IGCSE Biology 2012 exam revision notes by Samuel Lees

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Things to note about the formatting:

- Words in red are words where in the syllabus it says “define aerobic respiration as ...” so I copy pasted the definition, therefore you should probably memorise these definitions.
- Important vocabulary is normally in **bold**.
- I have put all the section and sub-section names in **bold and underlined** e.g. “1. Characteristics of living things” so that you can find the corresponding section in the syllabus easily.
- Any information marked with a * is not necessary, but can make other stuff make more sense, or I used it on diagrams where I couldn’t remove a label without ruining the diagram.
- As far as I can remember, I have written on top of a diagram if you have to know the diagram or the position of the labelled parts etc.

Section I: Characteristics and classification of living organisms

1. Characteristics of living organisms

Movement: an action by an organism or part of an organism causing a change of position, place, or aspect
Respiration: the chemical reactions that break down nutrient molecules in living cells to release energy
Sensitivity: the ability to detect or sense changes in the environment (stimuli) and to make responses
Growth: a permanent increase in size and dry mass by an increase in cell number or cell size or both
Reproduction: the processes that make more of the same kind of organism
Excretion: removal from organisms of toxic materials, the waste products of metabolism (chemical reactions in cells including respiration) and substances in excess of requirements
Nutrition: taking in of nutrients which are organic substances and mineral ions, containing raw materials or energy for growth and tissue repair, absorbing and assimilating them

2. Classification and diversity of living organisms

2.1 Concept and use of a classificatory system

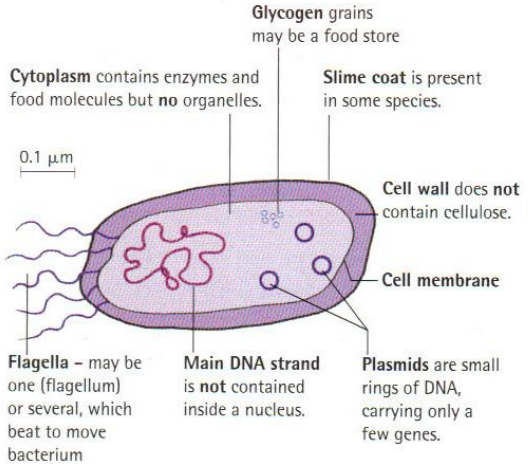
binomial system: a system of naming species in which the scientific name of an organism is made up of two parts showing the genus (starting with a capitol letter) and species (starting with a lower case letter), written in *italics* when printed (therefore underlined when handwritten) e.g. *Homo sapiens*

	Skin	Habitat	Legs	Breathing	Birth Method
Bony fish	Scales	Water	Fins	Gills	Soft Eggs
Amphibians	Moist	Land/Water	4	Gills/Lungs	Soft Eggs
Birds	Scales on legs, feathers	Land	2 legs & 2 wings	Lungs	Hard Eggs
Reptiles	Scales	Land	usually 4	Lungs	Hard Eggs
Mammals	Fur/Hair	Land/Water	4	Lungs	Live birth

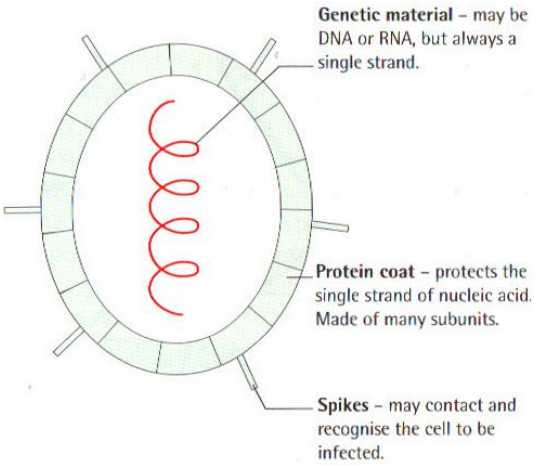
Viruses and bacteria:

	Virus	Bacteria
Covered by	Protein coat	Cell wall
Cell membrane	No	Yes
Cytoplasm	No	Yes
Genetic material	DNA or RNA – only a few genes	DNA – enough for several hundred genes
Living or not?	Non-living unless in host	Living

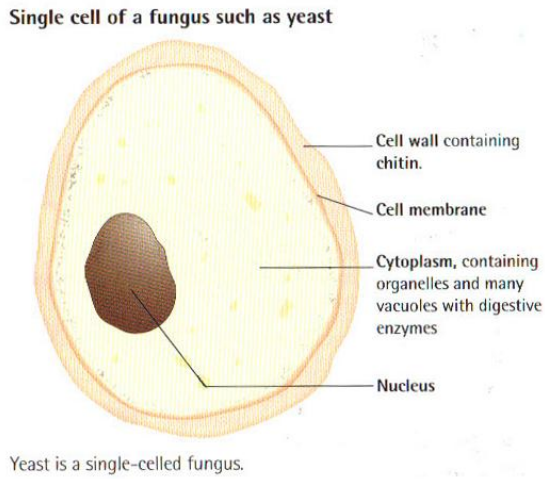
Bacteria:



Virus:

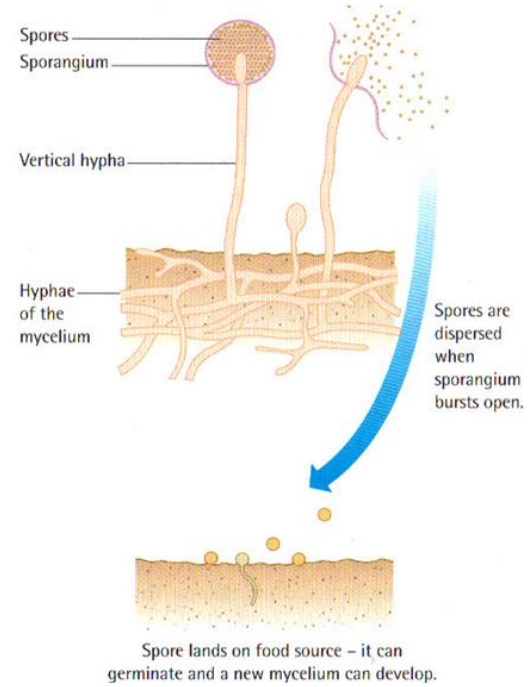


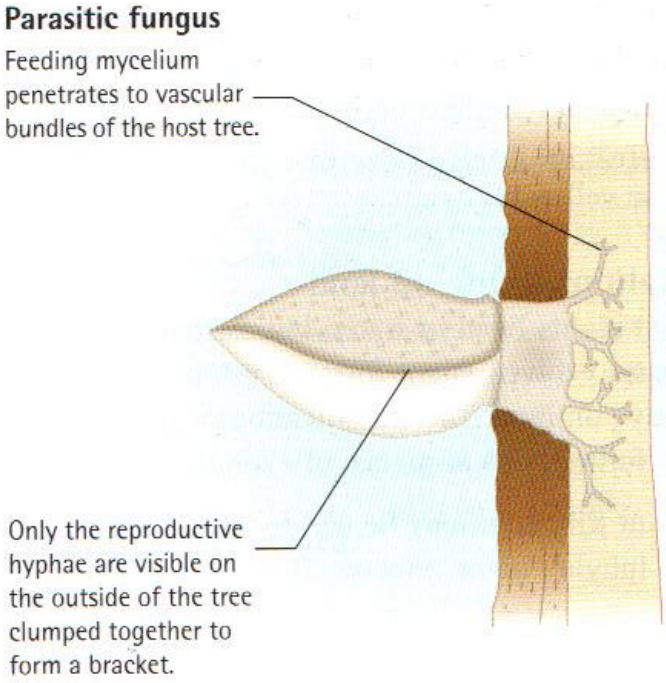
Fungi:



"Adaptation to the environment, as appropriate":

The environment needs to be moist, warm, have a nutrient source but light is not necessary, darker environments have less evaporation (so more moist)





There are other classification systems e.g. cladistics (based on RNA/DNA sequencing data)

The five kingdoms:

Animal: Multi-cellular ingestive heterotrophs (eat living organisms)

Plant: Multi-cellular photosynthetic autotrophic (make their own food) organism with a cellulose cell wall.

Fungi: Single celled or multi cellular heterotrophic organism with a cell wall not made of cellulose, saprotrophs (feed off dead organisms) or parasites

Monera: Single celled organism with no true nucleus

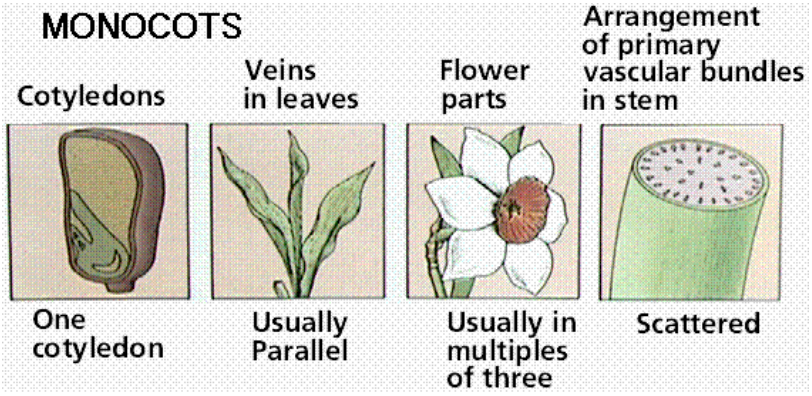
Protista: Single celled organism with a nucleus

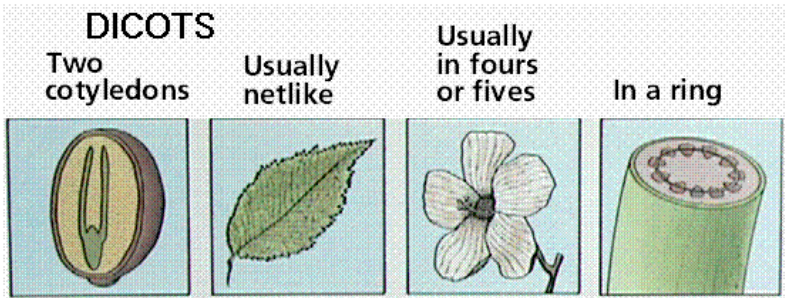
2.2 Adaptations of organisms to their environment

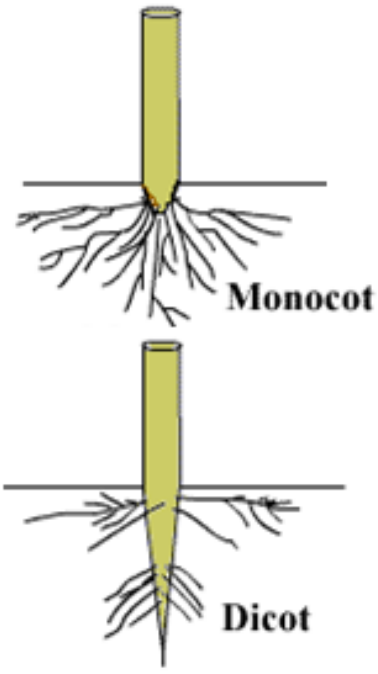
Types of flowering plants:

Monocotyledons: one cotyledon in seed, parallel veins in leaves, elongated leaves, flower parts often in multiples of three (stamens, petals, ovary) e.g. tulip.

Dicotyledons: have two contyledons in seed, branching veins in leaves, have broad leaves e.g. oak trees.







Types of invertebrates:

- **Arthropods**: have jointed legs, a hard exoskeleton (carapace), body divided into segements, there are different types:
  a. **Insects**: 6 legs, 3 body parts (head, thorax and abdomen), made of many segments, and two antennae e.g. bees.
  b. **Crustaceans**: many legs, 4 antennae, 2 body parts (head-thorax and abdomen), made of many segments e.g. crabs.
  c. **Arachnids**: 8 legs, no antennae, 2 body parts (head-thorax and abdomen) e.g. spiders.
  d. **Myriapods**: many legs, many segments, 2 antennae e.g. centipede
- **Annelids**: ringed worms, no legs, chaetae (bristles) e.g. earthworms.
- **Nematodes**: un-segmented worms, no legs, no chaetae e.g. nematodes.
- **Molluscs**: un-segmented, have gills and one muscular foot e.g. snails.

3. Simple Keys

Dichotomous key: uses visible features to classify organisms. It is which gives you a choice of two features and you follow the one that applies: each choice leads to another choice until the organism is narrowed down to its genus and finally species.

Section II: Organisation and maintenance of the organism

1. Cell structure and organisation

All living things are made of cells.

All (typical) cells have: (i.e. some for example the red blood cell do not have all these things, no nucleus)

Cell Membrane: a membrane that controls the entry and exit of dissolved substances and separates the cell's contents from its surroundings.

Cytoplasm: contains water and dissolved substances such as sugars and salts

Nucleus: contains the genetic material (DNA). This carries the coded instructions for controlling the activities and characteristics of the cell.

Mitochondria: organelle where aerobic respiration happens.

A typical animal cell (e.g. the **liver cell**) has all the above things.

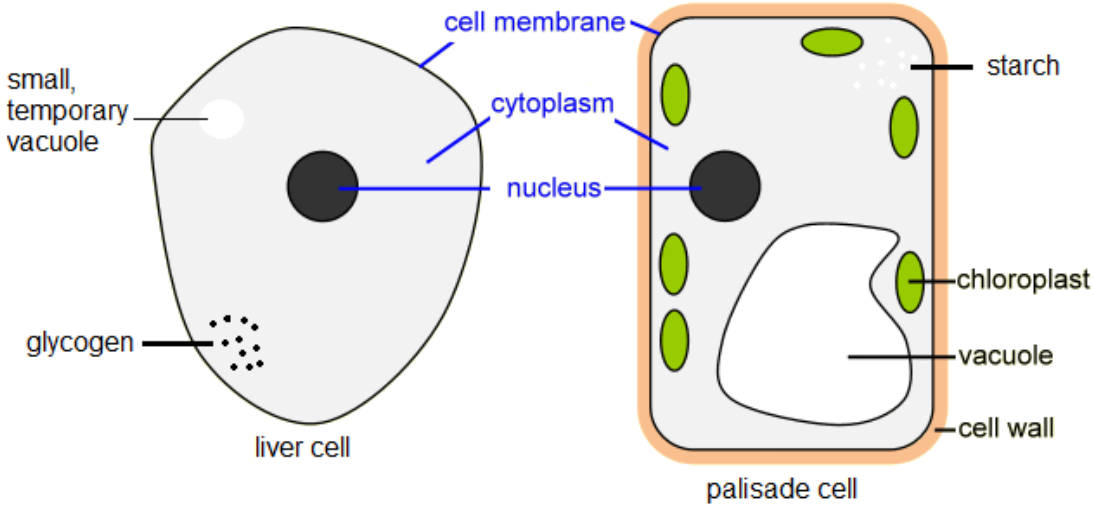
Only plant cells have:

Chloroplast: Small organelle which contains chlorophyll (dye used for light absorption) and enzymes necessary for the production of glucose by photosynthesis.

(Large permanent) **Vacuole**: contains water necessary to provide turgor pressure and may store ions and molecules.

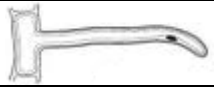
Cellulose **cell wall**: provides structural support, permeable for dissolved substances and water and prevents damage when the cell is in a hypotonic solution i.e. cell can't explode.

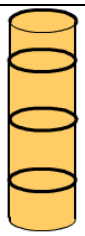
A typical plant cell (e.g. the **palisade cell**) has all the above things.



2. Levels of organisation:

Adapted Cells:

Cell:	Function:	Adaptations:	Appearance
Red blood cell	transport of oxygen	-biconcave shape -no nucleus -flexible -has haemoglobin	
Muscle cell	contracts to get structures closer together	-long -many protein fibres in cytoplasm to shorten cell when energy is available	
Ciliated cell	move and push mucus	-tiny hairs called cilia	
Root hair cell	absorb minerals and water	-elongated shape for more surface area	

xylem vessel	transport water, support plant	-no cytoplasm so water passes freely -no end wall so all cells connect to form a tube -lignin makes in waterproof	
palisade cell	carries out photosynthesis	-regular shape so many can fit in small space -many chloroplasts	

Organelle: a specialized part of a cell that has its own function, e.g. the nucleus or the mitochondrion

Cell: the smallest part of a living structure that can operate as an independent unit e.g. the red blood cell

Tissue: a group of cells with similar structures, working together to perform a shared function e.g. muscle tissue

Organ: a structure made up of a group of tissues, working together to perform specific functions e.g. the heart

Organ system: a group of organs with related functions, working together to perform body functions e.g. respiratory system

Organism: an individual made of organ systems which work to keep that organism alive e.g. a cat

3. Size of specimens

Magnification = size of drawing (mm) / size of specimen (mm)

4. Movement in and out of cells

4.1 Diffusion

Diffusion: the net movement of molecules from a region of higher concentration to a region of lower concentration down a concentration gradient, as a result of their random movement (until equilibrium is reached)

• The diffusion of gases and solutes is important as without it, molecules which are needed for life, for example glucose & oxygen for respiration, would not be able to get to the places they are needed. Water is needed as a solvent, seeds do not germinate without water (role of water in germination)

Solute (e.g. glucose) is a substance which is dissolved. **Solvent** (e.g. water) is a liquid in which a solute is dissolved. A solute dissolved in a solvent is called a **solution**.

4.2 Active transport

Active transport: movement of ions in or out of a cell through the cell membrane, from a region of lower concentration to a region of higher concentration against a **concentration gradient**, using energy released during respiration and a **channel protein**.

Active transport is needed when an organism wants to optimise the amount of nutrients it can take up - ion uptake by root hairs and uptake of glucose by epithelial cells of villi.

4.3 Osmosis

Osmosis: the diffusion of water molecules from a region of low solute concentration (dilute solution) to a region of higher solute concentration (concentrated solution), through a partially permeable membrane.

Effect of osmosis on plant and animal tissues:

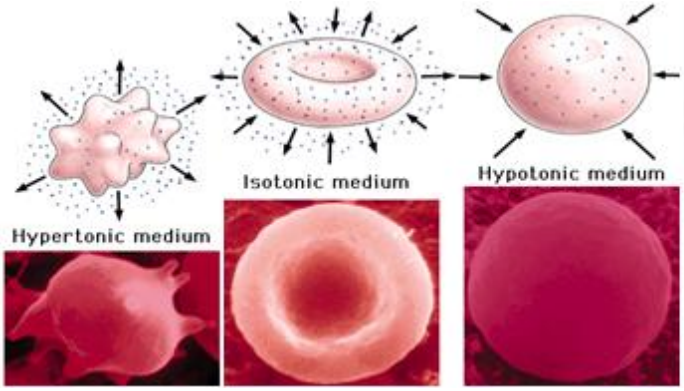
In an **isotonic solution**: concentration of solute outside cell = concentration inside cell ⟶ no change in size

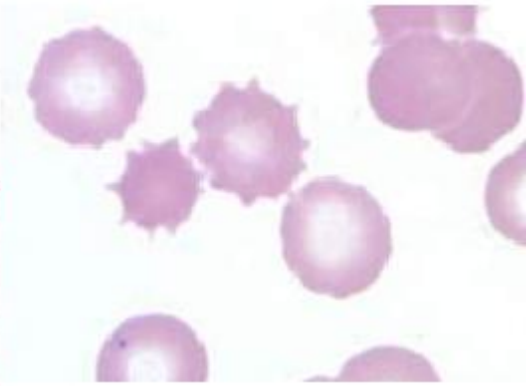
In a **hypertonic solution**: concentration of solute outside cell > concentration inside cell ⟶ cell shrinks

In a **hypotonic solution**: concentration of solute outside cell < concentration inside cell ⟶ cell swells

In animals: (Arrows on the diagram show movement of water)

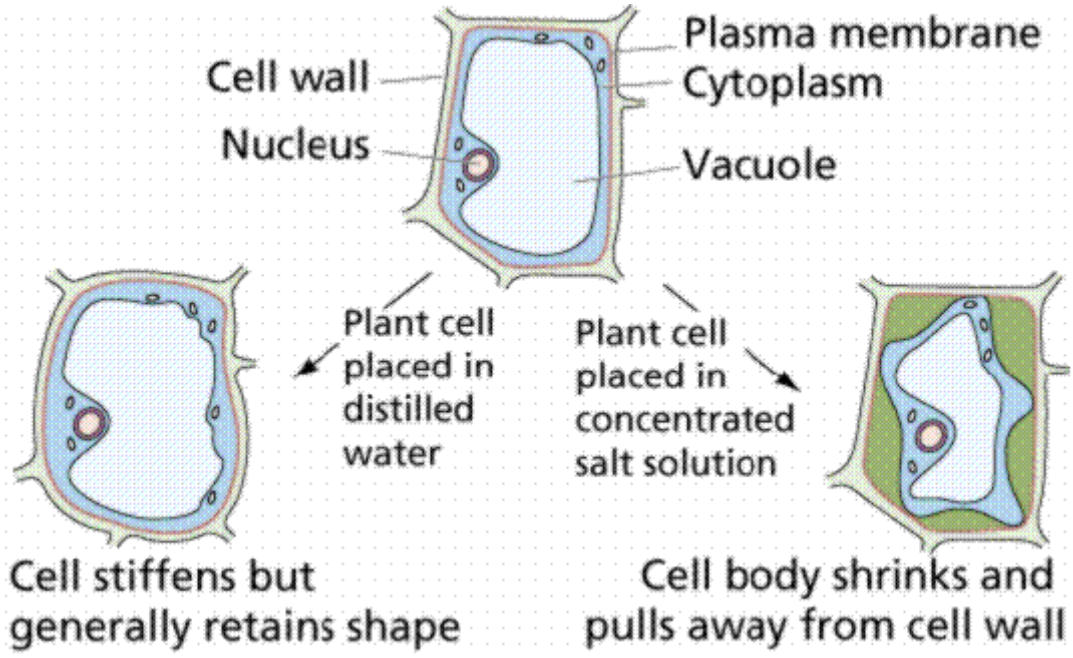
⟶ ⟶ ⟶ ⟶ increasing solute concentration inside of cell ⟶ ⟶ ⟶ ⟶





This can cause an **animal** cell to explode as a result of it having too much water, this is called **crenation** (picture on the very right). The kidney, through a process of osmoregulation, keeps the blood plasma and body fluids at the same water potential as body cells (see Osmoregulation)

In plants:



Water potential is the correct term for saying "water concentration" a high water potential is equivalent to a low solute concentration and vice versa. For plants to take in water through their roots they must have a high solute concentration or low water potential in the roots and low solute concentration or high water potential outside the roots.

