transport.

56. Adaptation and interdependence

Ecosystem	The interaction of a community of living organisms with the non-living parts of their environment.
Community	A group of species that live in the same place. A change in an abiotic or a biotic factor can affect the community.
Interdependence	Each species in a community depends on other species for food, shelter, pollination, seed dispersal etc. If one species is removed it can affect the whole community.
Stable community	All the biotic and abiotic factors are in balance. Population sizes remain fairly constant.

Adaptation

Organisms have features (adaptations) that enable them to survive in their natural environment.

Adaptations can be:

structural

behavioural

functional

Some organisms are adapted to very extreme environments – high temp, pressure or salt concentration. They are known as **extremophiles** e.g. bacteria in deep sea vents.

57. Competition

To survive and reproduce, organisms require materials – from biotic and abiotic sources.

These materials are limited; this leads to competition between individuals.

Competition in plants

Light

Space

Water

Mineral ions

Competition in animals

Food

Mates

Territory

Abiotic factors caused by non-living things:

light intensity

temperature

moisture levels

soil pH

soil mineral content

carbon dioxide (for plants)

oxygen (for aquatic animals)

wind intensity and direction

Biotic factors: caused by living organisms

availability of food

new predators

new pathogens

one species outcompeting another, leaving too few individuals to breed

58. Organisation of an ecosystem

Feeding relationships are shown in food chains.

Every food chain starts with a producer.

Producers synthesise (make) molecules.

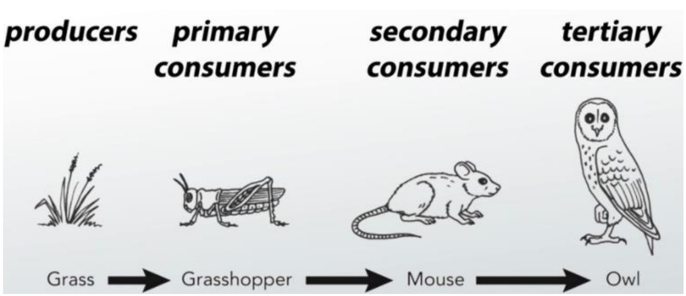
Usually, the **producer** is a green plant or alga that makes glucose by photosynthesis.

Photosynthetic organisms are the producers of biomass for life on Earth.

Producers are eaten by **primary consumers.**

Primary consumers may be eaten by **secondary consumers** and then **tertiary consumers.**

In a food chain, the arrow shows the direction of energy or biomass movement – from producer to consumer.



Predators kill and eat other animals.

Animals that are eaten are **prey.**

In a stable community the numbers of predators and prey rise and fall in cycles.

Environmental changes affect the distribution of species in an ecosystem.

These changes include:

temperature

availability of water

composition of atmospheric gases (abiotic factors)

The changes may be seasonal, geographic or caused by human interaction.

59. Trophic levels in an ecosystem

Trophic levels can be represented by numbers, starting at level 1 with plants and algae. Further trophic levels are numbered subsequently according to how far the organism is along the food chain.

Level 1: Plants and algae make their own food and are called producers.

Level 2: Herbivores eat plants/algae and are called primary consumers.

Level 3: Carnivores that eat herbivores are called secondary consumers.

Level 4: Carnivores that eat other carnivores are called tertiary consumers.

Apex predators are carnivores with no predators.

Decomposers break down dead plant and animal matter by secreting enzymes into the environment.

Small soluble food molecules then diffuse into the microorganism.

Pyramids of biomass can be constructed to represent the relative amount of biomass in each level of a food chain.

Trophic level 1 is at the bottom of the pyramid.

Producers are mostly plants and algae which transfer about 1 % of the incident energy from light for photosynthesis.

Only approximately 10 % of the biomass from each trophic level is transferred to the level above it.

Losses of biomass are due to:

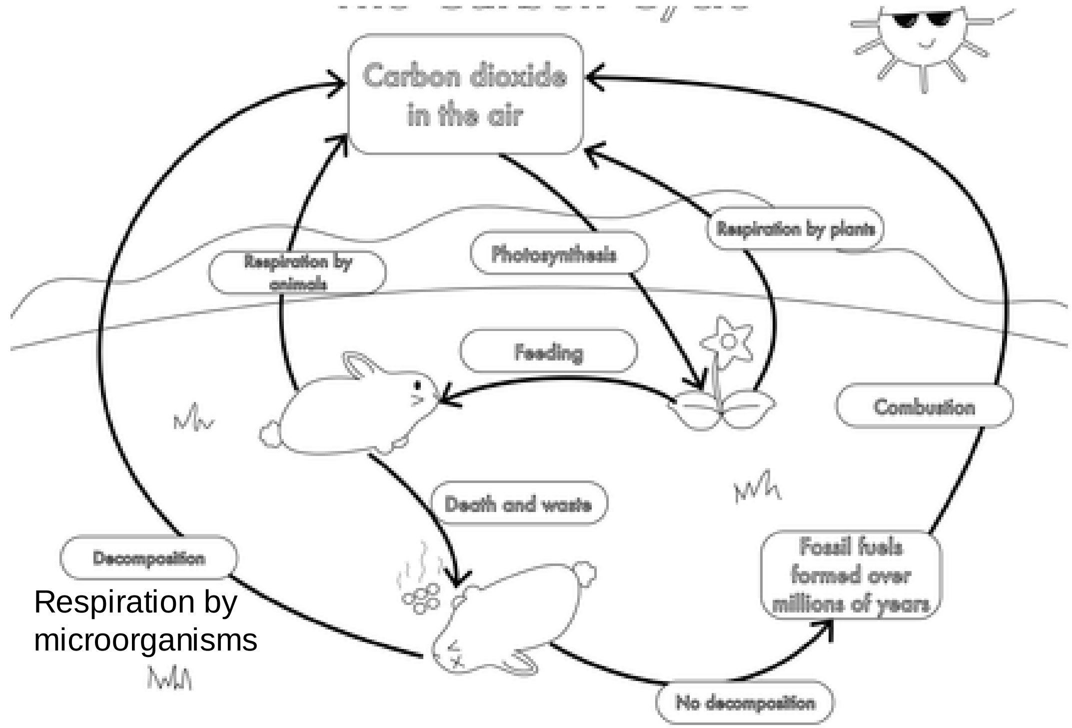
Not all the ingested material is absorbed, some is egested as faeces

Some absorbed material is lost as waste, such as carbon dioxide and water in respiration and water and urea in urine.

Large amounts of glucose are used in respiration.

60. Recycling materials: carbon

All materials in the living world are recycled to provide the building blocks for future organisms. Two examples are the carbon and the water cycle.



