GCSE DA Biology

REVISION NOTES – New Specification

B1.1- Investigating Ecology, Classification and Biodiversity Populations

1.1.1 use appropriate sampling techniques, for example quadrats, pooters, pitfall traps and nets, to investigate changes in the distribution of organisms within a sample area of a habitat

Sampling Technique	Description	Picture
Quadrat	A **square** frame that is placed over the ground to **measure the distribution of plants and stationary animals** *e.g. limpets*. Usually a number of quadrats are used and an average obtained. The quadrats are thrown randomly over the area to be sampled. Plants that are difficult to measure as separate individuals *e.g. grasses*, can be **measured as percentage cover**. For areas that show obvious gradation over an area *e.g. rocky shore*, a belt transect is used. Quadrats are placed along a line from the bottom boundary to the top boundary. They can be used continually or at intervals.	
Pooter	A small tube that is used for **sucking up small insects**. One sucks through one pipe when the other pipe is just above the insect, the insect is sucked into the tube. One pipe is covered with a mesh to **stop the insect being inhaled**.	
Pitfall Trap	A container is placed in a **hole in the ground** and a flat stone raised on smaller **stones prevents the rain getting in**. This is suitable for small ground living insects *e.g. beetle*.	
Net	Nets are useful **for trapping insects or animals** which live in **long grass, rivers or ponds**.	

Suggest a suitable sampling method for collecting invertebrates

on the ground. _____

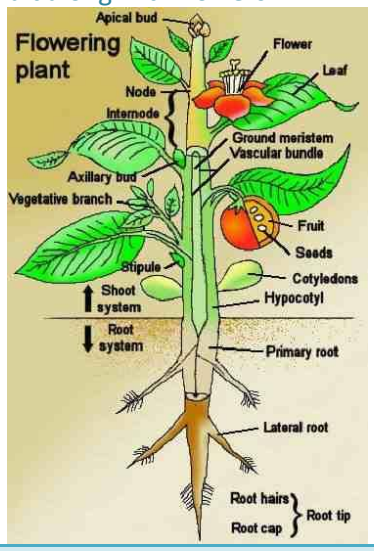
in the vegetation. _____ [2]

1.1.2 use observations from organisms identified in fieldwork to help describe the main features of:

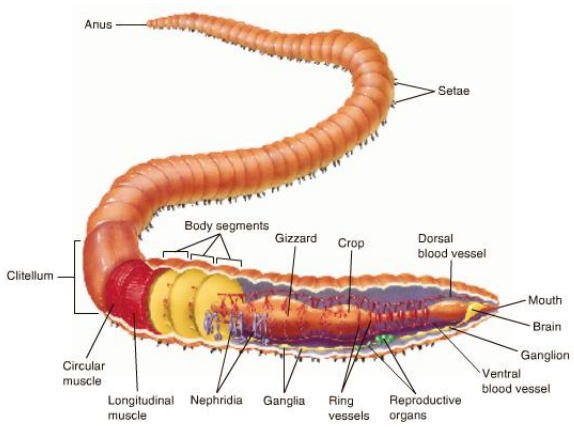
– flowering plants – true roots, stems and leaves with specialised vascular tissue, flower and seed production with a fruit;
– annelids – segmentation, chaetae, and body temperature not constant;
– insects – exoskeleton, three regions to body (head, thorax and abdomen), three pairs of jointed legs, two pairs of wings, and body temperature not constant; and
– chordates – only as animals with backbones;

In this section it is necessary to only be aware of the following features of plants and animals, in-depth detail does not need to be known.

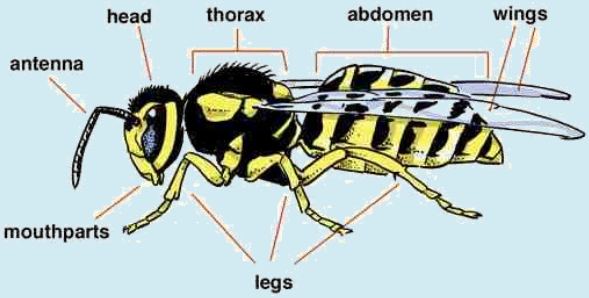
Flowering Plants- Plants with an intricate root system, a thick stem and leaves which contain a phloem and xylem system. Seeds are produced inside a fruit along with flowers.