5. Enzymes

Catalyst: a substance that speeds up a chemical reaction and is not changed by the reaction

Enzymes: proteins that function as biological catalysts

Enzymes lower the amount of energy needed for a reaction to take place

Substrate: the molecule(s) before they are made to react

Product: the molecule(s) that are made in a reaction

***Catabolic reaction**: molecules are broken down e.g. digestion reactions

***Anabolic reaction**: molecules are combined e.g. turning glucose into starch for plant storage

Factors that control how well enzymes work:

Temperature: enzymes have an **optimum temperature:** the temperature at which they work best giving the fastest reaction. In humans, most enzymes have an optimum temperature of 37°C, but in plants it is around 25°C. When

temperature increases, the molecules move faster so collide with an enzyme in less time (collisions are needed for a reaction to take place – collision theory), having more energy makes them more likely to bind to the **active site**: the part of an enzyme where a specific substrate will fit perfectly. If the temperature is too high, the enzyme molecules vibrate too vigorously and the enzyme is **denatured**: it loses its 3D shape and will no longer bind with a substrate. When the temperature is too low there is not enough **kinetic energy** for the reaction so it reacts too slowly.
pH: The base or acid conditions can denature enzymes too, but the enzyme can be denatured if the pH is too low OR too high. Enzymes have an **optimum pH** too, for example amylase has an optimum pH of 7.5, and pepsin's is pH 2.
Experiment

$2H_2O_2$ (l) ⟶ $2H_2O$ (l) + O_2 (g)

This reaction can be catalysed by an enzyme (catalase) or by a non-biological catalyst (Manganese IV oxide)

1. Put $3cm^2$ of hydrogen peroxide in a test tube.
2. Add fresh potato strips and shake gently.
3. Keep you're thumb on top of the test tube, or use a stopper, to retain the gas.
4. Do the "glowing splint" test ⟶ the splint relights

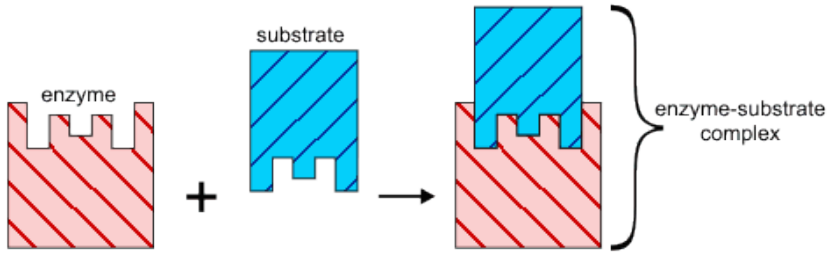
Positive control: repeat the original experiment using manganese IV oxide ⟶ bubbles of oxygen form
Conclusion: the reaction happens because of a catalyst

1st negative control: repeat the original experiment using boiled potato strips ⟶ nothing happens
Conclusion: enzymes denature when they are at high temperatures

2nd negative control: repeat the original experiment using water instead of hydrogen peroxide ⟶ nothing happens
Conclusion: hydrogen peroxide is the substrate

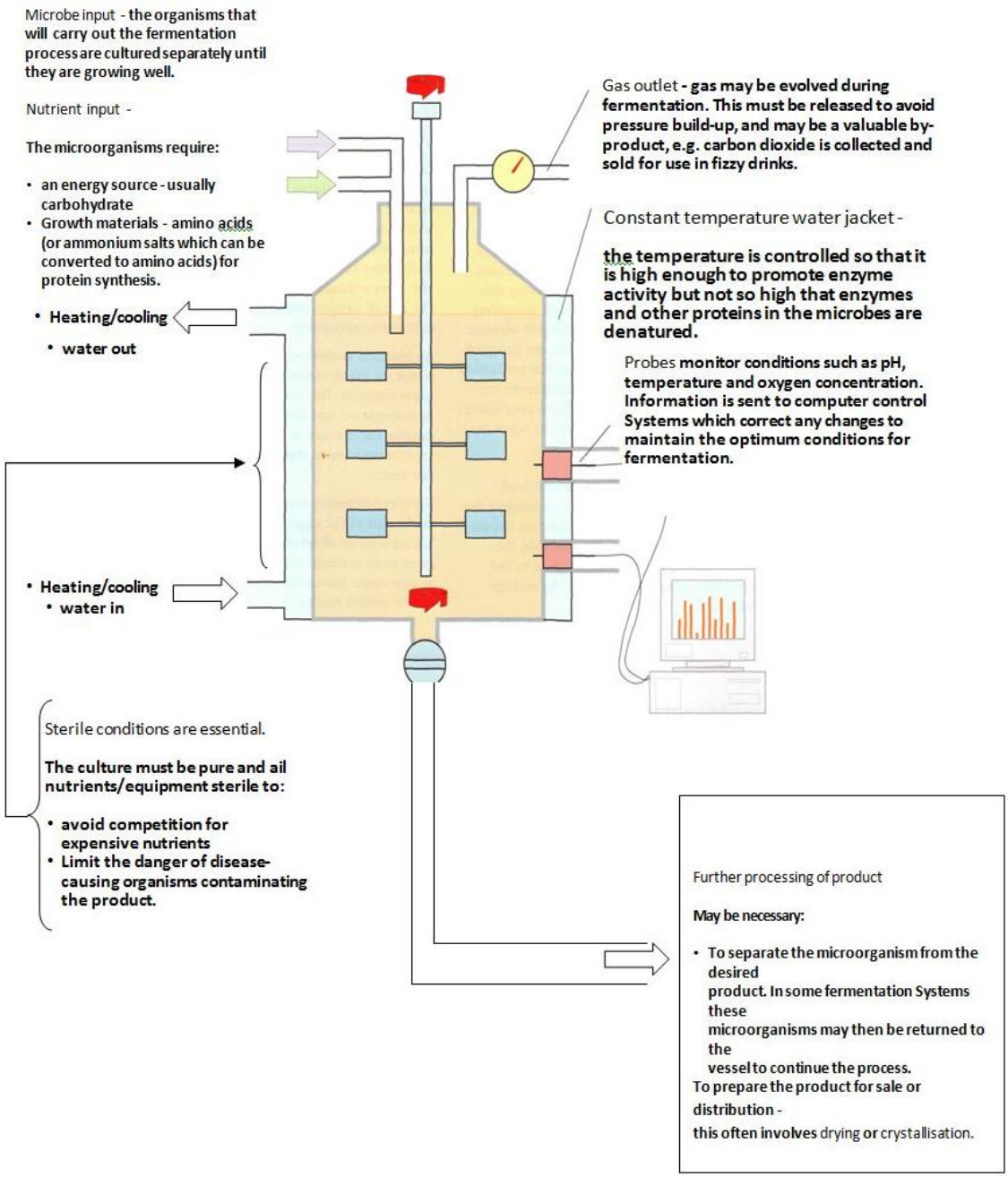
3rd negative control: repeat in a cold environment, the effervescence should be slower
Conclusion: enzymes don't work as well in the cold

This is how you have to be able to represent enzymes (lock-and-key hypothesis):



Enzymes are needed for:
Seeds to germinate: the enzymes turn insoluble food stores to soluble.
Biological washing powders: enzymes are added to washing powders to help remove stains for example:
-lipase for lipids from fatty foods and greasy fingerprints
-protease for proteins from blood stains
NOTE: for best results, give to a woman 🤔
Food industry:
-**isomerase** converts glucose to fructose which is sweeter, so less is needed to give a sweet taste (for slimming biscuits)
-**pectinase** (specifically on syllabus) helps to break down cell walls in fruit juice production so it increases the volume of juice obtained lowers the viscosity of the juice, and reduces the cloudiness of the juice.

Penicillin: an antibiotic produced by a fungus called **penicillium**. **Antibiotics** kill bacterial cells only. Penicillin prevents bacterial cell walls forming. It is manufactured in a fermenter (as are enzymes in washing powders) then filtered to remove fungus and then can be crystallized to make capsules.
Fermenters work like this:



6. Nutrition

Nutrition: taking in of **nutrients** which are organic substances (contain carbon) and mineral ions, containing raw materials or energy for growth and tissue repair, absorbing and assimilating them.

6.1 Nutrients

Carbohydrates are made from Carbon, Hydrogen and Oxygen, **CHO** for short. There are four types: cellulose, sugar, starch and glycogen.

Fats and oils are made from Carbon, Hydrogen and Oxygen, **CHO** for short.

Proteins are made from Carbon, Hydrogen, Oxygen, Nitrogen and sometimes Sulfer, **CHON(S)** for short.

Basic units (monomers)	Larger molecules (macromolecules)
simple sugars	starch and glycogen
fatty acids and glycerol	fats and oils
amino acids	proteins

Chemical tests:

-starch: add a few drops of **iodine solution**, a positive result (i.e. starch is present) is a **deep blue-black** colour, a negative result is orange.

-reducing sugars (e.g. glucose): **Benedict's reagent**, then the mixture is heated for 2 to 3 minutes. Positive result is an **orange/brick-red** colour, negative result is blue (the colour of the Benedict's reagent).
-proteins: add a few drops of **Biuret reagent**, a positive result is a **mauve/purple** colour.
-fats: the **emulsion test**: ethanol is added to the mixture, this is poured into a test tube with an equal amount of distilled water, a positive result: a milky-white emulsion forms.

Nutrient	Source
carbohydrates	cane sugar, rice, potatoes, wheat, sweets, soft drinks
fats	cocoa, coconut, nut oil, fish oil, meat, milk and eggs
proteins	poultry, fish and sea food, meat, dry beans and nuts, vegetables and lentils
vitamin C	citrus fruits, cabbage, sprouts, cauliflower, pineapple, strawberries and green and red peppers
vitamin D	milk, fish oil, eggs, fortified rice, canned pink salmon, canned tuna
calcium	milk, cheese and fish
iron	red meat, dark green vegetables e.g. spinach and parsley, and liver
fibre	Bread, pasta, cereals
water	drinks, foods (especially salad foods like tomatoes), aerobic respiration

Uses:

Nutrient	Uses
carbohydrates	Energy
fats	Source of energy, building materials, energy store, insulation (including electrical insulation for nerve cells), buoyancy, making steroid hormones from cholesterol such as sex hormones
proteins	Energy, building materials, enzymes, haemoglobin, structural materials such as muscle, hormones such as insulin, anitbodies
vitamin C	Protect cells from ageing, production of fibres in body
vitamin D	Absorption of calcium
calcium	development and maintenance of strong bones and teeth
iron	Making haemoglobin
fibre	Provides bulk for faeces, helps peristalsis
water	Chemical reactions, solvent for transport

Deficiencies that you need to know:

- vitamin C – scurvy: loss of teeth, pale skin and sunken eyes
- vitamin D – rickets: weak bones and teeth
- calcium – rickets: weak bones and teeth, also poor clotting of blood, spasms
- iron – anaemia: fatigue/tiredness (less iron ⟶ less haemoglobin ⟶ less oxygen transported ⟶ less respiration ⟶ less energy)

Food additives: substances with no nutrient value which are added to improve appearance, flavour, texture and/or storage properties of food (preservatives inhibit growth of fungi or bacteria e.g. SO_2 to control browning of potatoes, anti oxidants prevent deterioration). But they can have health hazards for example sulfer dioxide causes sensitivity in asthma sufferers.
Single-cell protein (SCP): sources of mixed protein extracted from pure or mixed cultures of algae, yeasts, fungi or bacteria (grown on agricultural wastes) used as a substitute for protein-rich foods, in human and animal feeds. Excess yeast from alcoholic fermentation is sometimes used as cattle feed. Fungi can be grown in a bioreactor to produce food for humans. This is called mycroprotein or Quorn.
Yoghurt: soured milk, partially clotted, with a mildly acidic taste = natural yoghurt. In incubation, the culture of bacteria are kept at 45°C and turn lactose into lactic acid (milk sugar) during respiration, then cooling at 4°C stops the reaction

6.2 Plant Nutrition

6.2.1 Photosynthesis

Photosynthesis: the fundamental process by which plants manufacture carbohydrates from raw materials using energy from light.

Carbon dioxide + water ⟶ (light + chlorophyll) ⟶ glucose + oxygen

$6CO_2 + 6H_2O \longrightarrow (\text{light} + \text{chlorophyll}) \longrightarrow C_6H_{12}O_6 + 6O_2$

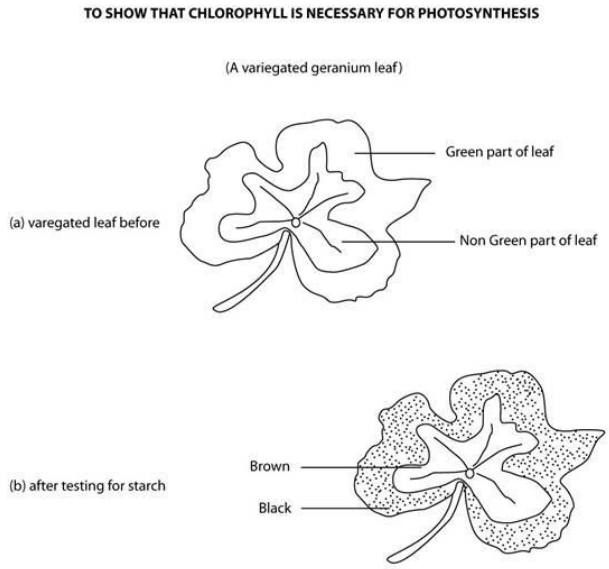
The carbon dioxide diffuses through the open stomata of the leaf of a plant. Water is taken up through the roots.

Chlorophyll is a dye, which traps light energy and converts it into chemical energy for the formation of carbohydrates and their subsequent storage.

Investigating the factors necessary for photosynthesis:

Chlorophyll – with a variegated leaf...

1) Leaf is boiled in water for 2 minutes: to break down cell walls, denature the enzymes and allow for easier penetration by ethanol.
2) Warmed in ethanol until leaf is colorless: to extract the chlorophyll, which would mask observation (you need to see a color change), chlorophyll is soluble in ethanol but not water.
3) Dipped in water briefly: to soften leaf
4) Leaf is placed on a white tile and iodine is added: if starch is present the color will be blue-black, if it is absent it will be orange-brown, this is shown against the white tile.



Light and CO_2: de-starch the plant by placing it in a dark cupboard or box for 48 hours, so that there is no starch in the leaves. Then you can:

A) Clip a black paper onto both sides of the leaf to make a strip

B) Make an air-tight bag around a leaf with soda lime (absorbs CO_2) in it.

C) Make an air-tight bag around a leaf with hydrogencarbonate solution (provides CO_2) in it.

A proves that light is needed. B and C prove that CO_2 is needed.

Then remove leaf and:

1. Leaf is boiled in water for 2 minutes: to break down cell walls, denature the enzymes and allow for easier penetration by ethanol.
2. Warmed in ethanol until leaf is colorless: to extract the chlorophyll, which would mask observation (you need to see a color change), chlorophyll is soluble in ethanol but not water.
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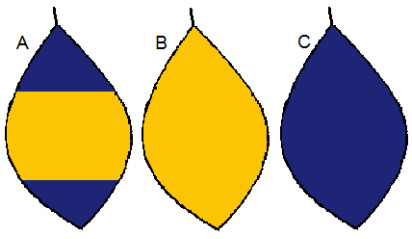


Carbon dioxide:

Required materials

2 Potted plants
2 Bell-jars
A Candle
Dish containing Caustic soda
Petroleum jelly
Glass sheets
Iodine solution to test leaves for starch

Estimated Experiment Time

Approximately 10 minutes to set up the apparatus and 8-12 hours to carry out the observations

Step-By-Step Procedure

1. Take two young potted plants.
2. Apply petroleum jelly on two glass sheets.
3. Place the potted plants on these glass sheets.
4. On one glass sheet, along with the potted plant place a burning candle.
5. In the other, place a dish containing caustic soda.
6. Cover them with the bell jars.
7. Leave undisturbed for a few hours and test the leaves from each pot for the presence of starch.

Note

Potted plants must ideally have been kept in the dark to make the leaves starch-free before including them in this experiment.
The petroleum jelly makes the bell jars airtight.

Investigating what happens when varying the factors affecting photosynthesis:

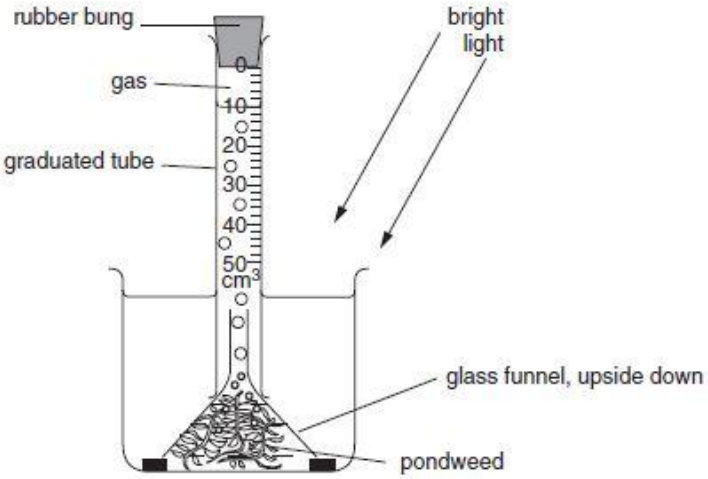


Fig. 4.1

NOTE: this diagram is from an IGCSE paper 6 (and the "gas" is oxygen and the pondweed is in water)

Light intensity: (NOTE: I copied this from the "model answer") First a lamp is placed as close as possible to the apparatus, then the experiment is repeated several times, each times with the lamp further away from the apparatus. Heat from the bulb is prevented from affecting the result by placing a clear glass sheet between the lamp and the apparatus, and the pond weed used is left for several minutes in each new light intensity to allow it to adjust to new conditions before rate is measured.