Carbon Cycle

Carbon moves from the atmosphere into organisms through photosynthesis.

It is released from organisms to the atmosphere through respiration.

When living things die and decay, microorganisms (bacteria and fungi) break chemicals down.

They return carbon dioxide to the atmosphere and mineral ions to the soil.

61. Recycling materials: water and decomposition

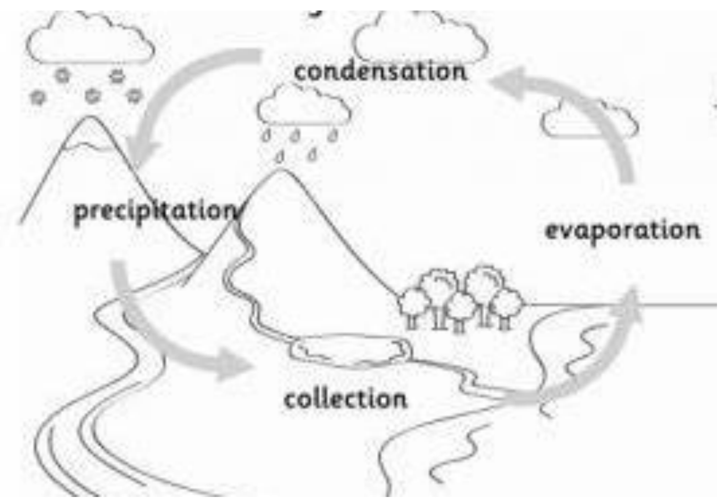
Water cycle

Rain provides fresh water for plants and animals on land.

The water drains into the sea through rivers.

There is continuous evaporation of water from land and sea.

There is continuous precipitation of water onto the land and into the sea.



Decomposition (Triple only)

Gardeners and farmers try to provide optimum conditions for rapid decay of waste biological material (warmth, oxygen, moisture) to make compost.

The compost is used as a natural fertiliser for growing garden plants or crops.

Anaerobic decay produces methane gas.

Biogas generators can be used to produce methane gas as a fuel.

62. Biodiversity and human interaction 1

Biodiversity: the variety of all the different species of organism on earth, or within an ecosystem.
High biodiversity is good for the stability of ecosystems.
It reduces the dependence of species on one another for food and shelter.
Biodiversity is good for humans too – for food, for medicines, for materials.
Human activities have reduced biodiversity.
Only recently have humans made efforts to stop this reduction.

Pollution is increasing.
There are more humans and an increase in the standard of living, so we are using more resources and producing more waste.
Pollution kills plants and animals; this reduces biodiversity.
Pollution can occur:
In water – from sewage, fertiliser or toxic chemicals
In air – from smoke and acidic gases
On land – from landfill and toxic chemicals

Global warming is happening.
This is the consensus of scientists all over the world, based on thousands of peer-reviewed publications.

We have increased the levels of carbon dioxide and methane in the atmosphere.

Global warming impacts:
loss of habitat
loss of food
the spread of disease

This will lead to extinctions and the loss of biodiversity.

63. Biodiversity and human interaction 2

Land use

Humans use land for building, quarrying, farming and dumping waste.

This reduces the land available for animals and plants.

We have destroyed **peat bogs** to produce cheap compost.

This reduces the habitat and reduces biodiversity. Compost increases food production.

When peat decays or burns, it releases carbon dioxide into the atmosphere.

Deforestation is the reduction in size of forests.

Deforestation is a big problem in tropical areas.

People want the land for cattle and rice fields, and to grow crops for biofuels.

Stopping the decline in biodiversity

There are breeding programmes for endangered species.

Rare habitats are protected and regenerated.

Farmers have reintroduced hedgerows to promote biodiversity.

Some governments have passed laws to reduce deforestation and carbon dioxide emissions.

Some governments have passed laws to increase recycling resources instead of dumping waste in landfill.

64. Food production

Food security is having enough food to feed a population. Sustainable methods must be found to feed all people on Earth.

Biological factors which are threatening food security include:

- the increasing birth rate has threatened food security in some countries
- changing diets in developed countries means scarce food resources are transported around the world
- new pests and pathogens that affect farming
- environmental changes that affect food production, such as
- widespread famine occurring in some countries if rains fail
- the cost of agricultural inputs
- conflicts that have arisen in some parts of the world which affect the availability of water or food.

The **efficiency** of food production can be improved by restricting energy transfer from food animals to the environment. This can be done by limiting their movement and by controlling the temperature of their surroundings**.** Some animals are fed high protein foods to increase growth.

Fish stocks in the oceans are declining. It is important to maintain fish stocks at a level where breeding continues, or certain species may disappear altogether in some areas.

Control of net size and the introduction of fishing quotas play important roles in conservation of fish stocks at a sustainable level.

Modern biotechnology techniques enable large quantities of microorganisms to be cultured for food.

The fungus ***Fusarium*** is useful for producing mycoprotein, a protein-rich food suitable for vegetarians. The fungus is grown on glucose syrup, in aerobic conditions, and the biomass is harvested and purified.

A **genetically modified bacterium** produces human insulin. When harvested and purified this is used to treat people with diabetes.

GM crops could provide more food or food with an improved nutritional value such as golden rice.

65. Variation

There is usually extensive genetic variation within a population of a species.

Variation means differences in the characteristics of individuals in a population.

Causes of variation:

The genes they have inherited (genetic causes)

The conditions in which they have developed (environmental causes)

A combination of genes and the environment.

66. Chromosomes

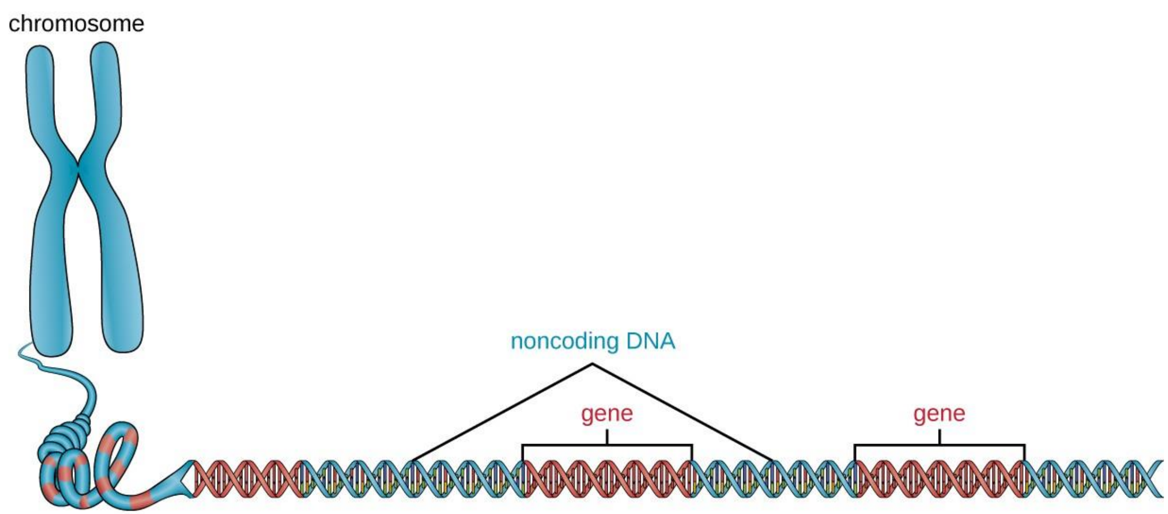
Refer back to paper 1 page 6

A **genome** is the entire genetic material of an organism.
The whole human genome has been studied.