Annelids (Ringed Worms)- They are segmented into many "ringed" parts. The temperature fluctuates constantly.



Insects- Most insects have an exoskeleton, three regions to the body and three pairs of joint legs. Most have a set of wings and the body temperature fluctuates.



Chordates- These animals have backbones and are vertebrates.

1.1.3 understand the meaning of the terms biodiversity, population, habitat, environment, community and ecosystem.

Biodiversity- Measure of the number of different types of plant and animal species in an area.

Population- the measure of the number of a specific species living in a given area.

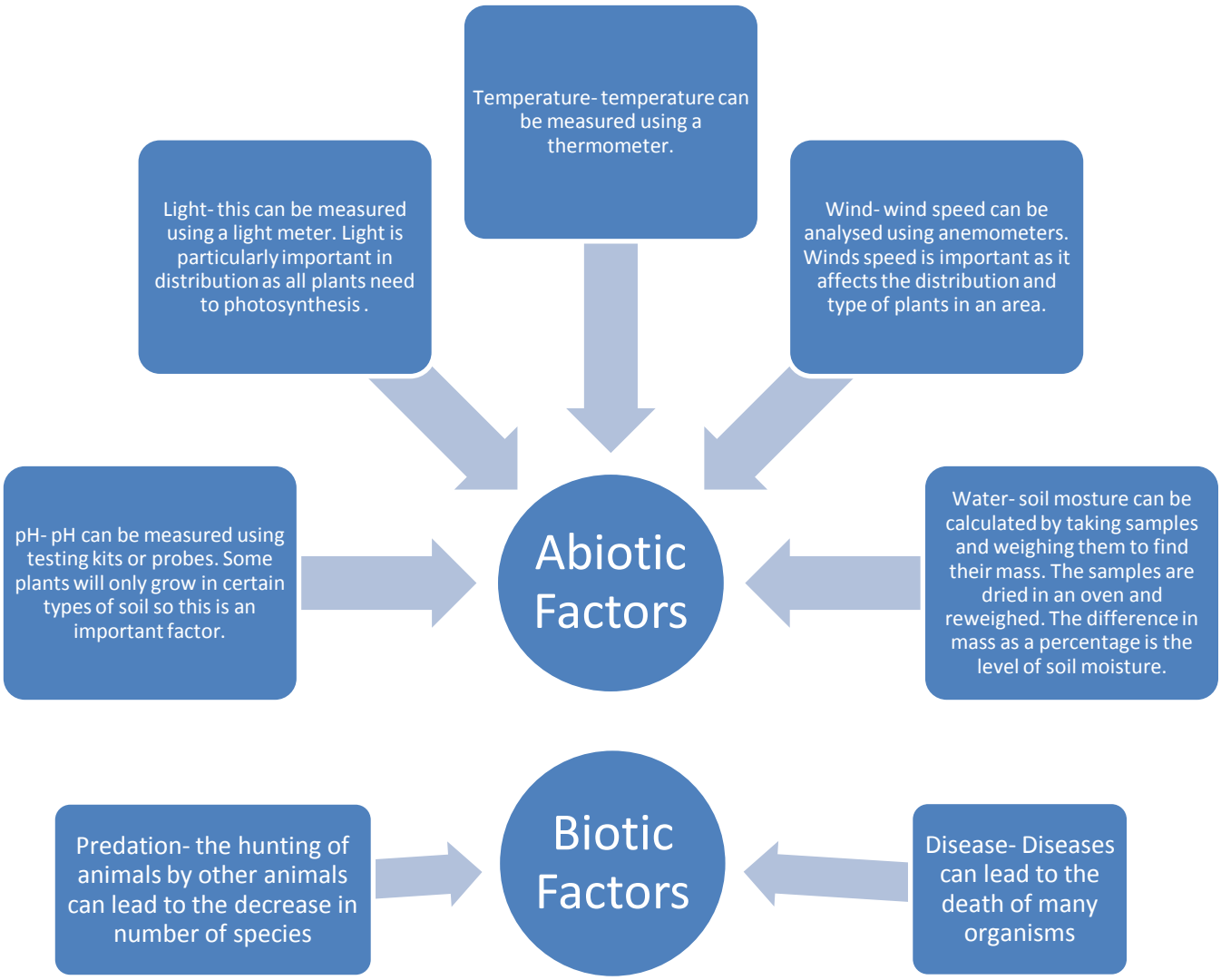
Habitat- the natural environment of an organism, in which it is normally found.