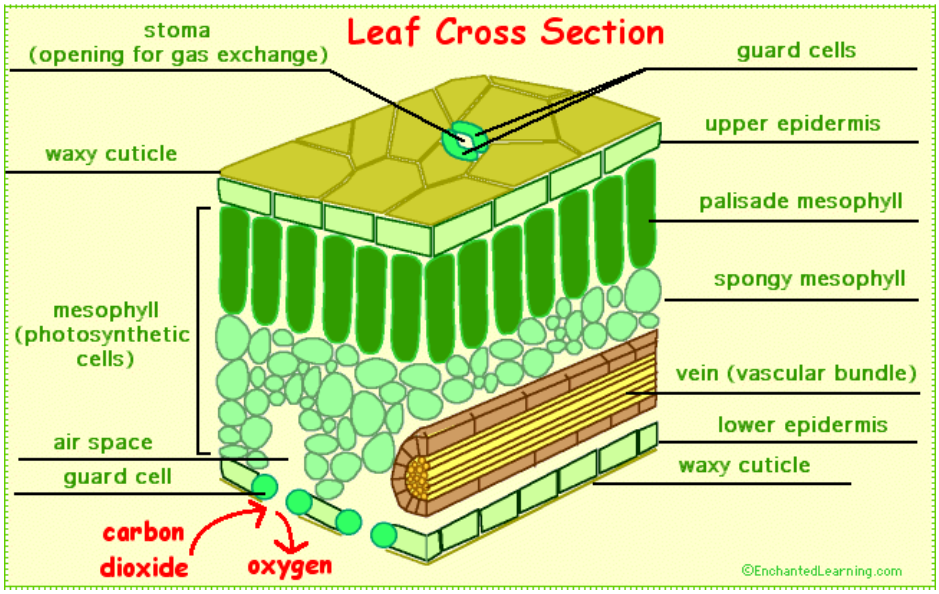
Carbon dioxide: vary the amount of hydrogen carbonate in the solution, this supplies the plant with carbon dioxide for photosynthesis (light intensity and temperature are controlled variables)

Temperature: set up the apparatus in several different-temperature environments

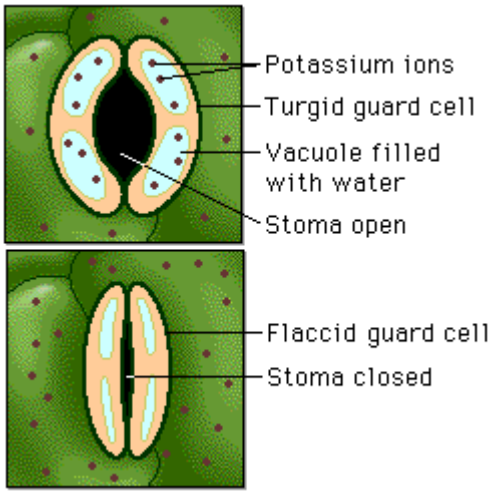
(For each experiment you measure the volume of oxygen produced per amount of time, or how long it takes to make a certain amount of oxygen.)

Limiting factor: is something present in the environment in such short supply that it restricts life processes.
Limiting factors in photosynthesis: plants need water, magnesium for chlorophyll, CO_2, the right temperature, light of the right wavelength, and a good intensity and duration and the amount of any other reactant needed for a reaction, so these can all be limiting factors.
Greenhouse systems: to increase the crop yield, farmers control the limiting factors:
-CO_2 enrichment: paraffin is burnt to increase the CO_2 concentration (*by three times the original amount and doubling the yield)
-optimum temperature: thermostatically controlled heaters make the temperature right for the enzymes to work
-optimum light: the light has a high intensity for more photosynthesis, the correct wavelengths (red and blue not green) and duration controls production of fruit

6.2.2 Leaf Structure



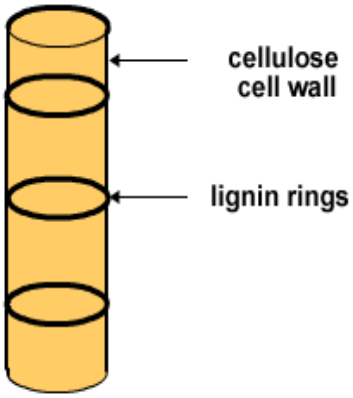
1. The cuticle is a waxy non-living layer that prevents water loss from the top of the leaf.
2. The upper epidermis is a thin layer of cells that protect the cells below.
3. The palisade mesophyll cells are column-shaped and full of chloroplasts for photosynthesis. They are close to the top of the leaf so they get a lot of light.
4. The spongy mesophyll cells are irregularly shaped to create air spaces to allow gases to diffuse and have many chloroplasts (fewer than the palisade mesophyll). They are lower so they get less light.
5. The lower epidermis is on the bottom of the leaf.
6. The bottom of the leaf also contains stomata (little holes) that can open and close for gas exchange (mostly, to let in CO_2 and let out O_2). The stomata can close to prevent water loss, and open to let gases come in and out. When guard cells LOSE water, the stoma CLOSE (at night), while the stoma OPEN when guard cells gain water & swell (during the day).



The **vascular bundle** or **vein** is made of two vessels:

Xylem vessel: is a unidirectional vessel which transports water and dissolved minerals. Its walls are made out of waterproof **lignin.**

Water is absorbed from the soil by root hair cells through **osmosis**. Water moves up the plant due to evaporation at the leaves, where water is lost to the environment. This is called **transpiration**. The movement of water up the plant is called the **transpiration stream**.



Phloem vessel: (bidirectional) contains **sieve elements** which allow sugars to pass from one cell to the next downwards and **companion cells** which provide the energy for active transport of sugars all over plant.

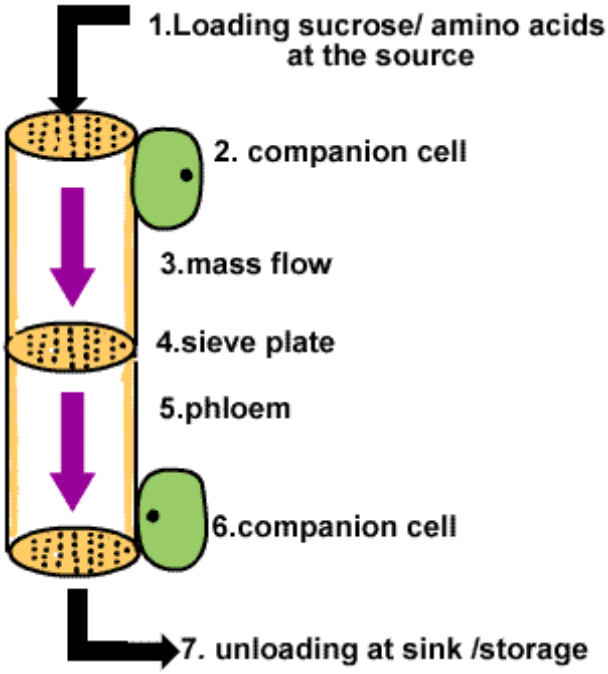
1.Translocation moves the organic molecules (sugars, amino acids) from their source through the tube system of the phloem to the sink. Phloem vessels still have cross walls called sieve plates that contain pores.

2. Companion cells actively load sucrose (soluble, not metabolically active) into the phloem.

3. Water follows the high solute in the phloem by osmosis. A positive pressure potential develops moving the mass of phloem sap forward.

4. The sap must cross the sieve plate. Current hypothesis do not account for this feature.

5. The phloem still contains a small amount of cytoplasm along the walls but the organelle content is greatly reduced.



6. Companion cells actively unload (ATP used) the organic molecules

7. Organic molecules are stored (sucrose as starch, insoluble) at the sink. Water is released and recycled in xylem.

6.2.3 Mineral Requirements (plants)

Nitrogen: in the form of nitrate/nitrite/ammonium ions are needed for protein synthesis. Nitrogen deficiency means the plant will be small, will grow slowly, top leaves are pale, bottom leaves are dead, roots are slightly affected.

Magnesium: is needed for chlorophyll synthesis. Magnesium deficiency means plant lacks chlorophyll, leaves turn yellow from the bottom up (roots normal).

Nitrogen fertilisers/artificial fertilisers: they provide the nitrogen in the form of nitrate ions, nitrite ions or ammonium ions (and phosphates & potassium too) needed for protein synthesis. But using fertilisers can lead to **eutrophication**, which is when the fertiliser is transported by rain and **leaches** into some (stagnant) water e.g. a pond.

6.3 Animal Nutrition

6.3.1 Diet

Balanced Diet: getting all the right nutrients in the correct proportions.

Malnutrition: means “bad feeding”, it can have several forms:

1. having a balanced diet BUT eating too much of everything (**overnutrition**)
2. having too little food (**undernutrition**)
3. eating foods in incorrect proportions i.e. having an unbalanced diet

Types of malnutrition for IGCSE, effects (*and causes):

Starvation: losing strength and eventually dying because of lack of food

Coronary Heart Disease (**CHD**): heart attacks (causes)

Constipation: faeces are not passed as regularly as they should be. (It is caused by too little fibre. Bacteria can work on the faeces and produce chemicals and cause colon cancer.)

Obesity: heart attack, stroke, joint pain, mobility impairment, high blood pressure

6.3.2 Food Supply

Food Production has increased because:

-improved machinery means less labour is needed

-**fertilisers** help crops to grow better

-**insecticides**: a type of pesticide that kills insects

-**herbicides**: a type of pesticide that kills weeds

-**selective breeding/artificial selection** and **genetic modification** means that yields are improved: cows produce more milk, cows are more muscular giving more meat, plant crops can resist insects and cold weather

Details of artificial selection

Genetic modification – see genetic engineering

(This is on the syllabus but it is geography)

The problems of world food supplies is that food can be very efficiently produced in places like Europe and can't be grown in sufficient amounts in places like Africa. Places like Europe have more than enough food (so-called food mountains and wine lakes), but don't want to share it.

Famine is caused by:

-unequal distribution of food

-drought: crops ruined

-flooding: crops ruined

-diseases

-poverty – can't afford fuel or fertilisers

-increasing population: more people to feed

6.3.3 Human alimentary canal

Ingestion: taking substances (e.g. food, drink) into the body through the mouth.

Egestion: passing out of food that has not been digested, as faeces, through the anus.

Functions:

Mouth: contains teeth used for mechanical digestion, and is the area where food is mixed with salivary amylase, it is where **ingestion** takes place.

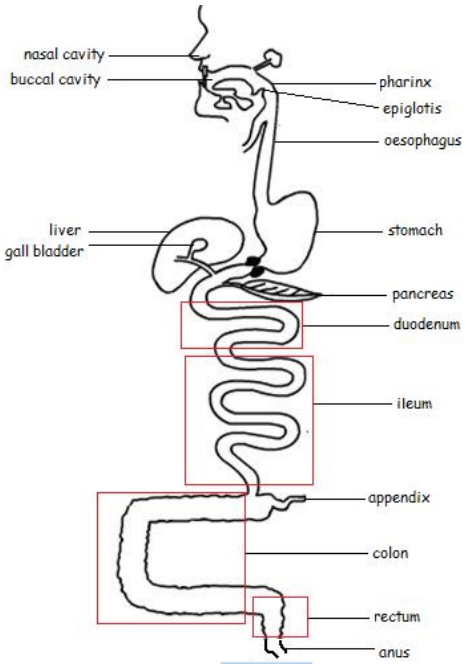
Salivary glands: produce saliva which contains amylase and helps to make the food slide down the oesophagus

Oesophagus: tube-shaped organ which uses peristalsis to transport food from the mouth to the stomach.

Stomach: has pepsin (a protease) to break down proteins into peptides, it also kills bacteria with hydrochloric acid.

Small intestine: tube shaped organ composed of two parts the:

-**duodenum**: where fats are emulsified by bile, and digested by pancreatic lipase to form fatty



acids and glycerol, pancreatic amylase and trypsin (a protease) break down starch and peptides into maltose and amino acids

-**ileum**: maltase breaks down maltose to glucose. This is where absorption takes place. It is adapted by having villi and microvilli.

Pancreas: produces pancreatic juice (you don't say) which contains amylase, trypsin and lipase and hydrogencarbonate.

Liver: produces bile, stores glucose as glycogen, interconversion of glucose and glycogen to keep glucose concentration constant, interconversion of amino acids: converting amino acids into others (**transamination**), **deamination** (defined later) and removal of old red blood cells and storage of their iron. The liver is also the site of the breakdown of alcohol and other toxins.

Gall bladder: stores bile from liver

Large intestine: tube shaped organ composed of two parts:

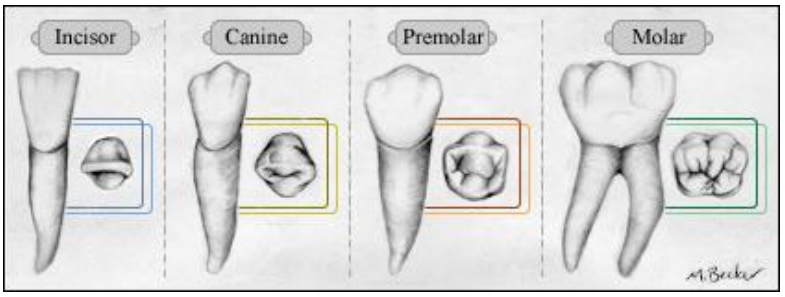
-**colon**: organ for the absorption of some minerals and vitamins, and reabsorbing water from waste to maintain the body's water balance

-**rectum**: where faeces are temporarily stored

Anus: a ring of muscle which controls when poop is released.

6.3.4 Mechanical and physical digestion

Digestion: the break-down of large, insoluble food molecules into small, water soluble molecules using mechanical and chemical processes



Incisors (4): rectangular shape, sharp for cutting and biting

Canine (2): sharp-pointed for holding and cutting

Premolar (4): blunt for chewing and crushing

Molar (6): blunt chewing and crushing (note the number of roots)

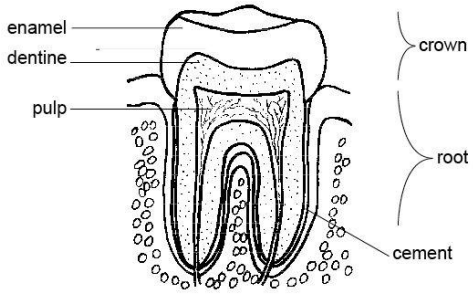
Tooth Decay: Sugars in the food we eat stay trapped in between teeth. Bacteria use the sugar for their own life processes. The bacteria produce a sticky matrix which traps food particles and forms a coating of **plaque** on the teeth. Bacteria convert sugars into acids. Acids remove calcium and phosphate from the enamel, allowing bacteria to reach the dentine beneath. This is the start of **dental decay**. Dentine decays rapidly and pulp cavity may become infected.

Prevention:

-eating food with low sugar content

-regular and effective teeth brushing to remove plaque

-finishing a meal with a crisp vegetable and a glass of water



Structure of tooth:

-**enamel**: the strongest tissue in the body made from calcium salts

-**cement**: helps to anchor tooth

-**pulp cavity**: contains tooth-producing cells, blood vessels, and nerve endings which detect pain.

-**dentine**: calcium salts deposited on a framework of collagen fibres

-**neck**: in between crown and root, it is the gums

Fluoridation: helps teeth by A) promotes tooth remineralisation by attracting other minerals like calcium B) it helps to make the tooth decay-resistant and C) slows down production of acids by bacteria.

The arguments for:

-helps to strengthen tooth enamel

-available to all / treats whole population

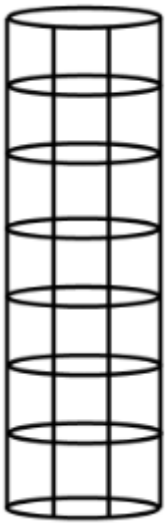
-free (to people) / cheap to supply

The arguments against:

-allergies/ side effects such as gastric disturbance, cardiovascular problems, head ache, fits

-bad taste

-dosage not controlled for individuals / no individual choice
-mottled / discoloured teeth / fluorosis
Chewing: to grind up food or other material with the action of the teeth and jaws, also called mastication.
Peristalsis: the waves of involuntary muscle contractions that transport food, waste matter, or other contents through a tube-shaped organ such as the intestine. The organ contains **circular muscles** (rings) and **longitudinal muscles** (lines). Circular muscles contract on either side of the bolus to push it downwards but not letting it fall. Longitudinal muscles contract to shorten the organ.



Bile: is produced by the liver and stored in the gall bladder, its role is to emulsify fats, to increase the surface area for the action of enzymes.

6.3.5 Chemical Digestion

Chemical digestion: is where enzymes are used to break down large insoluble substances such as proteins into smaller soluble substances like amino acids so that they can be absorbed.

These are the three enzymes you have to know:

Amylase: breaks down starch into maltose, it is produced in the pancreas (but also in the salivary gland?)

Protease: breaks down proteins to peptides (this is done by pepsin, a protease) then into amino acids (this is done by trypsin, another protease). Pepsin comes from the stomach and trypsin comes from the pancreas.

Lipase: breaks down lipids into fatty acids and glycerol, produced by the pancreas.

*But this table gives a better picture of how everything works:

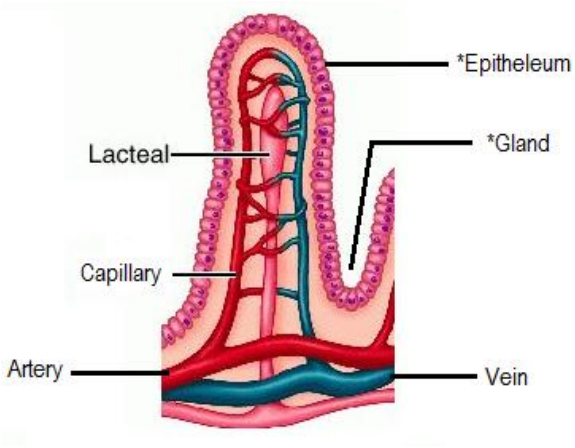
Region of gut	Digestive juice	Enzymes	Substrate	Product(s)	Other substances in juice	Function of other substance
Mouth	saliva	salivary amylase	starch	maltose	hydrogencarbonate	alkaline environment for amylase
Stomach	gastric juice from stomach glands	pepsin	proteins	peptides	hydrochloric acid	acidic environment for pepsin, kills bacteria
Small intestine (duodenum)	pancreatic juice bile	-amylase -trypsin -lipase	-starch -peptides -fats	-maltose -amino acids -fatty acids + glycerol	hydrogencarbonate bile salts and hydrogencarbonate	neutralise chyme, alkaline environment for enzymes emulsifies fats, neutralises chyme
Small intestine (ileum)	intestinal juice	maltase	maltose	glucose	NA	NA

6.3.6 Absorption

Absorption: the movement of digested food molecules through the wall of the intestine into the blood or lymph. The small intestine is the region for the absorption of digested food.

The small intestine is folded into many **villi** which increase the surface area for absorption. One villus will have tiny folds on the cells on its outside called **microvilli**. More surface area means more absorption can happen.

Capillary: transports glucose and amino acids
Vein: delivers absorbed products to the liver via the **hepatic portal vein**.
***Gland**: produces enzymes
***Epithelium**: only one cell thick for faster transport. The cells of the epithelium are folded to form microvilli.
Small intestine and colon: absorb water (the small intestine absorbs 5–10 dm^3 per day, the colon 0.3–0.5 dm^3 per day)



6.3.7 Assimilation

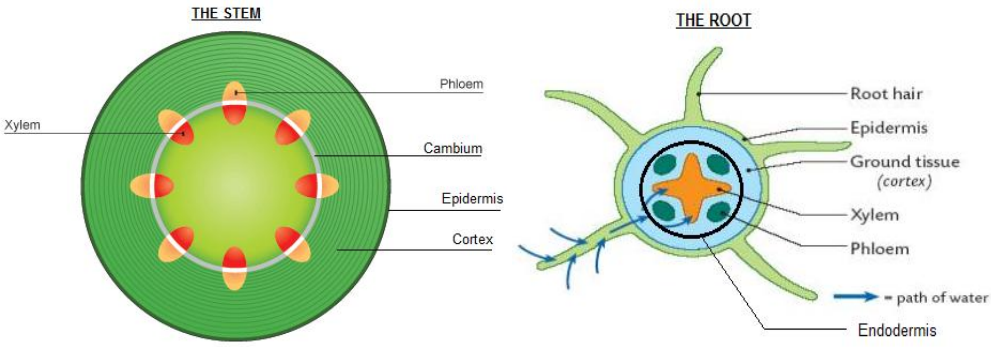
Assimilation: the movement of digested food molecules into the cells of the body where they are used, becoming part of the cells. The liver releases nutrients in ideal concentrations through the **hepatic vein** (not the hepatic PORTAL vein) to tissues around the body.
The liver in metabolism: converts glucose into glycogen as a means of storage (because glycogen is insoluble) and converts amino acids into proteins, and destroys excess amino acids.
Fat is an energy storage substance.
Deamination: as removal of the nitrogen containing part of amino acids to form urea, followed by release of energy from the remainder of the amino acid.
The liver is also the site of the breakdown of alcohol and other toxins.