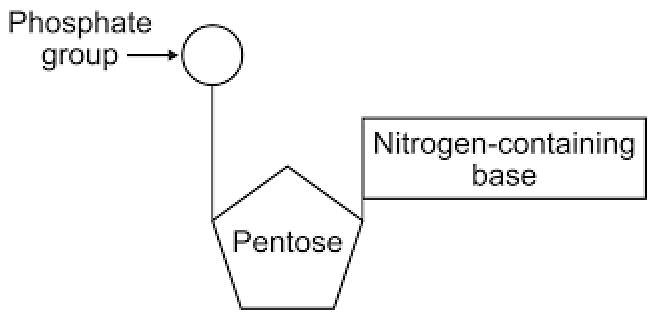
In a eukaryotic cell, genetic material is found in the nucleus, and contained in chromosomes.
Humans have 23 pairs of chromosomes in their body cells.
Genetic material is made of a chemical called DNA.

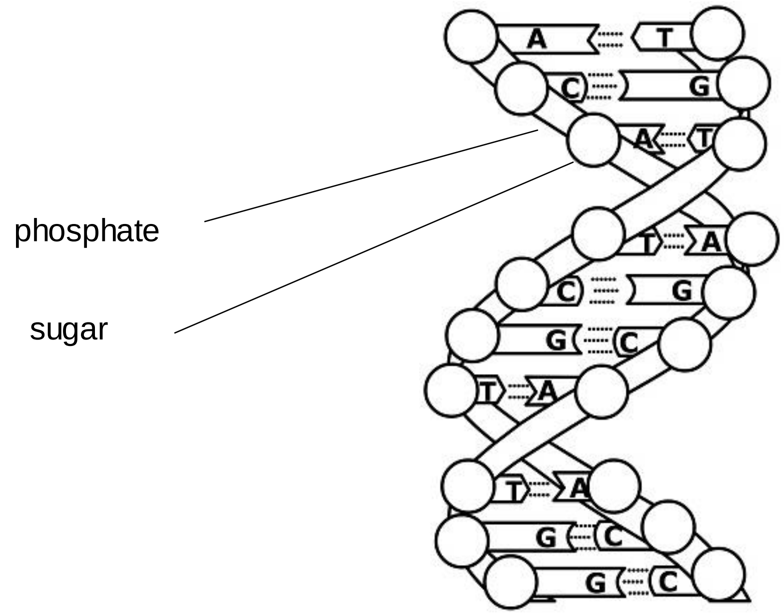
A **gene** is a short section of DNA on a chromosome
A gene codes for a sequence of amino acids, making a specific protein.

Not all parts of DNA code for proteins.
Non-coding parts of DNA can switch genes on and off, so variations in these areas of DNA may affect how genes are expressed.



67. DNA





DNA is a polymer made from four different **nucleotides.**

A **nucleotide** consists of a sugar, a phosphate group and one of four different bases.

The 4 bases are A, C, G and T.

DNA is made of 2 strands of nucleotides wound around each other in a **double helix.**

The long strands of DNA consist of alternating sugar and phosphate sections.

Attached to each sugar is one of the four bases.

In the complementary strands a C is always linked to a G on the opposite strand, and a T to an A.

68. Coding for Proteins

Each sequence of three bases of DNA is the code for a particular amino acid.

The order of bases on the DNA controls the order in which amino acids are assembled to produce a particular protein.

Proteins are synthesised on ribosomes, according to a template.

Carrier molecules bring specific amino acids to add to the growing protein chain in the correct order.

When the protein chain is complete it folds up to form a unique shape.

This unique shape enables the proteins to do their job as enzymes, hormones or forming structures in the body such as collagen.

Mutations

Any errors in the sequence of bases may result in a different protein being assembled.

A **mutation** is a change in the sequence of bases in the DNA.
Mutations occur continuously.
Most do not alter the protein, or only alter it slightly so that its appearance or function is not changed.

A few mutations code for an altered protein with a different shape.

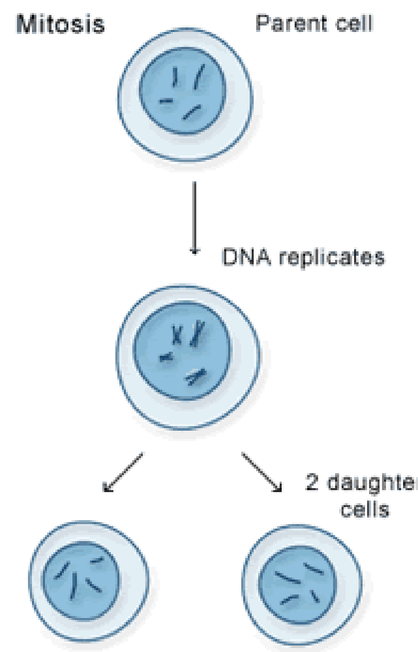
An enzyme may no longer fit the substrate binding site or a structural protein may lose its strength.

69. Cell Division: Mitosis (reminder from paper 1)

Mitosis happens in body cells.

In mitosis, the number of chromosomes remains the same.

Stage of the cell cycle	Events
1	The cell grows. The DNA replicates to form two copies of each chromosome. New mitochondria and ribosomes are made.
2.	**Mitosis**: one set of chromosomes is pulled to each end of the cell. The nucleus divides.
3	The cytoplasm and cell membranes divide. There are now two identical cells.