Environment- the abiotic and biotic factors surrounding and affecting a given organism at any time.

Community- an assemblage of interacting populations occupying a given area.

Ecosystem- a system formed by the interaction of a community of organisms with their environment.

1.1.4 measure biotic and abiotic factors such as wind speed, water, pH, light, temperature and biodiversity (the number of plant and animal species)



1.1.8 use keys to identify organisms and classify them into major groups based on observable features

Group	Nutrition	Cell Wall	Cell Arrangement
Protoctista	Saprophytic or Photosynthetic	Cellulose cell wall or none	Single celled with nucleus or algae that are not multicellular
Bacteria	Saprophytic	Non-cellulose	Single celled with no nucleus
Fungi	Saprophytic or Parasitic	Non-cellulose	Single or multicellular
Plants	Photosynthesis	Cellulose	Single or multicellular- typical cell arrangement
Animals	Eating organic food	None	Single or multicellular- typical cell arrangement

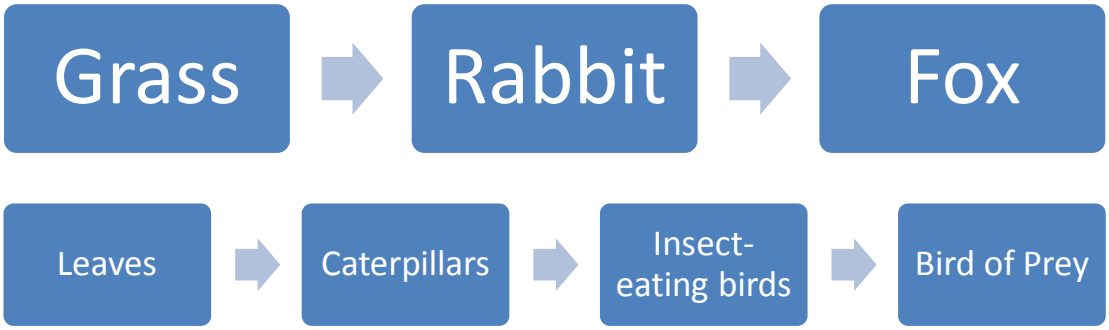
B1.2- Ecological Relationships and Energy Flow

1.2.1 understand that the Sun is the source of energy for most ecosystems on Earth and understand the role of green plants as producers in capturing this energy and making it available to other organisms;

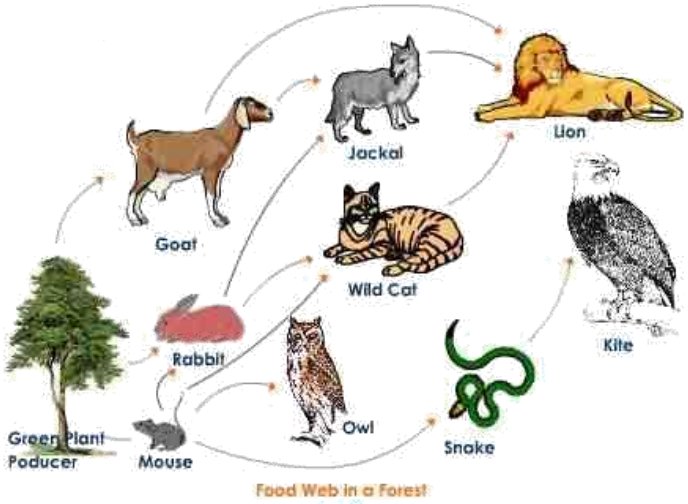
- The energy that helps ecosystems remain constant and alive comes from **the Sun** and is trapped by green plants in the process of photosynthesis.
- **Plants are known as producers** as they produce their own food and they in turn provide food for all other organisms.
- Herbivores which feed on plants are **primary consumers** and the carnivores which feed on primary consumers are known as **secondary consumers**, etcetera.
- The process of plants capturing the sun's energy and passing it onto other organisms as they feed is known as **energy flow.**
- The different stages in the feeding sequence are also referred to as **trophic levels**.

1.2.2 understand food chains and webs and identify producers, consumers and trophic levels.

Below are examples of food chains which are simple diagrams that show the feeding relationships and energy transfer between a number of organisms.