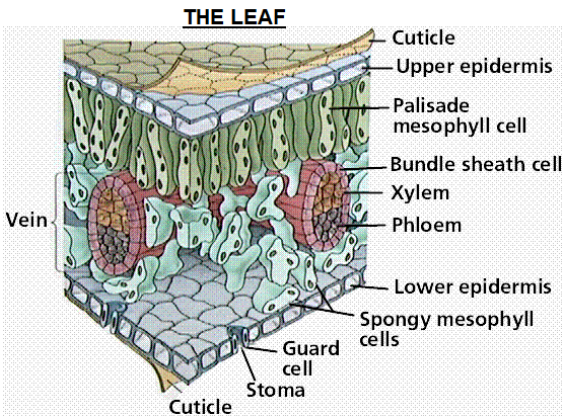
7. Transportation

7.1 Transport in plants

The **xylem** and **phloem** vessels have two functions: 1) to transport substances from **sources** (where they are taken in or made) to the **sinks** (where they are used or stored) and 2) to support the stem.

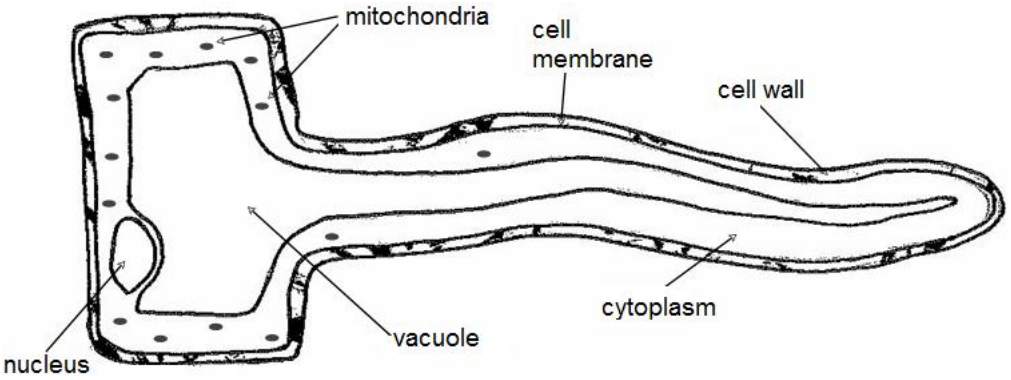
You need to be able to identify the positions of the xylem and phloem in a cross section of:





7.1.1 Water uptake

The **root hair cell**:



Function: to absorb water and minerals from the soil. They have an elongated shape for more surface area.

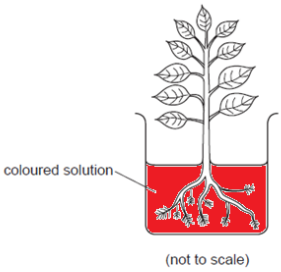
The PATH of water in plants is as follows:

1. Water enters the root hair cell for the moist soil because the water potential is higher in the soil, than in the cytoplasm.
2. Water passes through the **cortex cells** by osmosis but mostly by "suction".
3. Water (and dissolved substances) is forced to cross the **endodermis**.
4. Water enters the xylem then leaves when it gets to the mesophyll cells.

The uptake of water is caused by water loss in leaves through the stoma lowering the water potential in leaves, then water moves from xylem to enter leaf tissues down water potential gradient, then water moves up the stem in the xylem due to the tension (because of **cohesion** / sticking of water molecules to each other) caused by water loss from the leaves, and ends with the gain through roots. The upward flow of water is called the **transpiration stream**.

Investigating the pathway of water through the above-ground parts of a plant (using celery as an example):

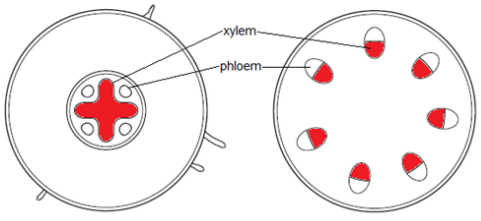
1. Cut a piece of celery and stand it in a coloured solution (suitable stains include red eosin and methylene blue)
2. Leave for a few hours
3. Carefully cut off about 5 cm of celery, to get a cross-section then, use a hand lens to look for the stain. The coloured solution has been carried up the xylem (diagrams page 88) but it should be similar to the diagram above, in this section, for the cross section of a stem.



(not to scale)

Fig. 1.1

Fig. 1.2 shows a section of a root and Fig. 1.3 shows a section of a stem.



root

Fig. 1.2

stem

Fig. 1.3

7.1.2 Transpiration

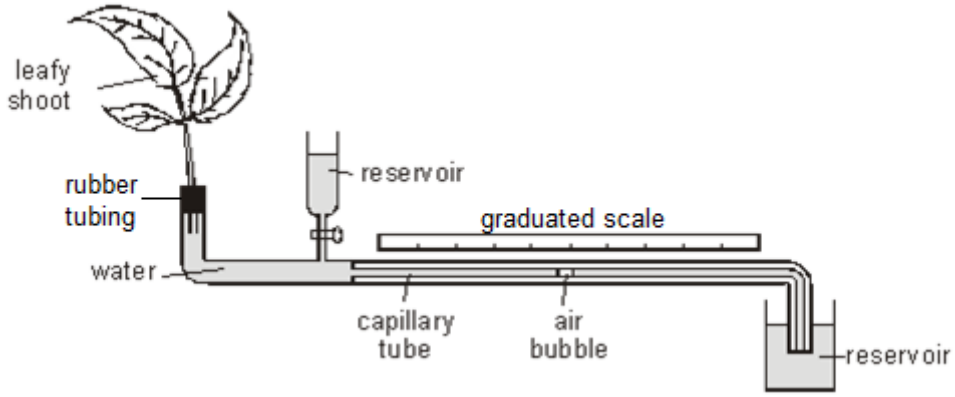
Transpiration: evaporation of water at the surfaces of the mesophyll cells followed by loss of water vapour from plant leaves, through the stomata.

Water leaves the mesophyll cells, into the air spaces created by the irregular shape of the spongy mesophyll cells, and then diffuses out of the stomata.

Factors affecting the rate of transpiration are:

-**temperature**: higher temperatures increase water-holding capacity of the air and increases transpiration rate

-**humidity**: low humidity increases the water potential gradient between the leaf and the atmosphere, and increases transpiration rate
-**light intensity**: high light intensity causes the stomata to open (to allow more photosynthesis) which allows transpiration to occur.
-***Wind** moves humid air away
Wilting: occurs if water loss is greater than water uptake – cells become **flaccid**, the tissues become limp and the plant is no longer supported.
Adaptations of stem leaf and/or root in a:
-**desert**: the **cacti** has a green stem which carries out photosynthesis, leaves reduced to **spines** to reduce surface area for water loss, stomata are sunk in grooves to avoid drying winds, swollen stem stores water, shallow roots to absorb lightest rainfall and deep roots penetrate to very low water table.
-**pond**: **aquatic plants** have little lignin in xylem, since leaf is supported by water, a very thin cuticle since water is plentiful, and stomata on the upper surface to allow carbon dioxide uptake from the atmosphere.
-**garden**: **wilting and leaf fall**:
a. wilting: leaves collapse and stomata close to reduce heat absorption and transpiration of water.
b. leaf fall: in very severe conditions, e.g. when water is frozen during winter, plants allow the leaves to fall off so that no water loss can occur. No photosynthesis can take place, but the plants can remove chlorophyll from leaves for storage before allowing leaves to fall (why leaves go yellow/brown/red in autumn)
Investigating transpiration rate: the potometer (page 91)



1. Leafy shoot must be cut, the apparatus filled and the shoot fixed to the potometer, all under water to prevent air locks in system. Capillary tube must be horizontal otherwise the bubble will move because of its lower density.
2. Allow plant to equilibrate (5min) before introducing air bubble. Measure rate of bubble movement at least 3 times, and use reservoir to return bubble to zero each time. Record air temperature and find mean of readings.
3. Find out leaf area to calculate rate of water uptake per unit of leaves.
Variables: temperature (propagator vs. fridge), air humidity (boiling water nearby vs. normal air), light intensity (lamp in a variable potential divider?) and wind (using a fan vs. no fan, I guess).

7.1.3 Translocation

Translocation: the movement of sucrose and amino acids (*and hormones) in phloem; from regions of production (**sources**) to regions of storage OR to regions of utilisation in respiration or growth (**sinks**).
Transpiration and translocation in different seasons:
-In spring: sucrose in transported from stores in the roots to leaves
-In summer and early autumn: sucrose goes from photosynthesizing leaves to root stores,
but always from source to sink.
Aphids (greenfly) insert their mouthpiece into the phloem to take nutrients. **Systemic insecticides** are sprayed onto plants and are absorbed into the phloem. They are used to kill only the pests (the aphids) instead of killing the useful insect species (pollinators).

7.2 Transport in humans

Circulatory system: a system of tubes (veins, capillaries and arteries) with a pump (the heart) and valves (in heart and in veins) to ensure one-way flow of blood.
Double circulation system: a low pressure circulation to the lungs and a high pressure circulation to the body tissues. One circulation has higher pressure because it has to travel a further distance (all the way around the body) while the

other is lower pressure (since the lungs are very close to the heart). Blood passes through the heart twice per complete circuit.

7.2.1 Heart

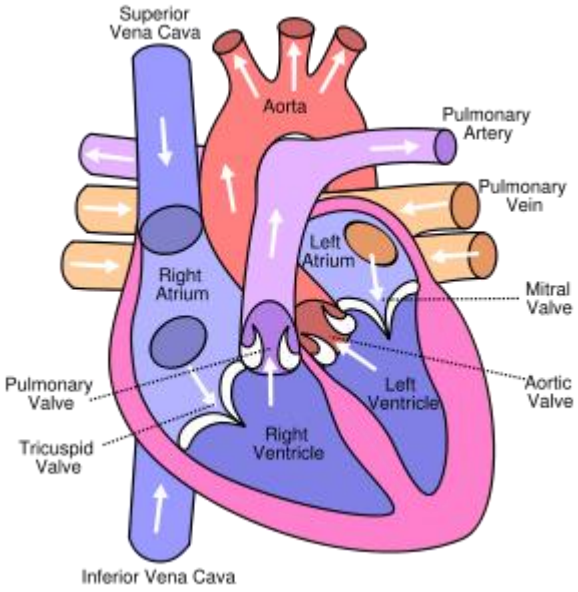
Muscular wall: is thicker on the right side (the left ventricle) because blood has to be pumped further.

Septum: partition dividing the left and right ventricle

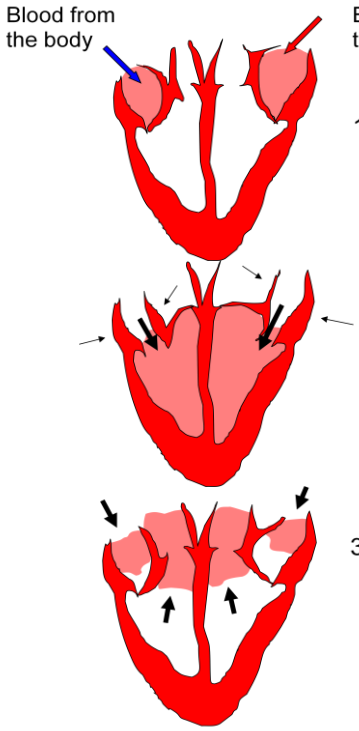
Chambers: there are **atriums** (on the top) and **ventricles** (on the bottom) the right atrium and ventricle are on the left and vice versa (since, for example, you right hand is on the left when someone is looking at you from infront)

Valves: there are four valves: the mitral valve, aortic valve, pulmonary valve and tricuspid valve. They stop the back flow of blood.

Blood vessels: there are two veins: the **vena cava** (deoxygenated blood from the body) and **pulmonary vein** (oxygenated blood from the lungs) and two arteries: **pulmonary artery** (deoxygenated blood to the lungs) and the **aorta** (oxygenated blood to the body).



The heart functions like this:



1. The heart beat begins when the heart muscles **relax** and blood flows into the atria.
2. The atria then **contract** and the valves open to allow blood into the ventricles.
3. The Ventricles contract forcing the blood to leave the heart. At the same time, the atria are relaxing and once again filling with blood.

The staged cycle then repeats itself.

Physical activity makes the heart beat more quickly and more deeply, for an increased circulation of blood so that more oxygen and glucose can get to the muscles.

Coronary Heart Disease: coronary artery becomes blocked, interrupting the supply of blood to the heart muscle. The heart muscle cells are deprived of oxygen and glucose, and poisonous wastes such as lactic acid build up. Part of the heart muscle stops contracting, causing a heart attack YAY!

Causes:

- **poor diet** – high levels of cholesterol or saturated fatty acids in the blood

- **poor lifestyle** – smoking, lack of exercise, stress
- **genetic factors** – being male ("sigh"), having a family history of heart disease

Prevention method:
-don't smoke
-avoid fatty foods
-take aerobic exercise often

7.2.2 Arteries, veins and capillaries

Blood vessels to know:

-Lungs ⟶ heart = pulmonary vein

-Heart ⟶ lungs = pulmonary artery

-Liver ⟶ heart = hepatic vein

-Heart ⟶ liver = hepatic artery

-Heart ⟶ kidneys = renal artery

-Kidneys ⟶ heart = renal vein

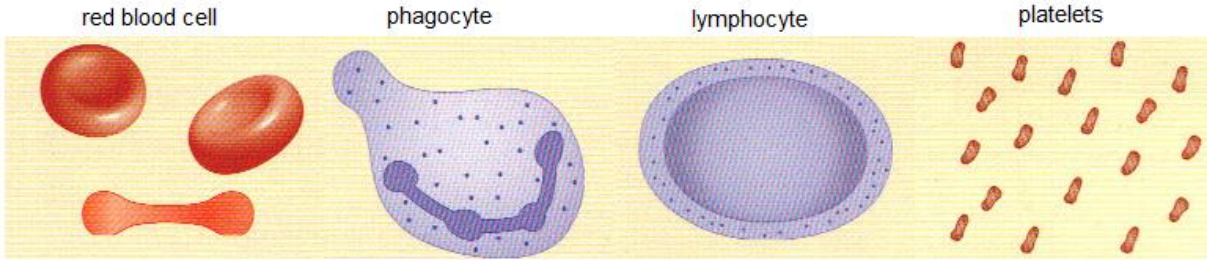
Artery:
Function: transport high pressure blood away from the heart
Structure: 1) elastic walls expand and relax as blood is forced out of the heart. This causes the pulse. 2) Thick walls withstand the high pressure of blood. Rings of muscle can narrow or widen the artery and control the blood flow in it according to the body's needs.

Vein:
Function: transport low pressure blood to the heart
Structure: 1) Valves prevent the backflow of blood. Blood is at low pressure, but nearby muscles squeeze the veins and help push blood back towards the heart. 2) Large diameter and thin walls reduce resistance to the flow of blood.

Capillary:
Function: allow substances to diffuse into cells
Structure: 1) one cell thick walls for easy diffusion 2) highly branched giving an enormous surface area 3) the capillary beds are constantly supplied with fresh blood, keeping up the concentration gradients of dissolved substances between blood and tissue, so diffusion can occur.
Useful substances move out of the plasma of the capillaries into the **tissue fluid** (fluid in between cells in tissues). The cells need oxygen and nutrients such as glucose and amino acids, and produce waste products such as CO_2 and useful products such as hormones. The capillaries are constantly supplied with new blood, otherwise diffusion could not occur.

7.2.3 Blood

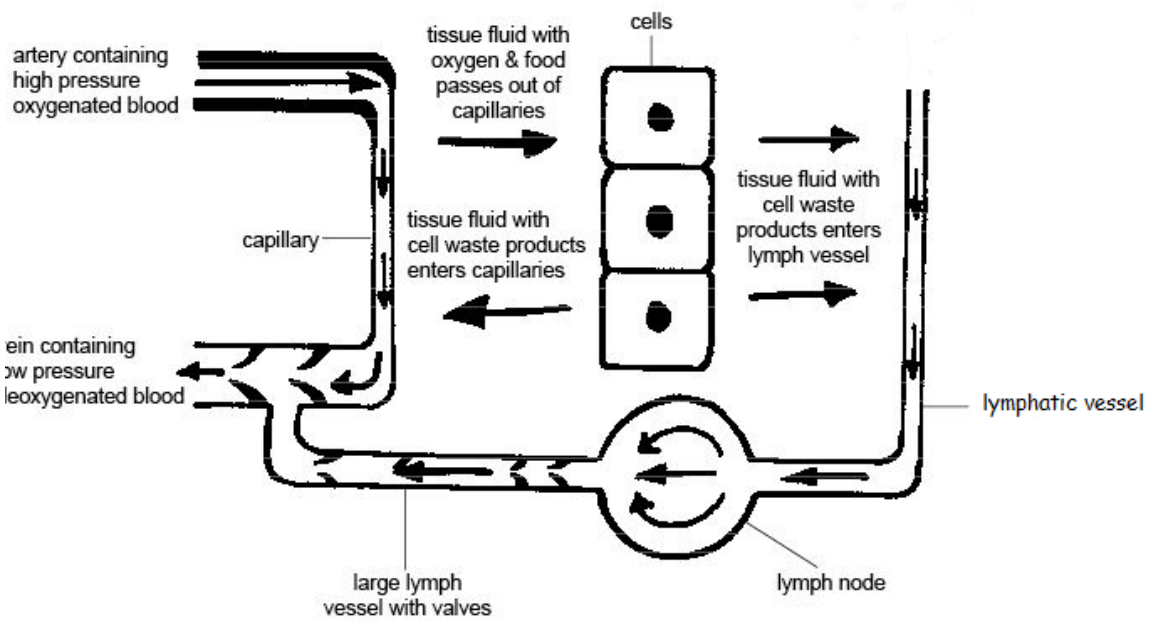
Blood = red blood cells, white blood cells, platelets and plasma
Functions:
• **red blood cells** – syllabus says "haemoglobin and oxygen transport", but haemoglobin is a characteristic not a function
• **white blood cells** – phagocytosis and antibody formation
• **platelets** – causing clotting (no details)
• **plasma** – transport of blood cells, ions, soluble nutrients, hormones, carbon dioxide, urea and plasma proteins
White blood cells (must be able to identify from picture/diagram):



Immune system: **Phagocyte** has a lobed nucleus and **vesicles** containing digestive enzymes. It engulfs the **pathogen** (something that can cause a disease e.g. bacteria) this is called **phagocytosis**, and then the vesicles fuse

with the vacuole containing the bacteria. The enzymes digest bacteria. An **antigen** is a protein or carbohydrate on the surface of the pathogen which provokes the immune system. **Lymphocytes** are white blood cells, found in circulating blood and in lymph nodes, have a large nucleus and no granules in the cytoplasm, and they produce **antibodies**, Y-shaped proteins that bind with pathogens to "label" them. Once they are labelled they are either destroyed by being ingested by phagocytes, or the antibodies may do it.

Lymphatic system: circulation of body fluids, and the production of lymphocytes. The **lymph node** contains many lymphocytes which filter the lymph. **Tissue fluid** is what is made when plasma is squeezed out of capillaries. Substances diffuse between cells and tissue fluid. **Lymph vessels** collect lymph and return it to the blood. Tissue fluid returns to the capillaries by osmosis.



Blood clotting: reduces blood loss and keeps pathogens out: **Fibrinogen** (an inactive blood protein) turns to **fibrin** (an activated blood protein), and forms a mesh to trap red blood cells, which eventually dries to form a scab.

8. Respiration

Respiration: the chemical reactions that break down nutrient molecules in living cells to release energy.

Uses of energy in the body of humans: muscle contraction, protein synthesis, cell division, active transport, growth, the passage of nerve impulses and the maintenance of a constant body temperature.

8.1 Aerobic respiration

Aerobic respiration: the release of a relatively large amount of energy in cells by the breakdown of food substances in the presence of oxygen.

Glucose + oxygen ⟶ carbon dioxide + water

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$$

8.2 Anaerobic respiration

Anaerobic respiration: the release of a relatively small amount of energy by the breakdown of food substances in the absence of oxygen.