Uses of cell division by mitosis

1. Growth
2. Repair of tissues
3. Asexual reproduction

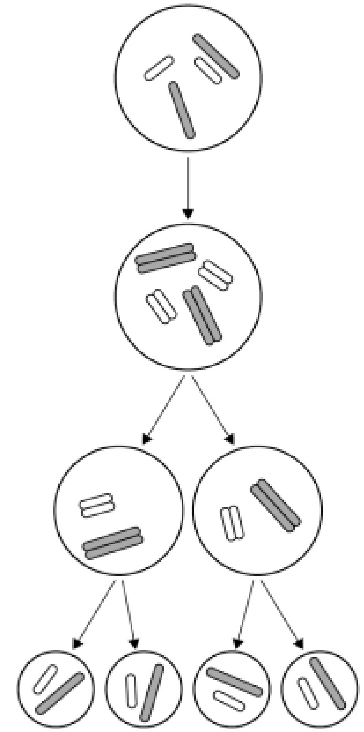
70. Cell Division: Meiosis

Meiosis happens in reproductive organs: ovaries and testes.

In meiosis, the number of chromosomes is halved.

The full number of chromosomes is restored when the male and female gametes fuse during fertilisation.

Stage of the cell cycle	Events
1	The cell grows. The DNA replicates to form two copies of each chromosome. New mitochondria and ribosomes are made.
2.	**Meiosis**: the chromosomes are pulled to opposite poles twice.
3	The cytoplasm and cell membranes divide twice. There are now four genetically different gametes (sex cells) Each gamete has just one set of chromosomes.



At fertilisation

Male and female gametes join.

The new cell has two sets of chromosomes.

The new cell divides by mitosis.

After fertilisation

The cells continue to divide by mitosis.

The cells begin to differentiate.

71. Reproduction: Asexual and Sexual

Asexual reproduction involves only one parent.

There is no fusion of gametes.

There is no mixing of genetic information.

The offspring are genetically identical.

They are clones.

Only mitosis is involved.

Advantages of asexual reproduction (Triple only)

Only one parent is needed

More time and energy efficient as they do not need to find a mate

Faster than sexual reproduction

Many identical offspring can be produced when conditions are favourable

Sexual reproduction involves the fusion of male and female gametes (sex cells)

In animals, these are sperm and egg cells.

In flowering plants, these are pollen and egg cells.

Sexual reproduction involves the mixing of genetic information.

This leads to variety in the offspring.

Gametes are made through **meiosis.**

Advantages of sexual reproduction (Triple only)

Produces variation in the offspring

If the environment changes, variation gives a survival advantage by natural selection

Natural selection can be speeded up by humans in selective breeding to increase food production

Some organisms reproduce by **both methods** depending on the circumstances.

Malarial parasites reproduce asexually in the human host, but sexually in the mosquito.

Many fungi reproduce asexually by spores but also reproduce sexually to give variation.

Many plants produce seeds sexually, but also reproduce asexually by runners such as strawberry plants, or bulb division such as daffodils.

72. Genetic Crosses: definitions and inheritance

Term	Meaning
gene	part of a chromosome that codes for a protein e.g. codes for eye colour
allele	version of a gene e.g. blue eyes, brown eyes
genotype	the alleles that an organism has e.g. AA, Aa or aa
phenotype	the characteristics that an organism has e.g. tall, dimples, red flowers
dominant	A dominant allele is always expressed, even if there is only one copy
recessive	two copies of a recessive allele are required for it to be expressed
homozygous	two of the same alleles for a gene e.g. AA or aa
heterozygous	two different alleles for a gene e.g. Aa

Polydactyly causes extra fingers or toes.

It is caused by a dominant allele.

Cystic fibrosis is a disorder of cell membranes, causing mucus to block narrow passages such as the bronchioles.

It is caused by a recessive allele.

Sex determination

Humans have 23 pairs of chromosomes in each nucleus but only one pair determines sex.

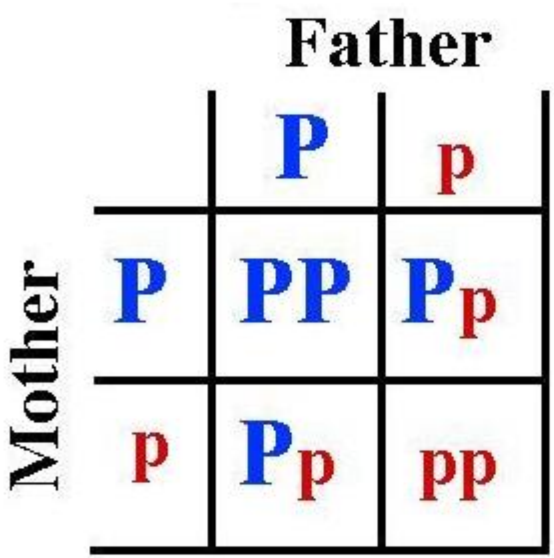
Human females have XX.

Human males have XY.

73. Genetic Crosses: Punnett Squares

Parents: Pp x Pp

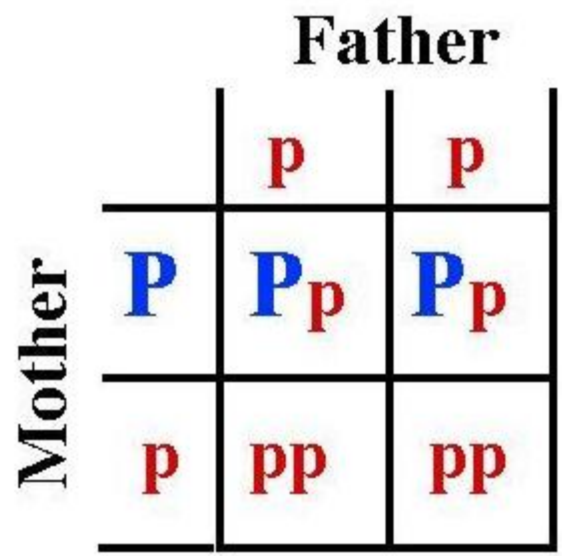
Gametes: P, p P, p



The chance of any one offspring being pp is 1 in 4 or 25%

Parents: pp x Pp

Gametes: p, p P, p



The chance of any one offspring being pp is 50% or 1 in 2

74. Evolution

Evolution is a change in the inherited characteristics of a population over time through a process of natural selection. This may result in the formation of a new species

The theory of evolution by natural selection states that all species of living things have evolved from simple life forms that first developed more than three billion years ago.