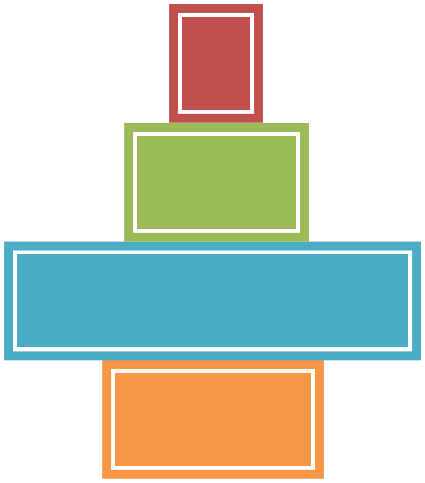


Food webs show how a number of food chains are interlinked and they give a much more realistic picture.



1.2.3 construct pyramids of numbers and biomass as models of food chains and explain the difference

- For a food web to be sustainable there must be enough food for all the organisms involved. There will usually be more producers than primary consumers and more primary consumers than secondary consumers. The number of organisms at each level can be presented in a pyramid of numbers
- However, a pyramid of numbers does not take into account the size of the organisms involved. The pyramid to the right shows this.



- When looking at energy flow through a food chain it is sometimes more accurate to use a Pyramid of Biomass. This takes into account the dry mass of each organism rather than the number of organisms.

1.2.4 use data to interpret and explain decreases in the amount of energy available at each trophic level due to heat from respiration, movement, waste materials, and uneaten structures, and understand why shorter food chains are more efficient

- At each stage during energy transfer, energy is lost. Even the absorption of light by plants is not efficient as energy is lost as light is reflected or misses chloroplasts.
- The transfer of energy between plants and animals and between animals of different trophic levels is usually 10-20%. This loss is due to three main reasons-

    - Not all the available food is eaten; most carnivores do not eat the skeleton or fur of prey.
    - Not all food is digested; some is lost as faeces in Egestion.
    - A lot of energy is lost as heat during respiration. Respiration provides energy for movement, growth, reproduction, etc.

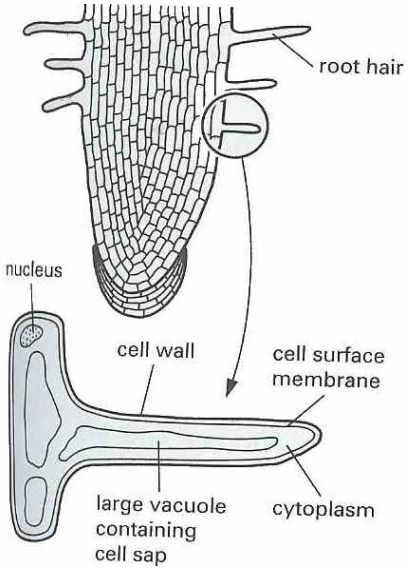
1.2.5 understand the significance of photosynthesis, respiration, combustion, fossilisation, feeding, excretion, egestion and decomposition within the carbon cycle, and the constant removing and returning of substances from the environment

- The carbon cycle is an example of a very important nutrient cycle. Carbon is the most important element in every living organism. The carbon cycle involves the exchange of carbon between living organisms and the environment. The main processes in the carbon cycle are-
    - **Photosynthesis-** carbon dioxide is taken in by plants and built up into sugar and starch and other organic compounds
    - **Feeding-** animals eat the plants and the carbon is built up into other organic compounds that can be transferred further along the food chain
    - **Respiration-** when plants, animals and decomposers respire they return carbon compounds to the atmosphere as carbon dioxide
    - **Decomposition-** carbon compounds in dead organisms and from Egestion are broken down into simpler products. As the decomposers break them down they respire and release carbon dioxide into the environment.
    - **Combustion-** when carbon-rich reserves of coal, oil and gas are burned the carbon is returned to the atmosphere as carbon dioxide. These fossil fuels were created from the dead remains of plants and animals which were preserved by fossilisation due to the conditions at the time.