In muscles: glucose ⟶ lactic acid

$$C_6H_{12}O_6 \longrightarrow 2\,C_3H_6O_3$$

In yeast (microorganism, a single-cell fungi): glucose ⟶ ethanol + carbon dioxide

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + CO_2$$

Brewing (wine):

1) Grapes (sugar source) are pressed to allow enzymes to begin fermentation
2) Yeast converts sugar into alcohol.
3) At 8-9% the alcohol (which is toxic) kills the yeast, (higher concentrations of alcohol are achieved by distillation)

Bread making:

1) Flour, sugar, water and salt are mixed with yeast to make the dough.

2) The dough is kept in a warm, moist environment (28°C). The yeast ferments sugar making carbon dioxide which creates bubbles, so the bread rises.
3) Cooking (at 180°C) – kills yeast, evaporates alcohol and hardens outer surface.
Disadvantages of anaerobic respiration:

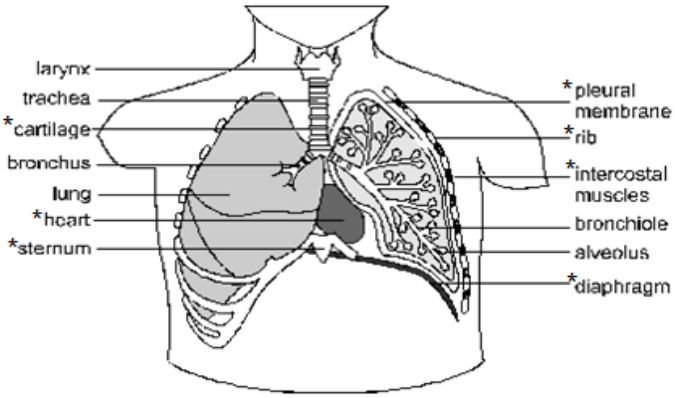
-only produces 1/20 of the energy per glucose molecule that aerobic respiration would
-produces poisonous lactic acid

Lactic acid: is transported in the blood to the heart, liver and kidneys, which oxidise it. The heart, liver and kidneys need extra oxygen to do this which causes you to continue breathing heavily after exercise. The extra oxygen is called the **oxygen debt**.

8.3 Gas exchange

Property of surface	Reason
Thin (ideally one cell thick)	short distance to diffuse
Large surface area	many molecules can diffuse at the same time
Moist	cells die if not kept moist
Well ventilated	concentration gradients for oxygen and carbon dioxide are kept up by regular fresh supplies of air
Close to blood supply	gases can be carried to/from the cells that need/produce them

Need to know where to label the following which are NOT marked with a *.



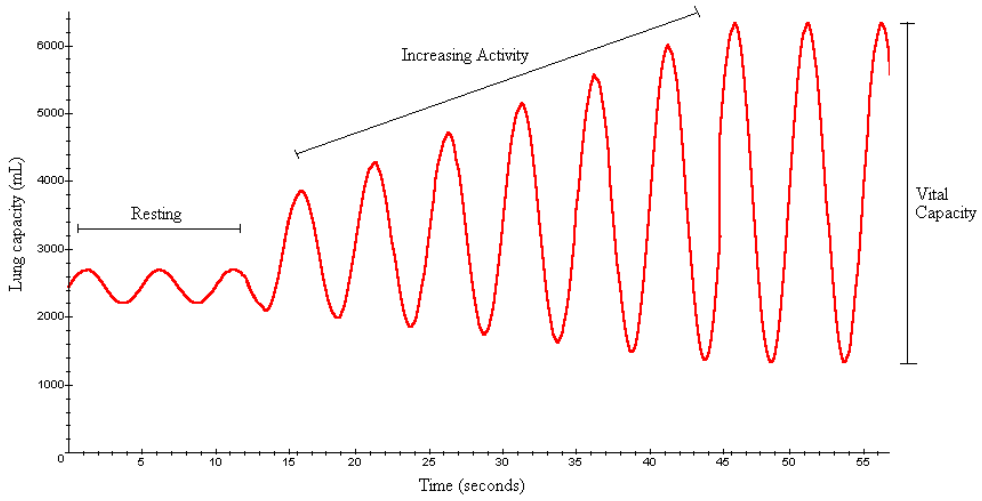
Inhaled (inspired) air: 21% oxygen, 0.04% carbon dioxide, 78% nitrogen and water vapour varies to climate

Exhaled (expired) air: 18% oxygen, 3% carbon dioxide, 78% nitrogen, and saturated water vapour.

Demonstrate CO_2's presence in exhaled air: blowing bubbles through a straw into a test tube with limewater (aqueous calcium hydroxide) giving a white precipitate (calcium carbonate).

Physical activity increases the **breathing rate** – more breaths per minute, and the **tidal volume** – more air per breath, this is measured with a **spirometer** to produce a **spirogram**. During exercise, tissues respire at a higher rate, the change in breathing volume and rate helps to keep CO_2 concentration and pH at safe levels.

Spirogram:

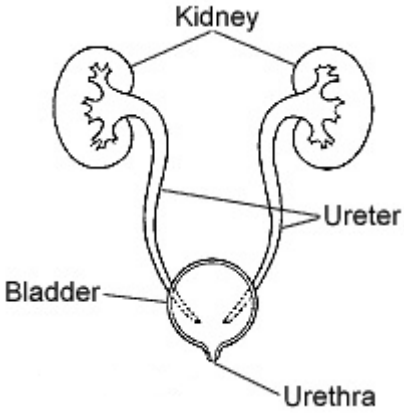


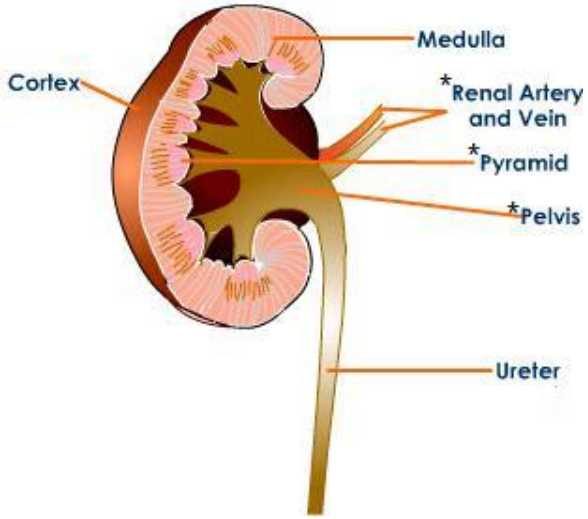
Breathing in:
1) **external intercostal muscles** contract – pulls rib cage upwards and outwards
2) **diaphragm muscles** contract – diaphragm moves upwards
3) Lung volume increases – and pressure falls (Boyle's law: pressure and volume are inversely proportional)
4) Air rushes in – to equalise pressures.
Breathing out:
1) **external intercostal muscles** relax – rib cage falls downwards and inwards
2) **diaphragm muscles** relax – returns to dome shape
3) Lung volume decreases – and pressure increases
4) Air is forced out
Internal intercostal muscles: are used in coughing and sneezing.
Mucus & cilia: **goblet cells** produce sticky mucus to trap and eliminate particulate matter and microorganisms.
Ciliated cells have cilia: little hairs which sweep back and forward in a coordinated way to brush mucus up the lungs into the mouth (yummy mucus, nom nom nom).

9. Excretion in humans

Excretion: the removal from organisms of toxic materials, the waste products of metabolism (chemical reactions in cells including respiration) and substances in excess of requirements. Substances should include carbon dioxide, urea and salts.
Kidney function: the removal of urea and excess water and the re-absorption of glucose and some salts (details of kidney structure and nephron are **not** required).
Urea is formed in the liver from excess amino acids
Alcohol, drugs and hormones are broken down in the liver.

You need to be able to "state the relative positions in the body" of the following in a diagram:

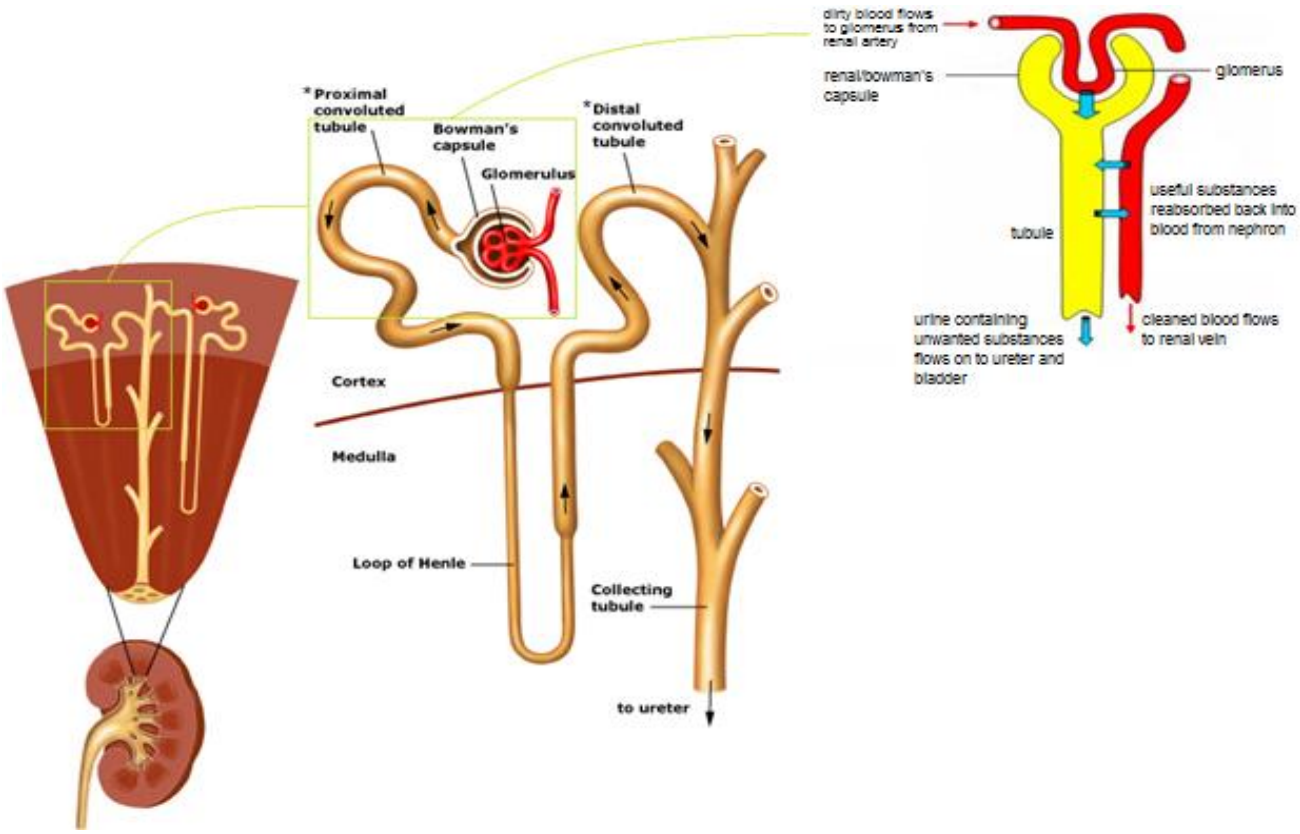




Know the structure of the kidney:
Cortex: contains Bowman's capsules and coiled tubules
Ureter: carries urine from kidney to bladder
Medulla: contains loops of Henlé and collecting ducts

1. Loop of Henlé selectively absorbs water/solutes
2. Collecting ducts reabsorbs water into blood and store wastes until they are passed into ureter

Urethra: carried urine from bladder to the outside.
Bladder: stores urine
Renal capsule: filters from blood: water, glucose, urea and salts.
Tubule: (yellow) reabsorbs 100% of glucose, most of the water and some salts back into the blood (red), leading to concentration of urea in the urine as well as loss of excess water and salts into the tubule.
Renal artery brings wastes and water from blood
Renal vein reabsorbs water and useful molecules and leaves wastes behind



(Page 133 for diagrams)

Dialysis: when a kidney machine takes a patient's blood and cleans it, then returns the blood to circulation. This is how it works:

1) Blood is taken from artery and goes through a **pump** to regulate pressure

2) it flows into a machine which has **dialysis fluid** which has a composition which means that urea and salts diffuse into it from blood but useful solutes and water do not, separated from the blood by a partially **permeable membrane** so that urea can pass but not blood cells and large proteins.

3) Blood then flows through a **chamber** which removes blood clots and warms blood (page 135)

Dialysis	Transplant
more expensive in the long run	less expensive
very disruptive (three 6-8 hour long sessions per week)	not very disruptive (only have to take medication)
do not need to find kidney	need a kidney
need a machine & must live near one	can go anywhere, anytime
-	risk of rejection

Osmoregulation - don't think this is on the syllabus but here it is anyway:

It is the body's way of balancing water taken in by the diet and water lost by excretion. This stops red blood cells from becoming crenated (see Crenation)

In the collecting duct, water is reabsorbed into the blood depending on how much is needed. This is controlled by the **antidiuretic hormone**, **ADH**

1. If we sweat then the volume of urine is reduced to compensate
2. Diarrhoea involves large amounts of water lost, which is why it often causes death by dehydration
3. Isotonic sports drinks are used by athletes because they have glucose, salts and water to replace what is lost by sweating

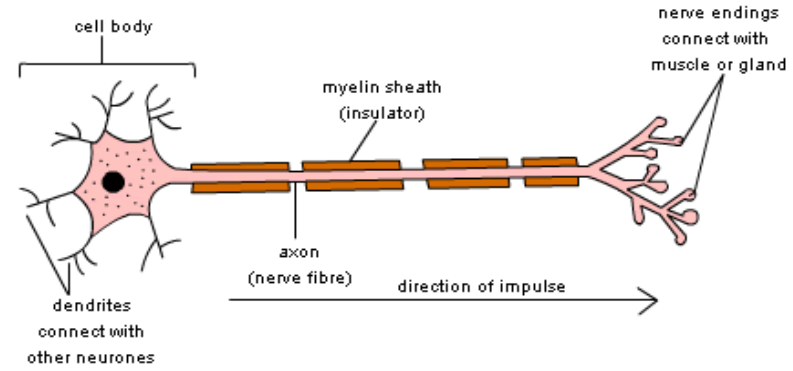
10. Coordination and response

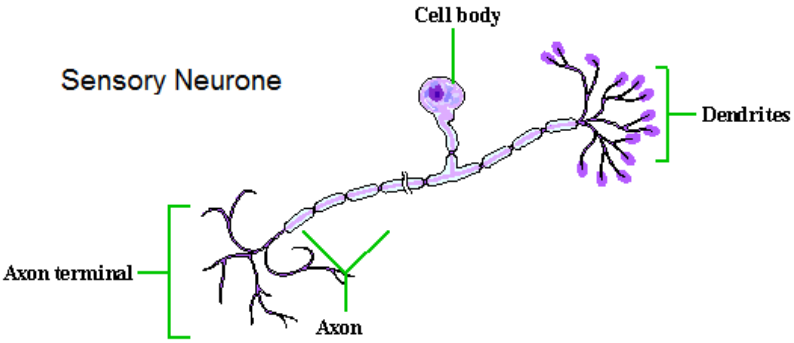
10.1 Nervous control in humans

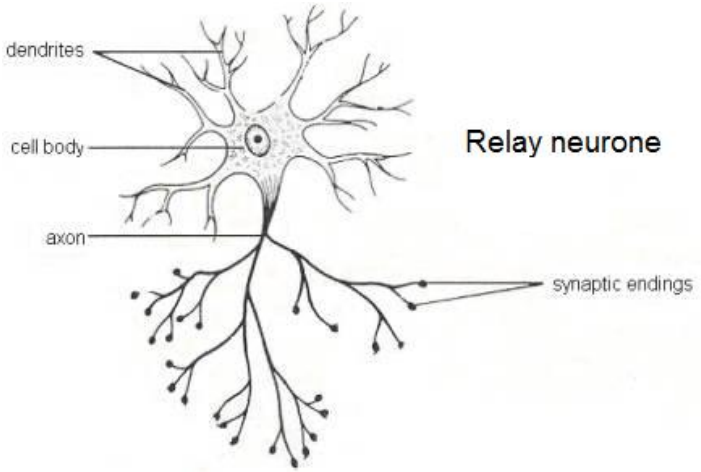
The nervous system consists of two parts the **CNS (central nervous system)** which is the **brain** and **spinal chord,** which are the areas of coordination and the **PNS (peripheral nervous system),** made up **nerves** and **neurones**, which coordinate and regulate bodily functions.

You need to be able to recognise diagrams of the following:

A Motor Neurone

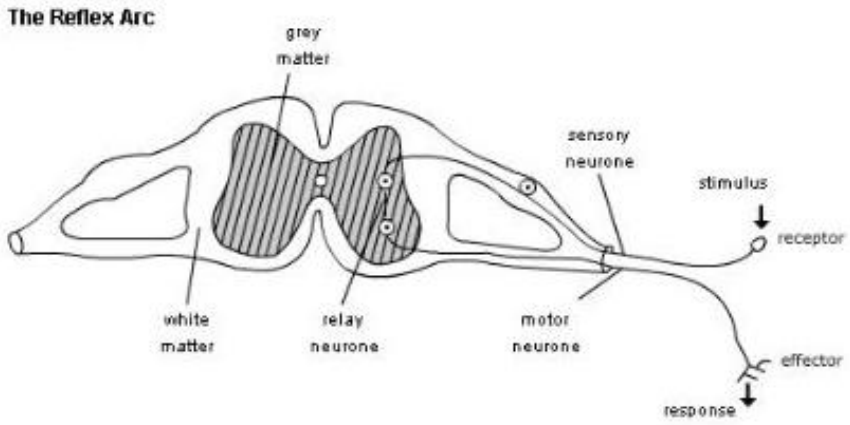






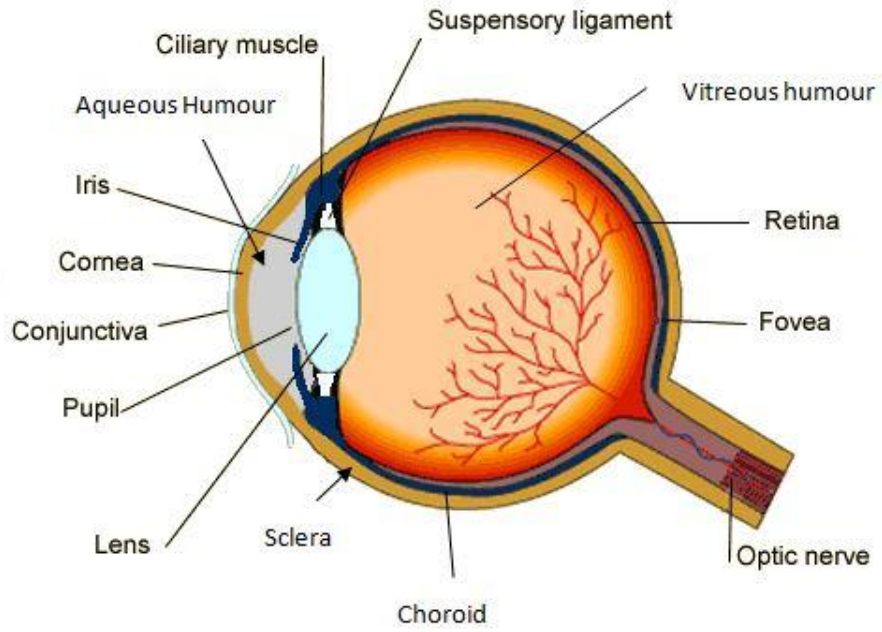
Reflex arc: a **reflex action** is an involuntary, quick action to respond to a stimulus, in order to protect the body from danger e.g. quickly removing your hand from a hot metal surface. They involve three neurones: a **sensory neurone**, **relay neurone** and **motor neurone**. The gap between neurones is called a **synapse**. The reflex arc works like this:

1) a stimulus affects a receptor (cell or organ that converts a stimulus into an electrical impulse)
2) A sensory neurone carries impulse from the receptor to the CNS
3) Connector/relay neurone carries impulse slowly (because it has no myelin sheath) across the spinal chord
4) Motor neurone carries impulse from the CNS to the effector
5) Effector (either a muscle or a gland) carries out the response

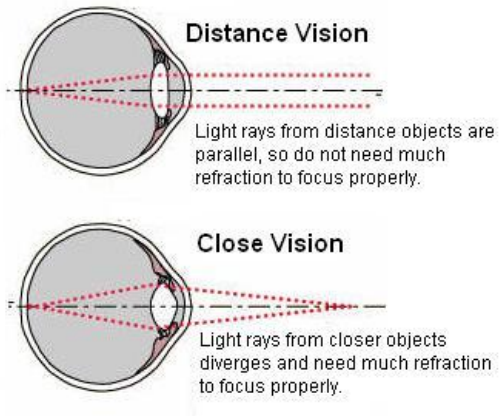


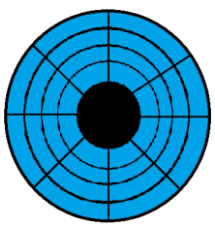
Antagonistic muscle: a muscle that opposes the action of another; e.g. the biceps and triceps are antagonistic muscles or the circular and radial muscles in the eye
*Agonist: a muscle that contracts while another relaxes; e.g. when bending the elbow the biceps are the agonist
*Antagonist: a muscle that relaxes while another contracts; e.g. when bending the elbow the triceps are the antagonist

Sense organ: groups of receptor cells responding to specific stimuli: light, sound, touch, temperature and chemicals.
The eye: the sense organ responsible for sight



Accommodation (picture on the right): adjusting for near and distant objects. Distant objects have parallel light rays, needing only a little refraction, ciliary muscles relax, eyeball becomes spherical, ligaments are tight, and the lens becomes long and thin. Close objects have diverging light rays, needing more refraction, ciliary muscles contract, ligaments relax, and the lens becomes short and fat. (Remember: looking at something very close seems to be more difficult, so muscles are contracting)





Iris reflex: in low intensity light **radial muscles** (straight lines) contract and become shorter to pull the pupil (black dot) making it wider, to let more light enter, to form a clear image on the retina. In high intensity light the **circular muscles** (circular lines) contract and become shorter to reduce the size of the pupil to protect the retina from bleaching.