Natural Selection

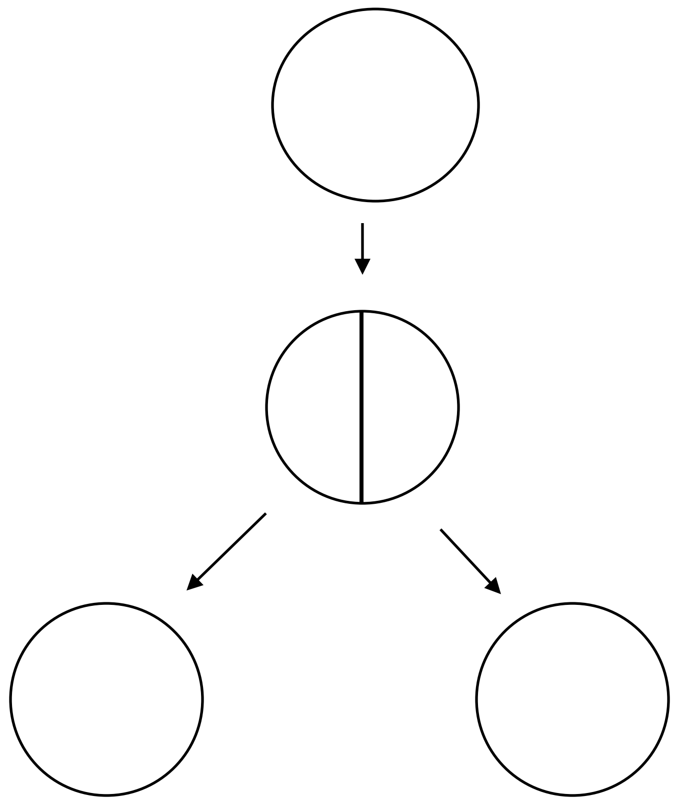
Mutation causes variation in the population

Individuals with characteristics most suited to the environment are more likely to survive to breed successfully. These characteristics are then passed on to the next generation.

Over many generations, the proportion of the population with this characteristic increases.

75. Speciation

Speciation is the formation of new species.



One population, which can breed together

A new geographical barrier divides the population – the population can no longer breed together.

Natural selection continues in both new populations.
Over many generations the two populations become so different in phenotype, that they can no longer breed together to produce fertile offspring – they have formed two new species.

76. Evidence for evolution: fossils, extinction, resistant bacteria

Charles Darwin was criticised in the 1800s as he didn't have sufficient evidence for his theory of natural selection. There is now lots of evidence for natural selection.

Fossils are evidence for natural selection.

Fossils are the remains of organisms from millions of years ago, found in rocks.

We can learn from fossils about how life changed over time.

Fossils show us that extinctions happen.

Extinction is due to :

New disease

New predator

Climate change

Habitat loss

Single catastrophic events e.g. an asteroid

Formation of fossils:

Replacement of hard parts of organisms with minerals as they decay

Imprints of organisms e.g. footprints, burrows, rootlet traces

Preserved parts of organisms that have not decayed, due to lack of oxygen, water or warmth

Problems with the fossil record

Many early life forms were soft bodied. They have left few traces behind. These have mainly been destroyed by geological activity. So we can't be certain about how life began.

Resistant bacteria are evidence for natural selection

Mutation causes variation in the population – some bacteria are more resistant to antibiotics than others. Resistant bacteria have an advantage as they are less likely to be killed by antibiotics. These individuals survive and reproduce. The genes for the resistance are passed on. The resistant strain becomes more common.

To combat resistant strains:

Doctors should not give antibiotics for mild infections or viral infections

Patients should complete the whole course of antibiotics so all bacteria are killed and none survive to mutate and become resistant

Antibiotics should be used less by farmers in pigs, cows, sheep etc.

77. History of ideas: Darwin and Wallace

Charles Darwin proposed the theory of evolution by natural selection.

He developed his ideas as a result of:

- observations on a round the world expedition
- years of experimentation and discussion
- the developing knowledge of geology and fossils,

Darwin published his ideas in **On the Origin of Species (1859).**

There was much controversy surrounding these revolutionary new ideas.

The theory of evolution by natural selection was only gradually accepted because:

The theory challenged the idea that God made all the animals and plants that live on Earth

There was insufficient evidence at the time the theory was published to convince many scientists

The mechanism of inheritance and variation was not known until 50 years after the theory was published.

Alfred Russel Wallace independently proposed the theory of evolution by natural selection.

He published joint writings with Darwin in 1858 which prompted Darwin to publish On the Origin of Species (1859) the following year.

Wallace worked worldwide gathering evidence for evolutionary theory.

He is best known for his work on warning colouration in animals and his theory of speciation.

Alfred Wallace did much pioneering work on speciation but more evidence over time has led to our current understanding of the theory of speciation.

Other theories, including that of **Jean-Baptiste Lamarck**, are based mainly on the idea that changes that occur in an organism during its lifetime can be inherited.

We now know that in the vast majority of cases this type of inheritance cannot occur.

78. History of ideas: Mendel

In the **mid-19th century Gregor Mendel** carried out breeding experiments on plants.

One of his observations was that the inheritance of each characteristic is determined by ‘units’ that are passed on to descendants unchanged.

Why weren't Mendel's ideas accepted?

The importance of his ideas was not recognised in his lifetime, due to a lack of evidence.

Why were Mendel's ideas accepted?

In the **late 19th century** behaviour of chromosomes during cell division was observed.

In the **early 20th century** it was observed that chromosomes and Mendel’s ‘units’ behaved in similar ways.

This led to the idea that the ‘units’, now called genes, were located on chromosomes.

In the **mid-20th century** the structure of DNA was determined, and the mechanism of gene function worked out.

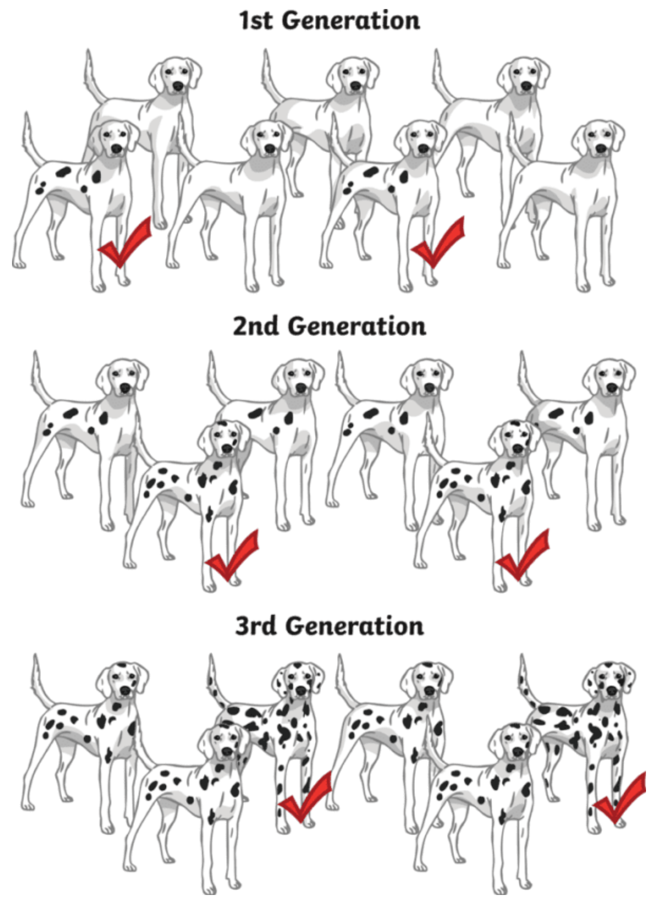
This scientific work by many scientists led to the gene theory being developed.