1.2.6 understand that plants need nitrates to form proteins and that they obtain these from the soil through root hair cells by active uptake;

1.2.7 identify root hair cells as specialised cells that are adapted by having an extended shape, providing an increased surface area for increased uptake of water and minerals;

1.2.8 understand that active uptake is a process that requires energy to transport the minerals against a concentration gradient



- Root hair cells are specialised cells in roots that are adapted to having a large surface area for the uptake of ions and water.
- Ions are taken into the root hair by the process of active uptake/transport.
- In active transport, minerals are moved from where they are less concentrated to where they are more concentrated- they move against the concentration gradient.
- To do this respiration is needed to produce energy, oxygen is needed.
- Active transport differs from osmosis in two ways-
    - It moves substances against the concentration gradient
    - It requires energy

Process A is the uptake of nitrates by plant roots. Describe and explain this process.

_____

_____

_____

_____

_____ [3]

Explain why nitrate uptake by plant roots is faster in well oxygenated (aerated) soils.

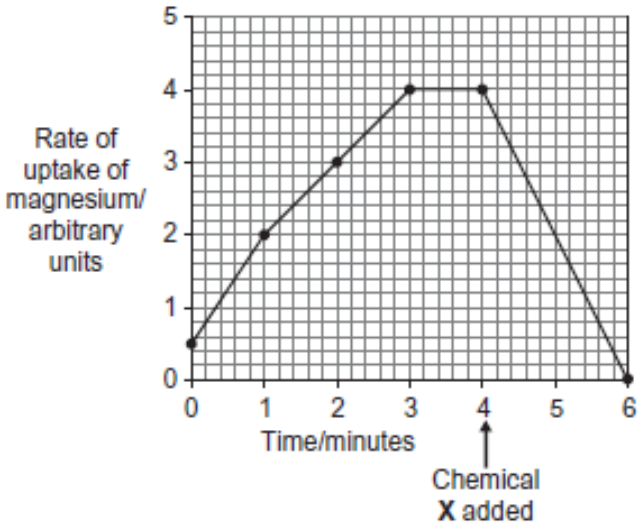
_____

_____

_____

_____ [3]

The graph shows the rate at which a plant absorbs magnesium through its roots by active transport. After four minutes a chemical **X** was added to the plant roots.



(a) Suggest why the rate of active transport had levelled off between three and four minutes.

_____ [1]

(b) Suggest which cellular process is stopped by chemical **X** that then caused the rapid decline in active transport.

_____ [1]

(c) State **one** advantage of active transport over diffusion.

_____

_____ [1]

1.2.9 understand why growers add minerals to the soil, to include calcium, magnesium and nitrogen, and compare the use of natural fertilisers (farmyard manure and compost) and artificial fertilisers as a means of replacing nitrates in soil

- Agricultural land needs to be fertilised frequently to replace nutrients which are taken from the soil either during harvesting or when animals are taken to the abattoir.
- There are three main minerals that need to be replaced by fertilisers-
    - **Calcium-** needed for plant cell walls
    - **Magnesium-** needed to make chlorophyll
    - **Nitrogen-** needed to make amino acids and therefore proteins for growth
- There are both advantages and disadvantages to using Natural Fertilisers and Artificial Fertilisers, which are shown in the table below.

Natural Fertiliser		Artificial Fertiliser	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Less soluble that artificial fertilisers so less will be lost by leaching and run-off into waterways.	Difficult to store and spread.	Easier to store.	Soluble so can be easily washed away creating pollution problems.
Improves soil quality by adding to the humus content in the soil.	Difficult to know the mineral composition exactly.	Can be applied in a more controlled manner.	Has to be purchased.

Explain how nitrogen fertiliser (nitrate) is absorbed by the plant roots.

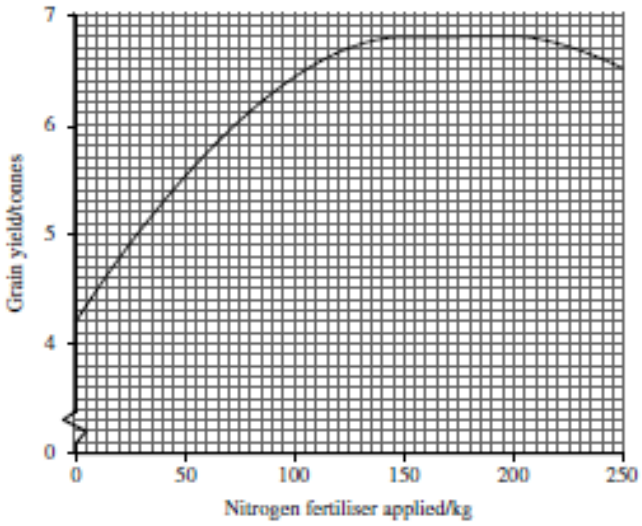
_____

_____

_____

_____ [3]

The graph shows the effect of different amounts of nitrogen fertiliser on cereal grain yields in a field.