Rods & cones: rods provide low detail, black and white images, good for seeing in low intensity light (at night). Cones provide detailed, coloured images; they work in high light intensity. Rod cells are packed most tightly around the edge of the retina so you can see things most clearly when not looking directly at them. Cones are most tightly packed at the centre of the retina, so objects are seen most clearly when being directly looked at.

10.2 Hormones

Hormone: a chemical substance, produced by a gland, carried by the blood, which alters the activity of one or more specific target organs and is then destroyed by the liver.

Adrenaline: a hormone secreted by the **adrenal gland**. It increases the pulse rate, makes the glycogen in muscles get converted to glucose, and released into blood, makes you breath deeper and more rapidly, airways become wider, and makes skin become pale as blood is diverted away. It increases the concentration of glucose in the blood for respiration.

Adrenaline is secreted for example: while bungee jumping or riding a rollercoaster.

Nervous and hormonal systems compared:

Comparison	Nervous system	Endocrine system
speed of action	very rapid	can be slow
nature of message	electrical impulses, travelling along nerves	chemical messenger (hormones) travelling in bloodstream
duration of response	usually within seconds	may take years (puberty)
area of response	localised response (only one area usually)	widespread response (in many organs)
example of process controlled	reflexes such as blinking	growth: development of reproductive system

Hormones are used in food production, for example oestrogen is used to boost growth rate of chickens.

Disadvantages: this may cause human males to develop feminine characteristics, and it is unnatural.

Advantage: chickens grow quickly meaning more profit.

10.3 Tropic responses

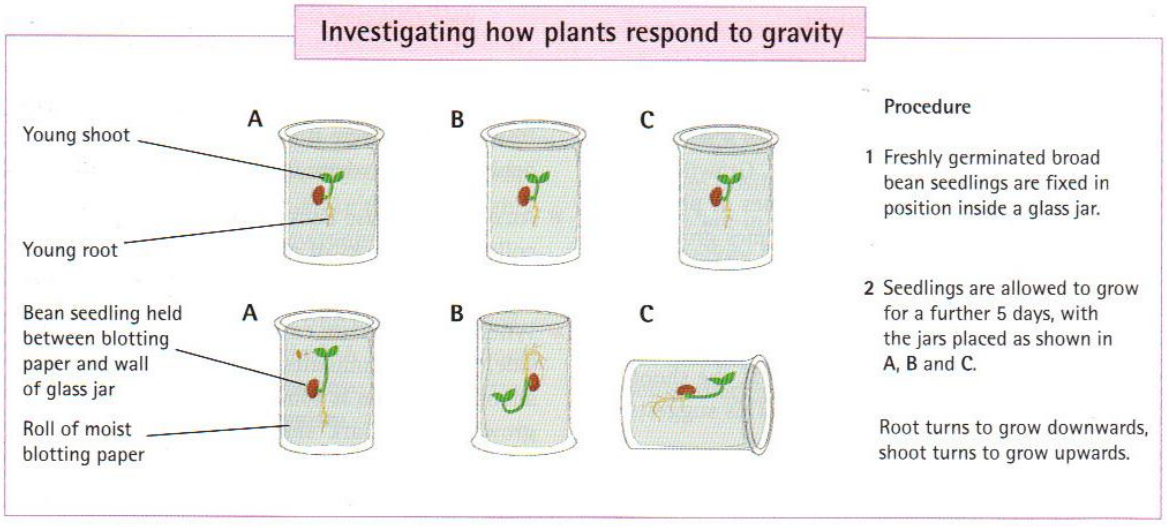
Geotropism: a response in which a plant grows towards (**positive**) or away (**negative**) from gravity.

Investigation: how plants respond to gravity

1) Freshly germinate broad bean seedlings inside a glass jar, the seed is held by a roll of moist clotting paper.

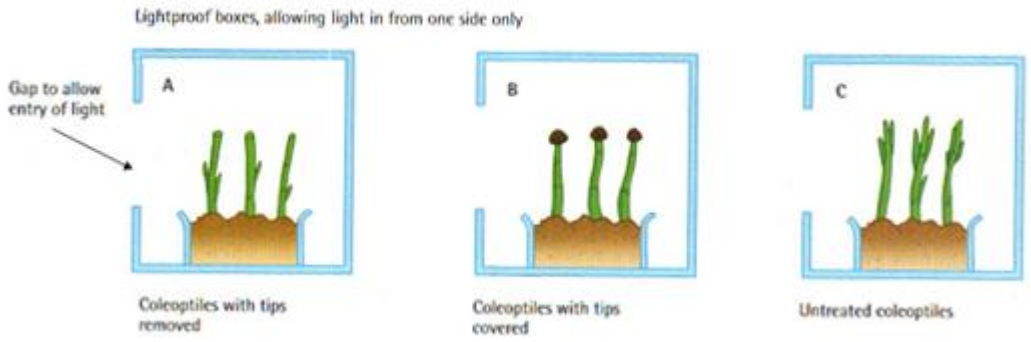
2) Seedlings are allowed to grow for a further five days, with the jars placed A) the right way up B) upside down and C) on its side.

In each case the roots will turn to go downwards (positive geotropism), and the shoot turns to grow upwards (negative)

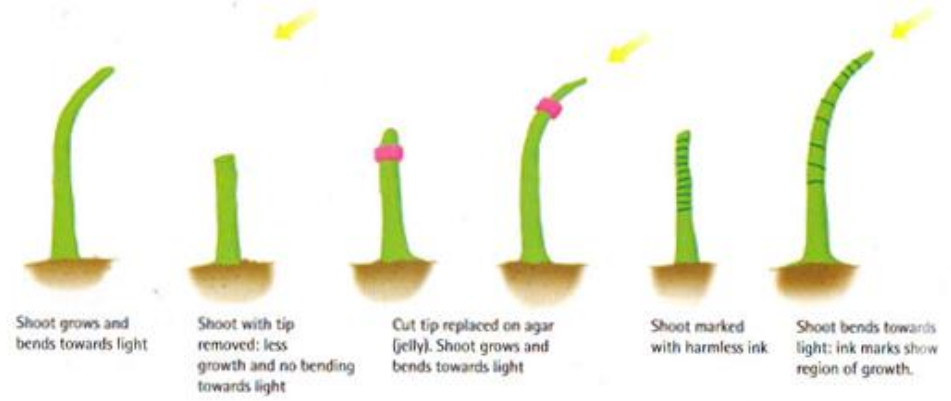


Phototropism: a response in which a plant grows towards (positive) or away (negative) from the direction from which light is coming.

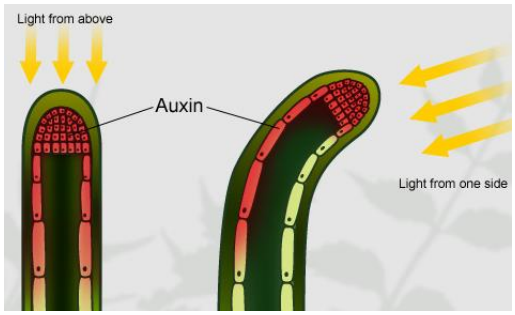
Investigation of the light sensitive region
1) There are three groups of coleoptiles (oat shoots). A) Has its tips removed, B) tips are covered and C) are untreated.
2) The coleoptiles are measured, and lengths recorded.
3)They are put in light proof boxes with one gap which only allow light to enter laterally (from the side).
4) They are measured 2-3 days later, and new lengths are recorded.
Untreated coleoptiles will grow the most.

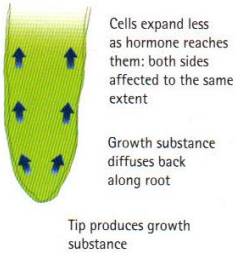


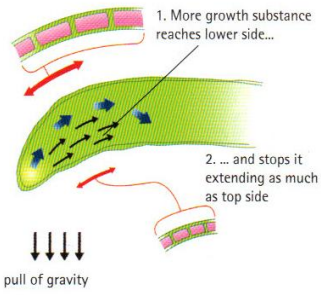
Other experiments:



Auxin: plant hormones/plant growth substances. It controls phototropism. The auxin is produced in the tip because if the tip is removed it doesn't respond to stimuli. Auxin makes the shaded side of the shoot grow more. It also causes geotropism. Auxin reduces cell expansion in roots but stimulates cell expansion in shoots. If you take a horizontal root, the auxin will be in higher concentration on the bottom side, so the bottom side expands less so the root curves downwards.

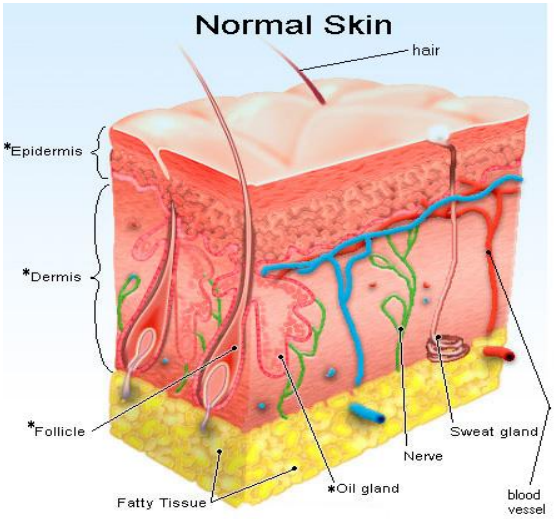






Hormones can be used as **weed killers** – spraying with high concentrations of hormone upsets normal growth patterns. It affects different species differently so might only kill one species not the other (this is good).

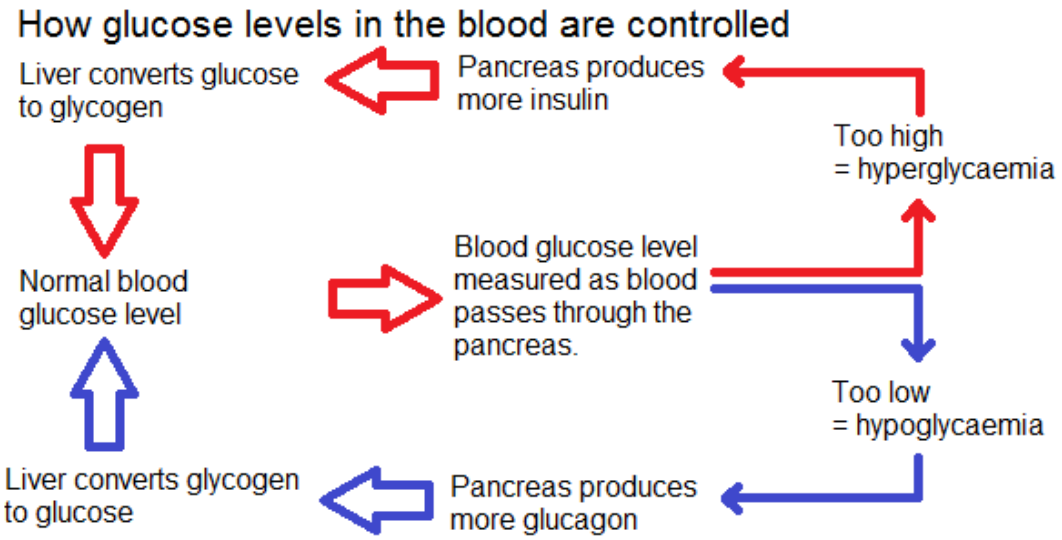
10.4 Homeostasis



Homeostasis: the maintenance of a constant internal environment.
<----You should be able to identify the parts of the skin on the diagram on the left:
Constant body temperature is maintained by:
Insulation: provided by the fatty tissue retains heat/prevents heat loss. Hairs become erect to trap warm air by contracting erector muscles and vice versa.
Vasodilatation: when it is hot, arterioles, which supply blood to the skin-surface capillaries, dilate (become wider) to allow more blood near to skin surface to increase heat loss (face goes red after running the mile)
Vasoconstriction: the opposite
Sweating: the water evaporates giving a cooling effect
Skin receptors: sense heat and sensory neurones send impulses to the **hypothalamus** – the thermoregulatory centre.
Shivering: muscular activity generates heat
Temperature control centre: in the hypothalamus, it controls the use of corrective mechanisms (e.g. sweating and shivering).

Control by **negative feedback**: the production of hormones is controlled by feedback – the hormones regulate their own production. A negative feedback control is when the change in hormone level acts as a signal to cancel out that change, so when blood hormone level is low, hormone production is stimulated, when it is high, it is inhibited.

Insulin: is secreted by the pancreas. It controls the conversion of glucose (soluble) to glycogen (insoluble). A deficiency in insulin is diabetes – unregulated blood sugar levels
Glucagon: is secreted by the pancreas. It controls the conversion of glycogen to glucose.



Homeostatic organs:

1. cells: change composition of blood as they remove nutrients and O_2 and add wastes and CO_2
2. Heart: keeps blood pressure constant to deliver oxygen and nutrients around body
3. Skin: to maintain heat exchange with external environment
4. kidneys: regulate water and salt levels (osmoregulation) and the removal of wastes like urea (excretion)
5. lungs: regulate gas exchange
6. intestines: supply soluble nutrients and water to blood
7. liver: regulates blood solutes and removes toxins

10.5 Drugs

Drug: any substance taken into the body that modifies or affects chemical reactions in the body.

Antibiotics: a product made by one organism to kill another, it is used to treat a bacterial infection. Antibiotics do not work on viruses because viruses are not alive. A bacterium is a living, reproducing life form. A virus is just a piece of DNA (or RNA). A virus injects its DNA into a living cell and has that cell reproduce more of the viral DNA. With a virus there is nothing to "kill," so antibiotics don't work on it.

Effects of the abuse of **heroin**: a powerful depressant

-problems of addiction
-malnourishment as drug depresses appetite
-financial problems – stealing, loss of job
-infection from sharing needles e.g. HIV/AIDS and hepatitis
-danger from other substances mixed with drugs

Effects of excessive consumption of **alcohol** –a depressant:

-causes CHD
-reduced self-control
-depressant,
-effect on reaction times
-damage to liver – cirrhosis
-cancer of tongue and oesophagus
-social implications: sex organs do not work well haha ☺

Some effects of tobacco smoke:

1) drying effect and heat irritate lungs
2) **nicotine** is **addictive**, it is also a **stimulant**, it increases pulse rate and narrows blood vessels which can cause damage
3) **tar** causes cancer, and is an **irritant** so causes coughing. There are other irritants in tobacco smoke including: smoke particles, ammonia, and sulfer dioxide
4) **Emphysema**: walls between alveoli break making large sacs, reducing surface area massively and making you breathless after a couple of steps
5) Loss of limbs due to poor circulation, CHD and lower sperm-count
6) Carbon monoxide irreversibly bonds with haemoglobin which can lead to oxygen starvation ☺
7) Cancer of the stomach, pancreas and bladder and so on...

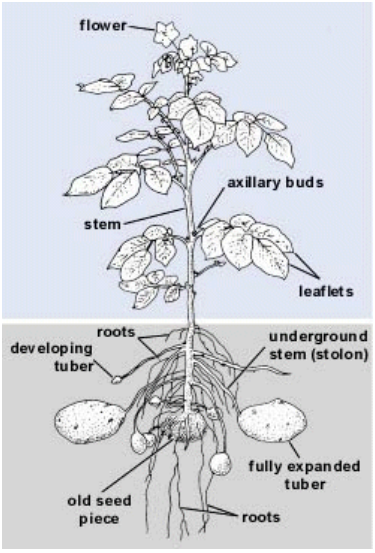
Section III: Development of the organism and the continuity of life

1. Reproduction

1.1 Asexual reproduction

Asexual production: the process resulting in the production of genetically identical offspring from one parent.

Bacteria: reproduce by **binary fission**, each bacterium divides into two. The **generation time** is the time taken for a cell to divide into 2.



Fungi: single-celled yeast reproduces by binary fission. All other fungi produce via spores. When the sporangium bursts it spreads the spores. Spores land and grow mycelium (roots) for example mushrooms

Potatoes: The shoot from a potato goes back underground and the stem swells to form a new genetically identical potato. The swollen stem acts as a storage organ. Being identical, if one is susceptible to disease, they all are.

Advantages of asexual reproduction:
-fast: no need to find mate, fertilise etc.
-good characteristics are kept

Disadvantage: they are all genetically identical so if there is a change in the environment they could all die (although bacteria can survive from an antibiotic by mutation, then the mutated bacteria reproduce creating an antibiotic-resistant strain)

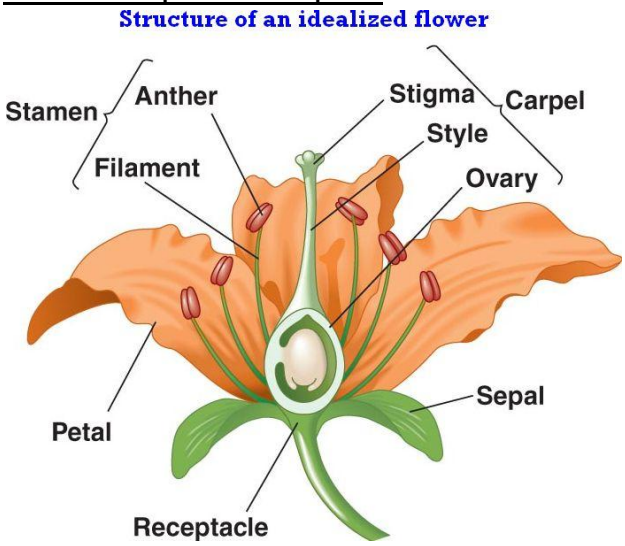
1.2 Sexual reproduction

Sexual reproduction: the process involving the fusion of haploid nuclei (23 chromosomes) to form a diploid zygote (46 chromosomes) and the production of genetically dissimilar offspring.

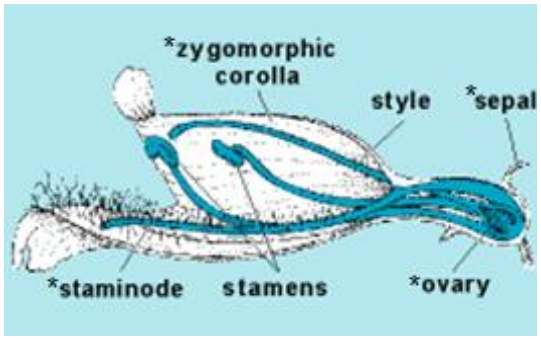
Advantages: produces genetically different offspring so they don't all die from change in the environment.

Disadvantage: it takes lots of time and energy, good characteristics can be lost, and since a nice appearance might be needed, energy used on colourful scented flowers (insect pollinated) or a huge amount of pollen needed (wind-pol.)