79. Selective breeding

Selective breeding is the process where humans breed plants and animals for particular characteristics.
People have been doing this for thousands of years to produce food crops and domesticated animals.

Mutations cause variation in the population.
Individuals with a particular characteristic are chosen by humans.
These individuals are allowed to reproduce.
The genes for the characteristic are passed on and become more common over time.

Examples include:
Disease resistance in crops
Animals that produce more meat or milk
Domestic dogs with a gentle nature
Large or unusual flowers



Disadvantages:
Selective breeding can lead to inbreeding.
Some breeds are prone to disease.

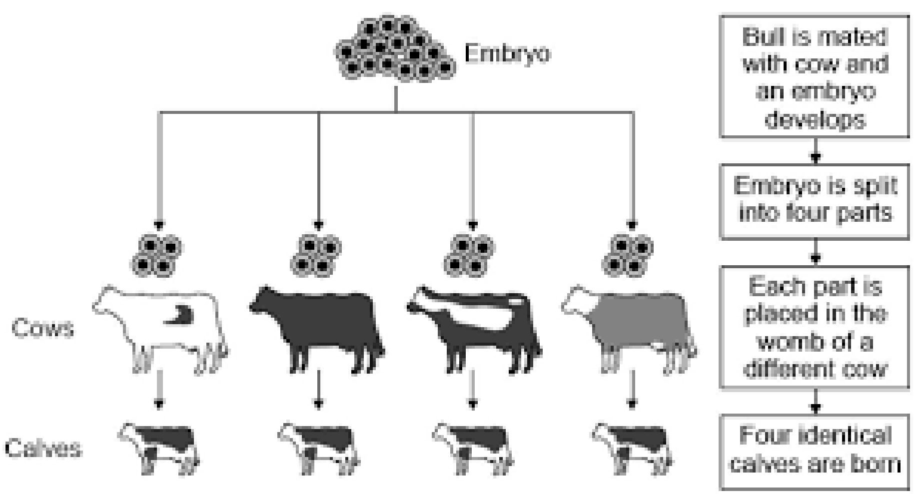
80. Cloning

Tissue culture: small groups of cells from part of a plant are used to grow identical new plants.

This is important for preserving rare plant species or commercially in nurseries.

Cuttings: an older, but simple, method used by gardeners to produce many identical new plants from one parent plant.

Embryo transplants: split apart cells from a developing animal embryo before they become specialised, then transplant the identical embryos into host mothers.



Adult cell cloning:

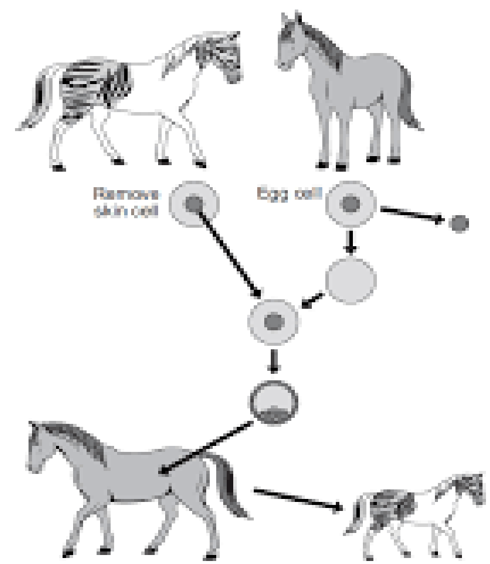
The nucleus is removed from an unfertilised egg cell.

The nucleus from an adult body cell is inserted into the egg cell.

An electric shock stimulates the egg cell to divide to form an embryo.

These embryo cells contain the same genetic information as the adult skin cell.

When the embryo has developed into a ball of cells, it is inserted into the womb of an adult female to continue its development.



81. Genetic Engineering

Genetic engineering is where a genome of an organism is changed by technology.

A gene is taken from one organism and given to another to produce a desired characteristic.

Examples:

Plants have been genetically engineered to produce a bigger yield and be resistant to disease.

Bacteria have been engineered to produce useful chemicals e.g. insulin.

The method (higher only)

Enzymes are used to cut out the useful gene from one organism.

The useful gene is inserted into a vector

The vector inserts the useful gene into the required cell

This is done at an early stage of development

Objections

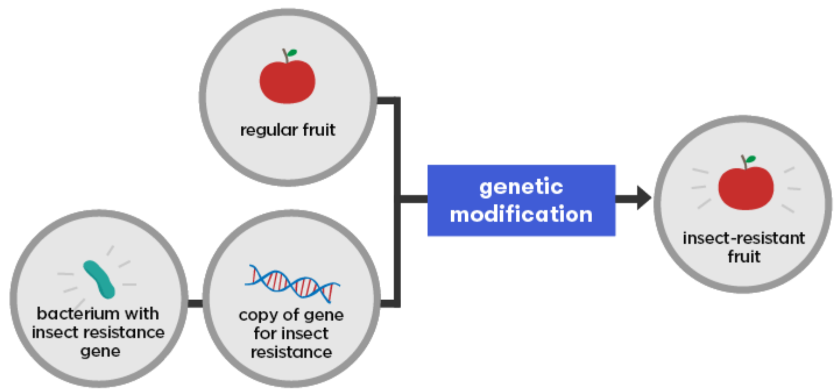
Some people object to genetic engineering.

There may be risks to human health that we don't yet understand.

There may be an effect on wild populations of flowers and insects.

Benefits

Genetic engineering could be used to cure diseases.



82. Classification

Classification

Originally **Carl Linnaeus** classified organisms by their structure and characteristics into the following system:

Animal Example	Taxonomic Rank
Animalia	**Kingdom**
Chordata	**Phylum**
Mammalia	**Class**
Primate	**Order**
Hominidae	**Family**
Homo	**Genus**
sapiens	**Species**
Human	Common Name

The genus and the species gives the binomial name, e.g. *Homo sapiens*

The genus always starts with a capital letter, and the species with a small case letter.

Our understanding of internal structures, biochemistry and genetics meant that some organisms were reclassified.