1.2.1 Sexual reproduction in plants



Named, insect pollinated, dicotyledonous flowering plant: the **foxglove**



Sepal: protect the flower bud.

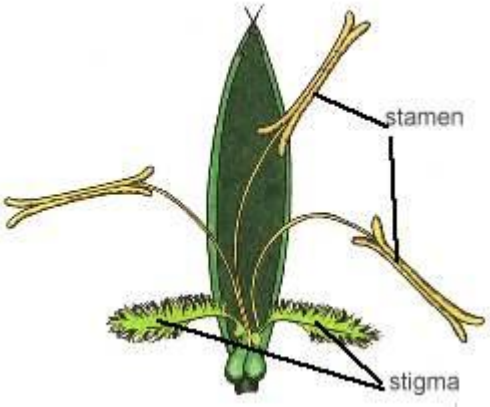
Petal: brightly coloured and scented and may have nectaries which are all used to attract insects, petals in wind pollinated flowers are tiny, and used for pushing the bracts (leaf-like structures) apart to expose stamens and stigma

Anther: has pollen sacs with pollen grains which contain the male nucleus (male gamete).

Stigma: platform on which pollen grains land

Ovary: hollow chamber, ovules grow from the walls.

Typical wind pollinated flower structure: **grass** (only need to know anther and stigma):



Pollen is light and smooth (can't find picture).

Pollination: the transfer of pollen grains from the male part of the plant (anther of stamen) to the female part of the plant (stigma).

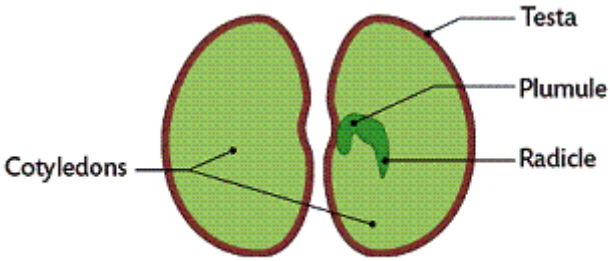
Agents of pollination: insects, birds, mammals, water and the wind.

Insect pollinated	*Wind Pollinated*
Large Colorful Petals- Attract Insects	Dull petals
Sweetly Scented	No scent
Nectaries	No nectaries
Moderate amount of pollen	Huge amount of pollen
Pollen is spiky/sticky	Pollen is round and smooth
Anther & Stigma are inside the flower	Anther and Stigma hangs out
Sticky stigma	Stigma hairy

Insect pollinated flowers might also have stripes which act as guide-lines for insects.

Pollen tube: pollen grain lands on stigma and creates a tunnel down the style, through the micropyle, to the ovules.

Structure of non-endospermic seed:



Plumule + Radicle = embryo

Formation of a seed: the **zygote** divides many times by **mitosis** to form and **embryo**. The **cotyledon** is the food store. The **testa** stops drying out of embryo.

Wind and animal dispersal are used by plants to colonise new areas (*this is done because new areas have less competition for light, space and nutrients, so seeds are more likely to develop.)

Example of wind dispersed seeds/fruit: dandelion, sycamore

Example of animal dispersed seed/fruit: apple, tomato etc. (**internal**) or bur (**external**)

Self-pollination: pollen is transferred from the anther to the stigma of the same flower. Implications:

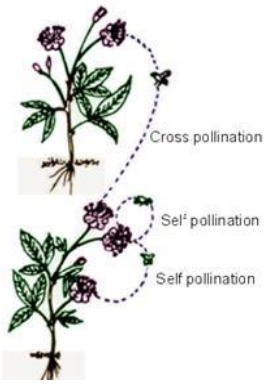
-very efficient

-not much chance for genetic variation

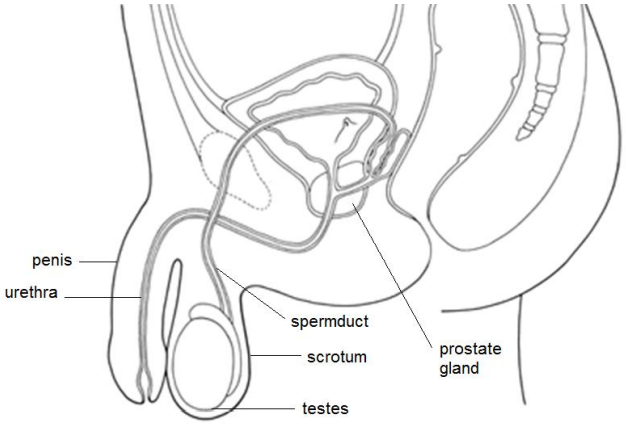
Cross-pollination: pollen transfer from anther to stigma of another flower of the same species.

-risky: pollen might not reach the other flower

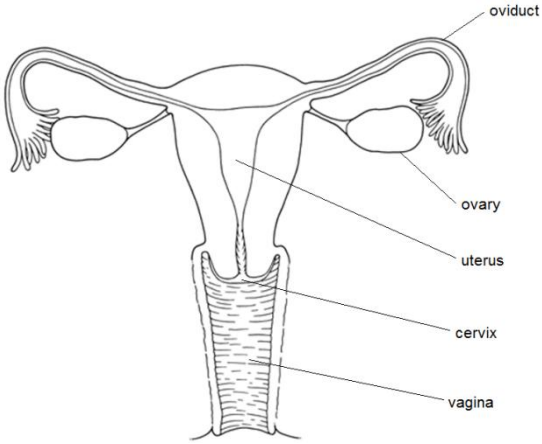
-higher chance for genetic variation



1.2.2 Sexual reproduction in humans

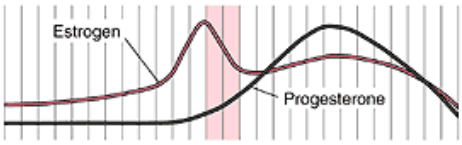


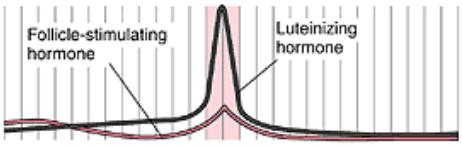
Testes: have many coiled tubes which produce **sperm**, and the cells between tubes produce **testosterone**.
Scrotum: holds testicles
Sperm duct: carries sperm from testicles to urethra.
Prostate gland: makes **seminal fluid** (semen = 99.5% seminal fluid and 0.5% sperm) (*actually it makes prostate fluid and the seminal vesicles make seminal fluid, but this is how the book describes it)
Urethra: carries semen from sperm duct to tip of penis
Penis: the male sex organ, used to transfer semen to the female. In most mammals, it is also used to expel urine from the body.

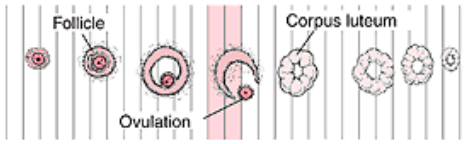


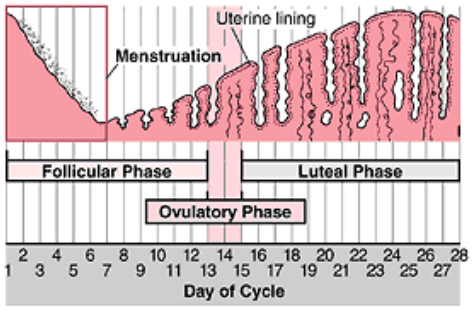
Ovary: contains follicles which develop into the ova and produces **progesterone** and **oestrogen** (hormones).
Oviduct: aka fallopian tube, carries the ovum to the uterus. Fertilisation occurs <u>in</u> the first 1/3.
Uterus: aka womb, where the fetus develops.
Cervix: neck of uterus: a strong rigid muscle, moist by mucus with a small opening
Vagina: aka birth canal, receives the penis during intercourse, and is the way out for the baby at birth. Moist tube of muscle about 8cm long, it is very flexible and secretes slippery mucus when aroused.

(FIY: we did learn more parts for each organ, for example fimbrae, but I just wrote the ones asked for on the syllabus)
Menstrual cycle:
Day 1~5:
Ovary:
-FSH secreted by the Pituitary Gland to stimulate the maturation of ONE follicle in the ovary.
*Egg is stored in the follicle
Uterus:
-The endometrium breaks down; menstruation
AKA Period
Day 5~12:
Ovary:
-Follicle keeps maturing
Uterus:
-Oestrogen is by follicle and the ovarian tissues to prepare the endometrium
Day 13/14/15:
Ovary: LH also secreted by the Pituitary Gland trigger the release of the egg from follicle into the fallopian tube
Day 15~28:
Ovary: LH triggers the formation of the Corpus Luteum/Yellow Body
Uterus: Progesterone Secreted by Yellow Body keeps the endometrium thick, waiting for the possible embryo implant.
Day 28; Scenario 1: Egg is not fertilized:









No implantation takes place, the corpus luteum degenerates, causing a lack of progesterone.
This means that the endometrium is no longer thick. Back to Day 1
Day 28; Scenario 2: Egg is fertilized:
Implantation occurs. This makes the hormones to keep the Corpus Luteum maintained. This means that progesterone is high. This keeps the Endometrium thick for pregnancy.

Sexual intercourse/sex/coitus/copulation: Penis fills with blood and becomes erect - hard enough to enter vagina. Vagina walls secrete a lubricant. Rubbing of the **glans** (end of penis) against the vagina wall sets of a reflex action, causes sperm to be released from the **testes**, and is transported by peristalsis along sperm ducts and urethra, where seminal fluid is added to make **semen**. The exit of semen from the penis is called **ejaculation**. Sperm then swim through the cervix and oviducts to the first third of the oviduct (1st third from the ovary) where one combines with the egg.

Fertilisation: the joining together (**fusion**) of an ovum and a sperm (**gametes**) to form a **zygote.**
Development of zygote:
1) One sperm penetrates
2) The ovum membrane alters to form a barrier against sperm.
3) Head of sperm (male nucleus) approaches and then fuses with the nucleus of the ovum.
4) Zygote divides over and over, to make a ball of cells called an **embryo** (6 days after fertilisation).
5) It implants itself in the wall of the nucleus (**implantation**) which is followed by **conception** (development into an individual)
Development of fetus: zygote is changed through **growth** (increase in number of cells by mitosis) and **development** (organisation of cells into tissues and organs)
Umbilical cord: contains umbilical artery which carries deoxygenated blood and waste products e.g. urea from the fetus to placenta and umbilical vein which carries oxygenated blood and soluble food such as iron, glucose and amino acids rom placenta to fetus. It contains the blood of the fetus
Placenta: organ for exchange of soluble materials such as foods, wastes and oxygen between mother and fetus, it is the physical attachment between the uterus and the fetus. It has the mother's blood in it. (*It also serves as a form of protection for the fetus from mother's immune system and blood pressure difference, and it secretes hormones to maintain the uterus since the corpus luteum degenerates on the third month)
(Note: syllabus says no "structural details" are required).
Amniotic sac: membrane which encloses amniotic fluid, broken at birth.
Amniotic fluid: protects fetus against mechanical shock, drying out and temperature fluctuations.
Antenatal (same as prenatal: before birth) care:
-change in diet:
1. more proteins ⟶ growth of fetus
2. slightly more fat ⟶ the new cells' cell membrane
3. more vitamin C and D ⟶ blood vessel walls and bones
4. iron ⟶ haemoglobin
5. calcium ⟶ growth of bones and teeth

-guidance on motherhood
-checks on fetus and mother including: weight check, blood tests, urine tests, vaginal examination, blood pressure checks, hormone checks, checks on fetus: size and position, heartbeat and ultrasound scanning
Labour and birth:
1) Labour
The uterine muscular wall contract and cervix tries to relax, then contractions get more frequent. Contractions cause amniotic membrane to break and release amniotic fluid.
2) Expulsion
Powerful Contraction pushes baby out.
3) Afterbirth
The Placenta is expulsed out. All contraction & pain are gone

Gamete:	Size	Mobility	Numbers
Sperm	smaller	very mobile (uses its tale)	many more (they can be made) 300 000 000 in one ejaculation!!!! :o
Egg/Ovum	larger	not mobile (moved by cilia and peristalsis in oviduct)	far fewer and limited number

Breast feeding vs. bottle feeding:

Breastmilk	**Battle**
Body Temperature	Need to be heated
Free	Need to buy
Mother has to be there	Can be anyone's milk
Antibodies included	None

1.3 Sex hormones

At puberty - the pituitary gland starts to stimulate the **primary sex organs** – the testes in males and the ovaries in females. **Sex hormones** – testosterone in males and oestrogen in females are released into the bloodstream. They only affect the target organs which have receptors which can recognise them. This causes secondary sexual characteristics such as the growth of under-arm hair and pubic hair and maturation of sexual organs.

1.4 Methods of birth control

Natural:

-**abstinence**: don't have sex

-**rhythm method**: don't have sex during the fertile period, only during the safe period (btw period=amount of time, not menstruating)

Chemical:

-**contraceptive pill**: there are two types – the mini-pill contains progesterone which affects the uterus and makes implantation difficult, and the combined pill which contains oestrogen and **progestogen** (synthetic progesterone) and prevents ovulation.

-**spermicide**: a chemical applied as a gel, cream or foam which kills sperm. It is very unreliable on its own but makes barrier methods of contracepton more effective.

Mechanical:

Condom: thin rubber covering over penis, it protects from impregnation and STDs, used by man

Diaphragm: used by woman, prevent sperm entering uterus, very reliable, must stay in place 6 hours after sex, needs a correct size

Femidom: closed end has a ring which gets pushed through cervix and open end's ring lies against the labia

IUD: plastic-coated copper coil, can be left inside for months or even years, has a string which is used to remove it out of the vagina, it is very reliable, it irritates the uterus wall preventing implantation

Surgical:

Vasectomy: sperm ducts are cut and tied, 100% reliable

Female sterilisation: oviducts are cut and tied, 100% reliable

Artificial insemination:

By donor: man's sperm has a problem, making impregnation impossible, so a donor gives his sperm.

In vitro fertilisation: an ovum is fertilised outside a woman's body. The fertilised ovum is implanted into the uterus.

Fertility drugs: drugs which enhance reproductive fertility. For women, fertility medication is used to stimulate follicle development of the ovary. The side effect is multiple pregnancies. They contain varying amount of FSH and LH.

1.5 Sexually transmissible diseases

Gonorrhoea – (*a bacterial infection, so it can be treated by antibiotics, if it were a virus it that would not work) caused by penetrative sex through the mouth, vagina or anus

Symptoms/signs: pain or burning when passing urine, a creamy discharge from the penis or vagina, inflammation of the testicles

Effects: in men the urethra becomes infected, in woman it is the cervix. If left untreated, the disease can travel through the reproductive tract (causing sterility) and spread to the bloodstream, infecting the brains, heart valves, and joints.
Treatment: once diagnosed (an easy test in a clinic), treatment is straightforward, involving a course of **antibiotics**.
Human immunodeficiency virus (HIV): the immune system become significantly weakened until an infection, from then on it is called AIDS (acquired immune deficiency virus).
Transmission: unprotected sex with an infected person, contact with an infected person's blood, from mother to child during pregnancy or childbirth or sharing syringes while injecting drugs
Prevention from spreading: physical ways - use a condom (or Femidom), don't come in contact with other people's blood, don't share needles, or get an education about STDs, but there is no cure, it can only be slowed down

2. Growth and development

Growth: a permanent increase in size and dry mass by an increase in cell number or cell size or both
Development: increase in complexity.
Germination (*a process controlled by enzymes) conditions stating and investigating:
Water – activates enzymes to turn insoluble food stores into soluble substances, and makes tissues swell so that the testa splits.
Method: Seeds placed with micropyle pointing down on 1) wet paper towels in dish 2) dry paper towels in dish.
Oxygen – enters through the gaps in the testa (along with water), and is used in aerobic respiration.
Method: seed is held by cotton wool completely submerged in water ⟶ germination
Water is boiled and oil placed on top to stop oxygen getting in ⟶ no germination.
(I think an aquatic plant might need to be used)
Temperature – must be suitable for enzymes to work (at optimum temperature).
Method:
Apparatus: a large group (e.g. 10) of seeds placed on damp cotton wool inside a jar with the lid open OR seeds placed on a damp paper towel in a dish ×2
Set 1 is placed in a temperature controlled propagator for growing seeds (or other warm place). Set 2 is placed in the refrigerator at about 4°C. Both sets are watered daily. Only the seeds in the propagator should germinate.

3. Inheritance

Inheritance: the transmission of genetic information from generation to (the next) generation.

3.1 Chromosome

Chromosome: a thread of DNA, made up of a string of genes
Gene: a length of DNA that is the unit of heredity and codes for a specific protein. A gene may be copied and passed on to the next generation
Allele: any of two or more alternative forms of a gene
Haploid nucleus: a nucleus containing a single set of unpaired chromosomes (e.g. sperm and egg)
Diploid nucleus: a nucleus containing two sets of chromosomes (e.g. in body cells)
Inheritance of sex (gender) in humans: the woman's gamete can only carry an "X" chromosome, and a male gamete can carry either an "X" or "Y" chromosome, so the male chromosome determines the sex of the child. So if you do a Punette square the results will be XX, XX, XY, XY so there is a 50% chance of getting a boy and vice versa.

3.2 Mitosis

Mitosis: the nuclear division giving rise to genetically identical cells in which the chromosome number is maintained by the exact duplication of chromosomes (details of stages are **not** required).
Mitosis is needed for:
-Growth: in animals each tissue provides its own new cells when they are needed. In plants cell division in the **cambium** increases girth (the plant gets thicker), and cell division in the meristems at the tips of the roots and shoots leads to an increase in length.
-Repair of damaged tissues: for example when you cut your skin, mitosis provides the new cells to cover up the cut.
-Replacement of worn out cells
-Asexual reproduction: in plants, vegetative propagation is done by forming a new miniature plant by copying the cells from the parent plant by mitosis.

3.3 Meiosis

Meiosis: reduction division in which the chromosome number is halved from diploid to haploid (details of stages are **not** required)

• Gametes are the result of meiosis

• Meiosis results in genetic variation so the cells produced are not all genetically identical.

3.4 Monohybrid inheritance

Genotype: is the genetic makeup of an organism in terms of the alleles present (e.g. Tt or GG)

Phenotype: the physical or other features of an organism due to both its genotype and its environment (e.g. tall plant or green seed) *blood type is one of them

Homozygous: having two identical alleles of a particular gene (e.g. TT or gg). Two identical homozygous individuals that breed together will be pure-breeding

Heterozygous: having two different alleles of a particular gene (e.g. Tt or Gg), not pure-breeding

Dominant: an allele that is expressed if it is present (e.g. T or G)

Recessive: an allele that is only expressed when there is no dominant allele of the gene present (e.g. t or g)

Homozygous dominant + homozygous recessive ⟶ 100% heterozygous

Homozygous dominant + heterozygous ⟶ 50% homozygous dominant + 50% heterozygous

Homozygous dominant + homozygous dominant ⟶ 100% homozygous dominant

Homozygous recessive + homozygous recessive ⟶ 100% homozygous recessive

Heterozygous + heterozygous ⟶ 25% homozygous dominant + 50% heterozygous + 25% homozygous recessive

Co-dominance: when neither of two alleles is dominant to each other.

There are three alleles for blood group given by the symbols I^A, I^B and I^O. I^A and I^B are co-dominant giving blood group AB or I^AI^B, and both dominant to I^O.

3.5 Variation

Continuous variation (variation which is usually quantitive, it has a range of intermediate classes) is influenced by genes and environment, resulting in a range of phenotypes between two extremes, e.g. height in humans

Discontinuous variation (variation which be classified as one thing or another, you are either blood group O, A, B or AB, nothing else, for example) is caused by genes alone and results in a limited number of distinct phenotypes with no intermediates

Mutation: a change in a gene or chromosome (*caused by mistakes in copying the DNA before cell division – pairing with the incorrect base, or damage to DNA for example by radiation, or uneven distribution of chromosomes in cell division).

Mutation is a source of variation for example in **Down's syndrome**, where a parent's chromosomes are unevenly distributed in meiosis (e.g. one chromosome has 22 and the other has 24). In fertilisation, a zygote with a number of chromosomes that is not 46 is created (e.g. 23 + 24 gives 47 chromosomes). This causes a variation in characteristics: broad forehead, short neck, fold in eyelid, spots in iris, downward-sloping eyes, short nose, protruding tongue, congenital heart defects and mental retardation.