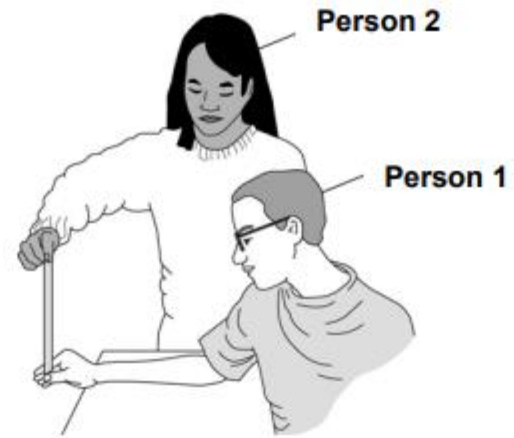
Three new groups called domains were proposed by **Carl Woese.**

Archaea – bacteria living in extreme environments

Bacteria – true bacteria

Eukaryota – animals, plants, fungi and protists.

83. Required Practical 6 – Human Reaction Time



Plan and carry out an investigation into the effect of a factor on human reaction time.

IV: number of times a ruler is dropped

DV: measuring the distance where it is caught (we get faster, up to a point)

CV: same person

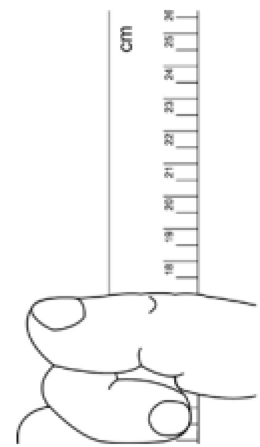
CV: same hand

CV: rest elbow on the table

CV: hold ruler in same position

Method

1. Place your weakest hand on a table with your hand over the edge.
2. Your partner holds a metre ruler at 0 cm above your hand so the top of your thumb is at the zero mark.
3. Without any notice, your partner drops the ruler and you catch it.
4. Read metre ruler from the top of the thumb.
5. Repeat steps 1-4 four more times.
6. Convert the distance on the ruler into reaction time in seconds using a table of data.



To improve the method

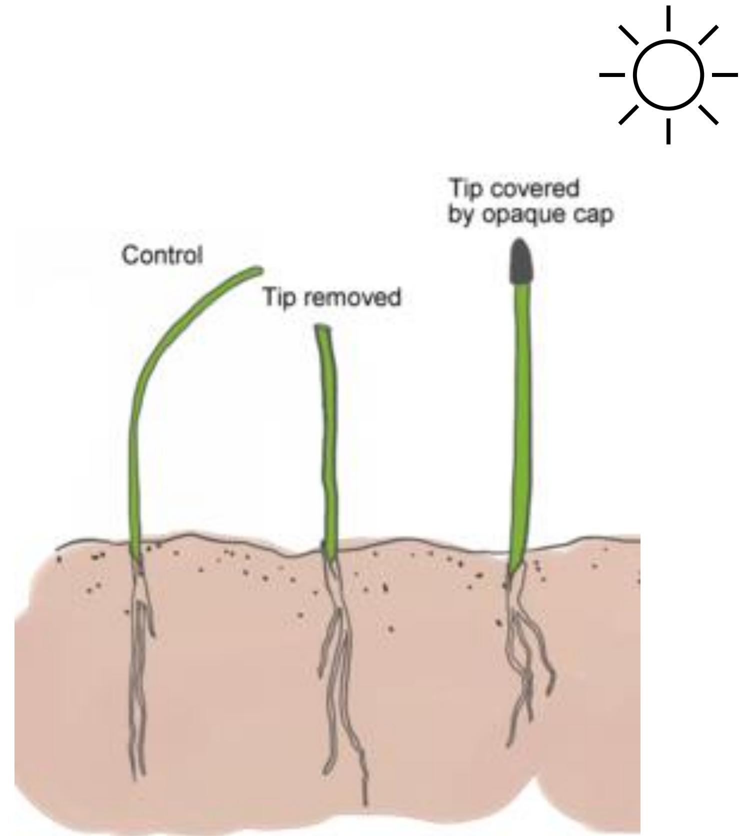
- To be more confident of the results, carry out 3 replicates on different people to identify anomalies; remove any anomalous results; calculate a mean.
- Use a computer to give a more precise reaction time because they remove the possibility of human error and it is more accurate.

84. Required Practical 7 – Plant Responses

Investigate the effect of light or gravity on the growth of newly germinated seedlings.

Set up the three groups of seedlings as follows:

1. Carefully remove the tip using the fine dissecting scissors
2. Carefully cover the tip with foil
3. Leave the seedling alone (control).
4. Place a light source to one side of the shoots, water the plants and leave for a few days.
5. Record the angle of growth away from the vertical.



Rules for biological drawings:

Sharp pencil

Label lines (no arrow heads) touch object and drawn with a ruler

Add a scale bar

Add annotation

No shading or colour

85. Required Practical 8 - Decay

Investigate the effect of temperature on the rate of decay of fresh milk by measuring pH change.

IV: temperature

DV: time for pH to change

CV: milk volume

CV: bile salts volume and concentration

CV: sodium carbonate solution volume and concentration

CV: number of drops of indicator

CV: lipase solution volume and concentration

Method

1. Add 20 cm^3 of milk to a beaker.
2. Using a clean measuring cylinder, add 5 cm^3 of bile salts solution.
3. Using a clean measuring cylinder, add 10 cm^3 of sodium carbonate solution.
4. Add 10 drops of phenolphthalein to the beaker, the mixture should be pink.
5. Put the beaker into a water bath at 20^{o}C and stir. Leave for 5 minutes for the beaker to reach the correct temperature.
6. Add 5 cm^3 lipase solution and start the stop clock.
7. Stir the contents of the beaker until the mixture loses the pink colour. At this point the mixture has become acidic.
8. Record how long it takes the pink colour to go.
9. Repeat steps 1 to 8 at 30^{o}C, 40^{0}C, 50^{0}C, 60^{0}C
10. Record the results in a suitable results table

Problems with the design of the method

The main problem will be maintaining the temperature.

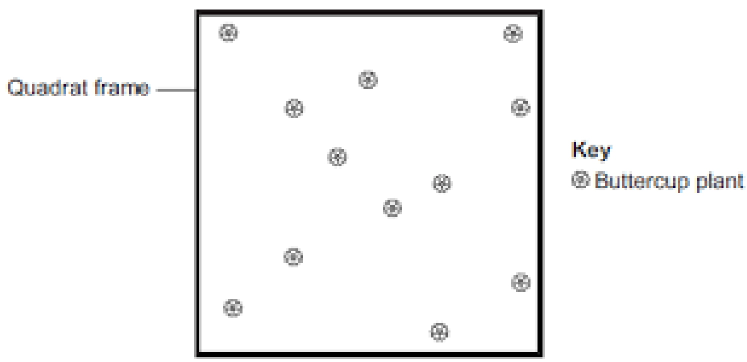
To improve the method

Several repeats are needed so that anomalies can be identified.