Sickle cell anaemia: is a disease in which the red blood cell has a sickle shape instead of a round biconcave shape, controlled by a recessive allele, which causes weakness, aching joints and poor circulation. The fact that it is recessive means that a heterozygous person can be a **carrier**: they have the allele but it is not expressed. Being a carrier of sickle cell anaemia makes you resistant to malaria (WIN!). In equatorial Africa, being sickle cell anaemic causes death, malaria causes death, but the carriers have immunity to malaria and (according to the book:) have some symptoms of anaemia, in severe cases they are very weak (but do not die).

Rate of mutation increases with:

-chemicals - tars in tobacco smoke, high concentrations of some preservatives and some plant control hormones

-radiation – gamma, ultraviolet and X-radiation can damage and cause mutations because they have an **ionising effect**.

*These factors are called **mutagens**.

3.6 Selection

Artificial selection: is breeding the organisms with the valued characteristics together in order to try to produce offspring which shares those useful characteristics (selective breeding). This can be used to produce organisms which

are more economically valued (i.e. they will earn you more money) for example Jersey cattle produce milk with a high cream content, domesticated dogs are bread for appearance, or hunting or because they are aggressive therefore make good guard dogs, and wheat has been bred so that all the stems are the same height to make harvesting easier and the ears separate easily from the stalk (making collection of grains easier).

Natural selection: the greater chance of passing on of genes by the best adapted organisms.

Variation is natural or random changes in all living organisms. Variation leads to survival of the fittest since the variations in certain organisms allow that organism to have an advantage over the others in its species in that area (*for example the peppered moth which is white-bodied had a variation producing black-bodied peppered moths. During the industrial revolution, pollution prevented lichen from growing on trees. The lichen previously camouflaged the peppered moth. The trees became blackish from pollution so the black-bodied moth survived better from its predators since *it* was now better camouflaged.) The surviving organisms reproduce, since they don't get eaten up, so the variation has caused the species to **evolve**. **Evolution** is caused by natural selection which is caused by a change in the environment.

Example to know: Strains of antibiotic-resistant bacteria are developing as the use of antibiotics is increasing. In a group of many, many bacteria, one might mutate to be resistant to the antibiotic, as a result it reproduces and the others die making a new strain of bacteria, which is resistant to antibiotics.

*A **selection pressure** is something in the environment which causes only some organisms to survive (e.g. an antibiotic)

*A **survival advantage** is a characteristic which allows the organism to survive instead of the others (e.g. resistance to an antibiotic)

3.7 Genetic engineering

Genetic engineering: taking a gene from one species and putting it into another species.

The gene coding from a pancreas cell for the production of human insulin is 'cut' from chromosome fragments (*using a specific restriction endonuclease enzyme). The **plasmid** (circle of DNA) from a harmless bacteria cell is cut to remove a part. They are combined (*using another enzyme) to form a **recombinant DNA**. The bacteria are put in a fermenter or bioreactor to get a large population, and then the product is processed.

Section IV: Relationships of organisms with one another and with their environment

1. Energy Flow

The **sun** is the principal source of energy input to biological systems.

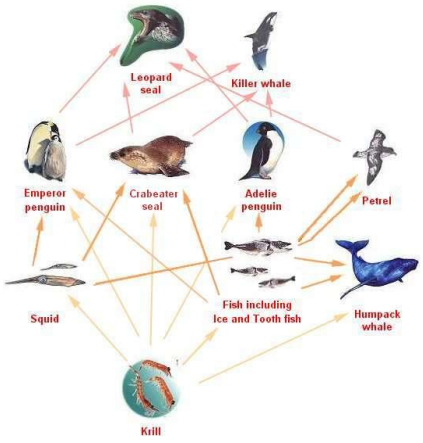
Energy flow is NOT a cycle. It starts from the sun (and obviously doesn't go back there) and then that energy is harnessed by plants which are eaten by animals which are eaten by other animals. At each step, energy is lost to the environment (for example by heat loss).

2. Food chains and food webs

Food chain: a chart showing the flow of energy (food) from one organism to the next beginning with a producer, for example:

mahogany tree ⟶ caterpillar ⟶ song bird ⟶ hawk

Food web: a network of interconnected food chains showing the energy flow through part of an ecosystem (picture on the right)



Producer: an organism that makes its own organic nutrients, usually using energy from sunlight, through photosynthesis

Consumer: an organism that gets its energy by feeding on other organisms

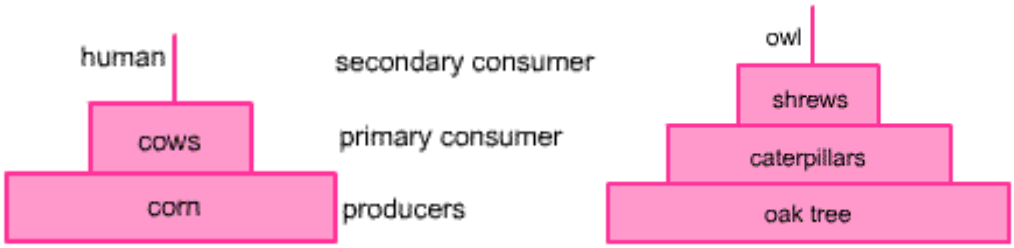
Herbivore: an animal that gets its energy by eating plants

Carnivore: an animal that gets its energy by eating other animals

Decomposer: an organism that gets its energy from dead or waste organic matter (*i.e. a saprotroph)

Ecosystem: a unit containing all of the organisms and their environment, interacting together, in a given area e.g. decomposing log or a lake

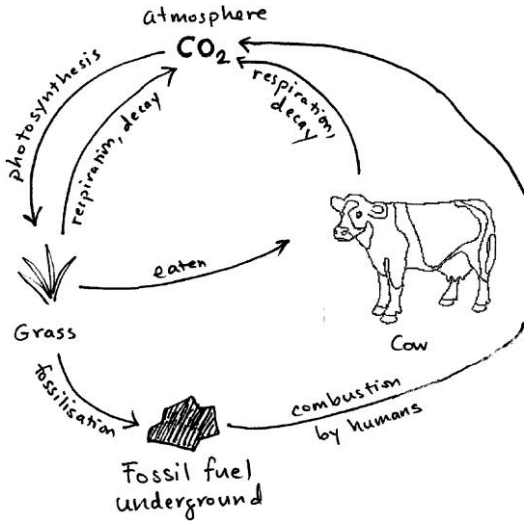
Trophic level: the position of an organism in a food chain, food web or pyramid of biomass, numbers or energy
Food chains usually have fewer than five trophic levels, because energy transfer is inefficient:
1. Sun produces light, less than 1% of the energy falls onto leaves.
2. Producers 'fix' (trap) only about 5-8% of that energy, because of: transmission (passing through), reflection and incorrect wavelength.
3. Primary consumer only gets between 5-10% because some parts are indigestible (e.g. cellulose) and not eating the whole plant.
4. Secondary consumer gets between 10-20% because animal matter is more digestible and has a higher energy value.
5. At each level heat is lost by respiration.
Humans eating plants is more efficient than humans eating animals because we need a couple of vegetables to have one meal, but to have meat we must feed the animal a lot of plant material in order to get far less meat. In the process of raising an animal, the plants lose energy to the environment, then the animal loses energy (throughout its whole life) to the environment and does not use up all the plant material so it is very inefficient but yummy.
Pyramid of numbers (left below): Shows the number of each organism in a food chain. When moving up the pyramid, the number of individuals' decreases but their size usually increases (except when it starts from a large plant like an oak tree). The problem is that there might be thousands or more producers feeding one single tertiary or quaternary consumer so this cannot be shown to scale without using a massive piece of paper, and if there is one large producer (e.g. an oak tree) and many if parasites feed on the consumers, the pyramid will be inverted.

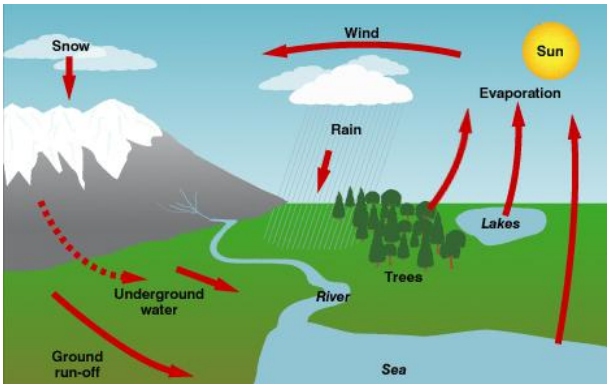


Pyramid of biomass (above right): a pyramid which shows the biomass (number of individuals × their individual mass). NOTE: in the diagram below, there is one tree but it has the largest rectangle and one owl, yet it has the smallest rectangle. The problem with this is that it only represents the biomass at the time of the sampling. This can be misleading since the feeding levels might have organisms that reproduce at different rates.

3. Nutrient Cycles

Carbon cycle and Water cycle:





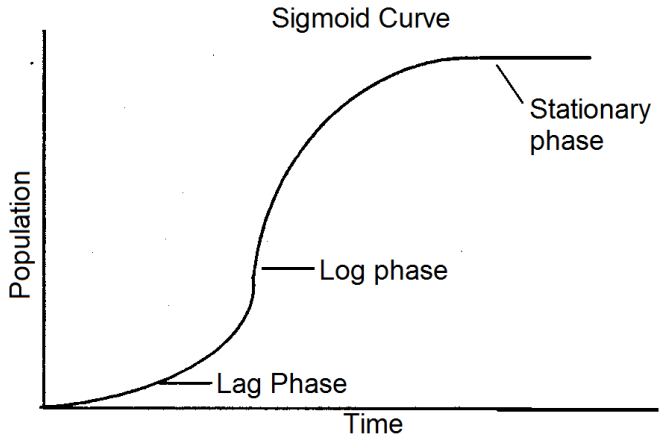
The nitrogen cycle: (page 243)
1) **nitrogen-fixing bacteria** provide usable nitrogen for plants, these may exist in the root nodules where they live in symbiosis with the plants (**nitrogen fixation**), or this can happen because of **lightning**, or **microorganisms** provide them through decomposition.

2) **Nitrifying bacteria** convert nitrogen-containing substances into better nitrogen-containing substances for the plants (**nitrification**).
3) plants absorb these substances and convert them into proteins
4) Primary consumers eat the plants and can make their own proteins, secondary consumers eat primary consumers and so on.
5) Death and decay happens at each trophic level leading to stage one (the decomposers bit)
6) **Denitrifying bacteria** carry out **denitrification**: they convert nitrogen-containing substances into atmospheric nitrogen

	oxygen concentration in air	carbon dioxide concentration in air	why?
Combustion of fossil fuels	decreases	increases	-burning uses up oxygen, and produces carbon dioxide
Deforestation	decreases	increases	-fewer trees means less photosynthesis -trees are usually burnt (combustion) -decomposition of tree trunks (respiration) other effects not needed (page 263)

4. Population size

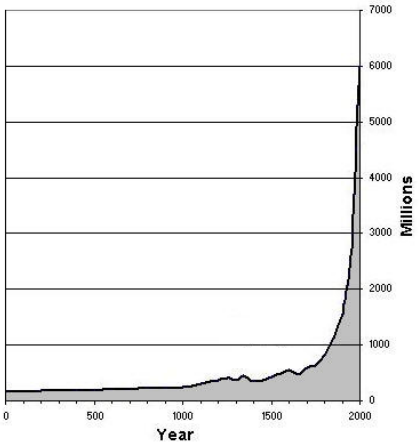
Population: a group of organisms of one species, living in the same area at the same time
Factors affecting rate of population growth:
Food supply: quantity and quality, for example snails need calcium to reproduce to make a shell (food quality).
Predation: if predator population falls, the prey population will rise and visa versa
Disease: causes organisms to die so a high death rate partly cancels out the birth rate meaning less population growth, especially if the organism dies before giving birth, or even population decline



Lag phase: number of mature, reproducing individuals is low and they may be widely dispersed
Log phase: a compromise between biotic potential (an estimate of the maximum capacity of living things to survive and reproduce under optimal environmental conditions) and initial environmental resistance (The effect of physical and biological factors in preventing a species from reproducing at its maximum rate). Growth is exponential. Limiting factors do not limit growth much.

Stationary phase: Limiting factors begin to slow growth: mortality rate begins to catch up with birth rate. Population has reached its maximum for the habitat (the "carrying capacity" of its environment) and mortality rate = reproduction rate; curve levels off and fluctuates around this maximum population size.

Human population growth: Ever since agriculture was invented about 10,000 years ago human population has been in exponential growth. Factors favouring growth: lower infant mortality, higher life expectancy, better nutrition, better housing, better sanitation, medicine, vaccination



Factors controlling growth: disease, famine, war

The human population is becoming stable (stagnation) due to:

-better education (particularly for women), so they work instead of getting married and having children

-better living conditions, fewer people die, fewer births needed

-cities, reduced need for physical labour on farms

-family planning

but overall the population in still increasing.

Social implications of human growth:

-demands for roads as there is an increases number of cars

-greater expectation for a variety of foods all year round

-smaller families increase demand for housing

-greater demand for leisure and recreation space

5. Human influences on the ecosystem

(I tried to make it as short as possible)

Agriculture:

-can cause eutrophication

-pesticides: can accumulate in the food chain so that secondary and tertiary consumers receive lethal doses

-deforestation

-reduced biodiversity, destroys habitats

-loss of CO_2 fixation, thus increase in CO_2, thus global warming

-soil erosion: tree roots can not retain soil, goes into rivers making the water dirty & causes blockages

-climate change: forests transpire more water than the soil alone

Urbanisation

-destroys natural habitats as cities expand

-produces more waste (sewage, garbage) - pollution

-consumes more energy – pollution, depletion of resources

Industrialisation

-creates pollution

-consumes energy and resources from the environment in the search for resources

Others:

Hunting – big game (tigers, rhinoceros, elephants, whales) going extinct

Fishing – certain fish are going extinct due to over-fishing (Atlantic cod, Pacific halibut, herring, etc.)

Pollution

a. Smoke –carbon in air causes cancer
b. CO – takes the place of O_2 in haemoglobin, oxygen starvation
c. sulphur dioxide and oxides of nitrogen – cause acid rain (more details later)
d. herbicides - damage surrounding environment and can be harmful for animals eating the plants
e. nuclear fallout – damages DNA and causes cancer and radiation illness
f. CFCs –destroys ozone layer (now banned though)
g. Sewage: spreads disease such as cholera and typhoid
h. Chemicals: mostly heavy metals (lead, mercury) = poisons to humans and other organisms; also cyanide etc.

Problems with fish farming:

-very high food costs

-lots of research necessary

-pollution by pesticides may kill other organisms which are food for wild species

-faeces and excess nutrients sink out of nets and stimulate bacterial growth creating an increased biological oxygen demand.

5.1 Agriculture

Deforestation:

-reduced biodiversity/destroys habitats/extinction

-loss of CO_2 fixation, thus increase in CO_2, thus global warming

-soil erosion: tree roots can not retain soil, goes into rivers making the water dirty & causes blockages, soil becomes less fertile

-flooding: usually 75% of water is absorbed by foliage, root systems or evaporates. After deforestation water may accumulate in river valleys.

Eutrophication: when water plants receive too many nutrients. Plants need minerals such as nitrates and phosphates. They absorb these from the soil. In general, the more they have, the better they can grow. It works like this:

1) Fertilisers put in soil by farmers

2) Fertilisers with nitrates / detergents with phosphates leach into rivers and lakes after rain

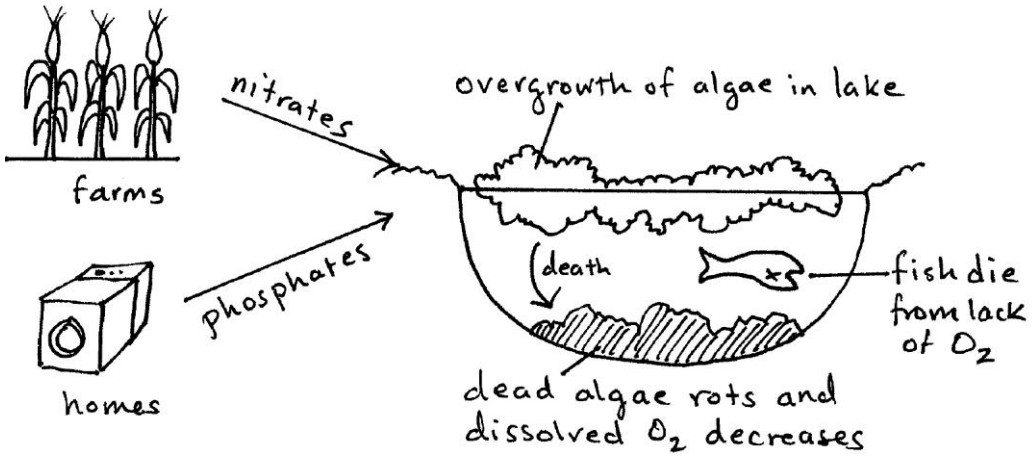
3) Water plants grow more than usual

4.1) they block sunlight and kill plants underneath

4.2) they die and sink to bottom

5) Bacteria/fungi decompose remains using the O_2 and decreasing the O_2 concentration

6) Fish and other creatures die from oxygen starvation



5.2 Pollution

-chemical waste and sewage in rivers ⟶ water is not drinkable and eutrophication can occur

-sulfer dioxide ⟶ acid rain lowers pH (increases acidity) of lakes/ponds and leaches aluminium out of the soil causing:

-the fishes gills to be damaged eventually killing them, this is fixed by adding calcium hydroxide (slaked lime)

-destroys the top of the trees and the aluminium damages tree roots = dead tree, important nutrients leached away

-SO_2 poses health hazards for humans (asthma sufferers)

-damages limestone buildings and sculptures

-fewer crops can be grown on an acidic field (fixed by adding lime)

-CO_2 and methane ⟶ greenhouse gases trap heat inside the atmosphere, contributing to global warming

-**pesticides**:

-**insecticides** (kill insects): are meant to kill the annoying insects (the ones which eat the plants), but can kill other, useful insects such as bees which are pollinators, or by bioaccumulation (the increase in dose of toxin from one level of the food chain to the next) for example DDT:

DDT	⟶	Water	⟶	Plankton	⟶	Daphina	⟶	Fish	⟶	Bird
concentration in parts per million (ppm)		0.02		5		50		250		1500

-**herbicides** (kill weeds): can be harmful to animals which eat the plants

-**nuclear fallout** ⟶ radioactive particles can be sprayed into the atmosphere in a nuclear accident or bombing; these "rain" back to earth from clouds, sometimes far from the accident site; radioactivity damages DNA and causes cancer and radiation illness at every level of the food chain.

Plastics:

-choke birds, fish and other animals / fill up the animals' stomachs so that they eat food

-collect in rivers, and get in the way of fish

Acid rain: caused by sulfer dioxide (burning fossil fuels) and nitrogen oxides (nitrogen and oxygen from air react in furnaces and hot engines), they cause acid rain (also cause respiratory problems). Acids rain which damages trees and plants, and kills fish and other river life. Prevention: catalytic converters, in factories slaked lime neutralises these acidic oxides.

Global warming: The average temperature on the surface of the Earth is increasing gradually. It seems to have started at the same time as humans began burning fossil fuels in the 19th century. That has been proven. Most scientists agree that the warming is probably due to humans burning fuels, but that has not yet been proven.

5.3 Conservation

Species and habitats: need to be conserved because:

-Organisms have value in themselves (ethical value)

-Value to medicine (new molecules from exotic plants = new drugs)

-Genetic resources are useful to humans as well and are lost when species disappear (DNA for genetic engineering)

-Each species has its role in its ecosystem: if it is removed, the whole ecosystem could collapse

Natural resources:

-water: we use water to grow food, keep clean, provide power, control fires and to drink. We get fresh water constantly through rainfall but people use up our planet's fresh water faster than it can naturally be replenished.

-fossil fuels: need to be conserved as they will soon run out, they should be therefore replaced with green forms of energy.

Recycling:

-water: the water from sewage can be returned to the environment for human use by sanitation (faeces is removed from the water so pathogens cannot infect the water) and sewage treatment (eliminates pathogens through high temperatures and chlorination and to remove organic compounds page 259).

-paper: is sent to special centres where they can be pulped to make raw materials for industry.

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