86. Required Practical 9 – Field Investigations 1

Measure the population size of a common species in a habitat.
Use sampling techniques to investigate the effect of a factor on the distribution of this species.

Quadrats are square shapes that are placed on the ground; the numbers of organisms in the square can be counted.
Transects are lines that are placed on the ground; quadrats can be placed at regular intervals along the transect to find out if the number of organisms changes along the line.



Method to estimate population size

1. Choose one area to investigate.
2. Divide the area into an imaginary grid.
3. Use a random number generator to select points in the area e.g. 4m in one direction, and 3m at right angles to this point.
4. Place the quadrat down so that the left-hand bottom corner is on the identified point.
5. Count the number of dandelion plants in the quadrat.
6. Record the number in your results table.
7. Repeat at least 10 times.
8. Calculate the mean number of dandelions per quadrat.
9. Calculate the total area of the field.
10. Divide the area by the area of one quadrat, then multiply this number by the mean number of dandelions per quadrat.

To improve the method

Dependent on random sampling, so will be more valid if more quadrats are used, or larger quadrats are used.
Repeat at different times of the year.

87. Required Practical 10 – Field Investigations 2

Use sampling techniques to investigate the effect of a factor on the distribution of this species.

Quadrats are square shapes that are placed on the ground; the numbers of organisms in the square can be counted.

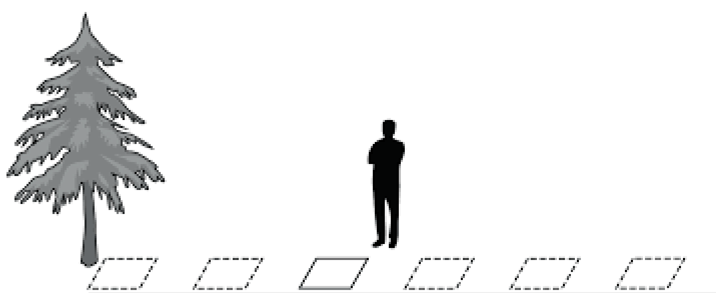
Transects are lines that are placed on the ground; quadrats can be placed at regular intervals along the transect to find out if the number of organisms changes along the line.

IV: light intensity

DV: number of daisies per quadrat

CV: size of quadrat

CV: sample every 1m along transect



Method to investigate the effect of light intensity

1. Choose two areas where dandelions grow; one in a sunny area and one in the shade.
2. Measure the light intensity in the sunny area.
3. Put down a transect line in the sunny area – do not look at the grass as you lay the line down.
4. Place the quadrat down next to the line at the start.
5. Count the number of dandelion plants in the quadrat.
6. Record the number in your results table.
7. Move the quadrat 1m further along the transect and repeat at least 8 times.
8. Repeat in the shady area.

Problems with the design of the method

Other variables are not controlled in this method. The soil pH, temperature, water availability and trampling may all affect the distribution of plants.

To improve the method

Complete three transects in each area.

Record observations.

Repeat at different times of the year.

88. Maths in Science 1

Anomalous result	A number that does not fit the pattern
Mean	Adding up a list of numbers and dividing by how many numbers are in the list. Exclude the anomalous result.
Median	The middle value when a list of numbers is put in order from smallest to largest
Mode	The most common value in a list of numbers. If two values are tied then there are two modes. If more than two values are tied then there is no mode.
Range	The largest number take away the smallest value in a set of data or written as X-Y.
Uncertainty	range ÷ 2
Surface area of a cube	(area of 1 side) x 6 sides
Volume of a cube	Width x height x depth
Area of a circle	∏ x (radius)^2

Prefixes

1 kJ = 1 x 10^3 J = 1000 J

1 pm = 1 x 10^{-12} m

1 mm = 1 x 10^{-3} m= 0.001 m

kilo	10 ^{3}
centi	10 $^{-2}$
milli	10 $^{-3}$
micro	10 $^{-6}$
nano	10 $^{-9}$
pico	10 $^{-12}$

5607.376

Standard form: 5.607 x 10^3

2 decimal places: 5607.38

3 significant figures: 5610

0.03581

Standard form: 3.581 x 10^{-2}

2 decimal places: 0.04

3 significant figures: 0.0358

89. Maths in Science 2

Calculating percentage: (part ÷ whole) x 100

e.g. Out of 90 insects, 40 of them were ladybirds. What is the % of ladybirds?

(40 ÷ 90) x 100 = 44 %

Calculating percentage change:

(difference ÷ starting value) x 100

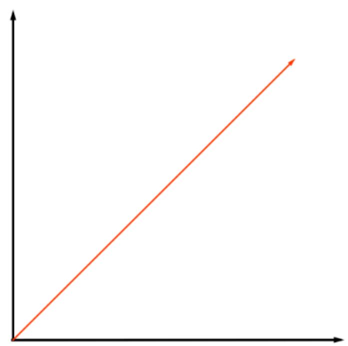
(0.59 ÷ 2.22) x 100 = 26.6 %

Conc of Sucrose (M)	Mass of potato at start (g)	Mass of potato at end (g)	Change in mass (g)
0	2.22	2.81	0.59

Graphs

Proportional (α)

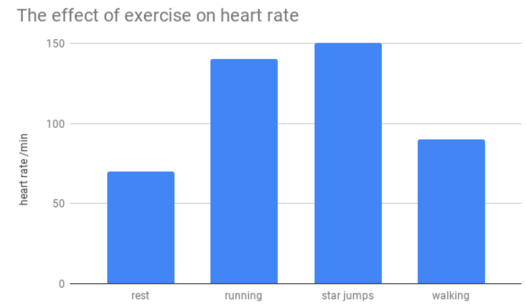
When the line passes through the origin



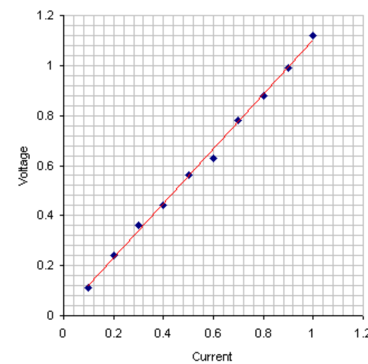
x axis = independent variable = left hand column of results table

y axis = dependent variable = right hand column of results table

Categoric data: data put into groups e.g. colour of eyes
Draw a bar chart



Continuous data: data that can take any value e.g. current
Draw a line graph



Gradient and Graphs

Gradient = $\frac{\text{Change in y}}{\text{Change in x}}$