(a) (i) Use the graph to recommend the most appropriate level of nitrogen fertiliser to use.

_____ [1]

(ii) Explain why there is still some grain yield when no nitrogen fertiliser is applied.

_____

_____ [1]

(b) In what form is the nitrogen taken up from the soil by the plant roots?

_____ [1]

A farmer planted a crop in spring and applied nitrate fertiliser to the soil at the same time.

After the crop started growing there was a cold spell.

(a) Explain why the plant roots could not absorb the fertiliser effectively during the cold spell.

_____

_____

_____

_____ [3]

(b) How would a shortage of nitrate affect the plant?

_____ [1]

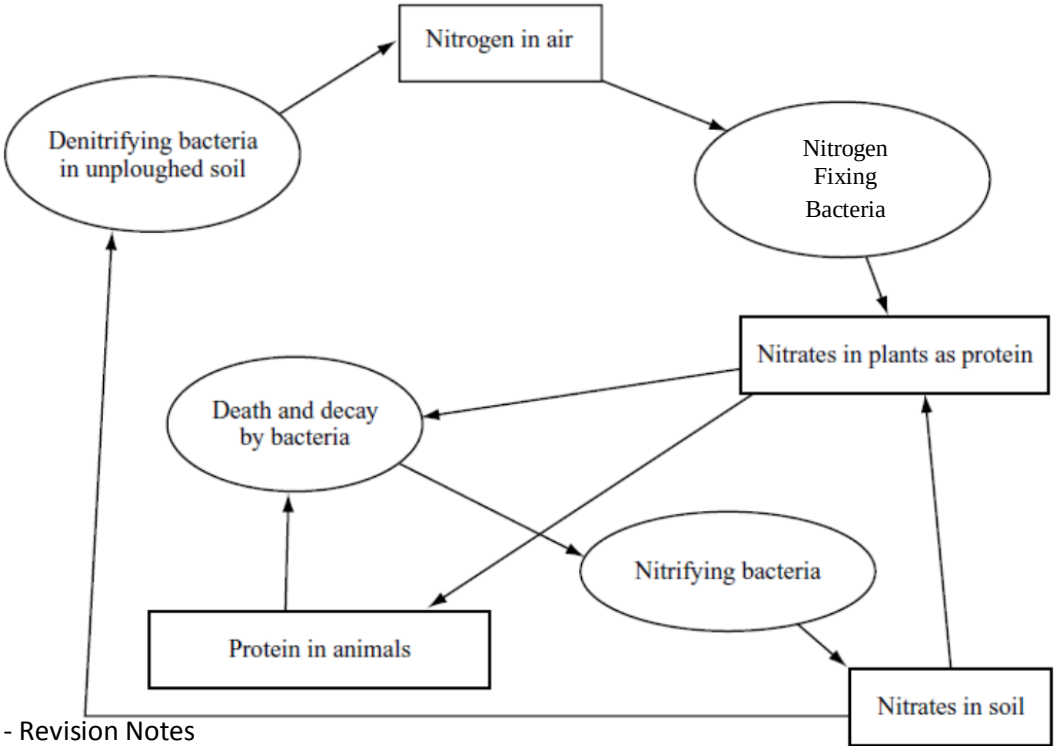
1.2.10 understand the role that microorganisms have in the nitrogen cycle, to include nitrogen fixation, nitrification, de-nitrification and decomposition (knowledge of the names of specific bacteria is not required) and apply this to different growing conditions

- Nitrogen in a very important for both plants and animals, where most of it is found in the form of amino acids and protein.
- There are three main phases to the Nitrogen Cycle and it is important to learn these for GCSE exams-

1. The build up of nitrogen into amino acids and protein in plants and animals and the eventual breakdown of these compounds into nitrates.
    i. Plants absorb nitrogen as nitrates and use them to make protein.
    ii. As plants and animals are eaten the proteins are eaten, digested and then built up into other proteins in sequence.
    iii. Eventually the nitrogen is returned to ground as urine or through the process of death and decay.
    iv. **Putrefying Bacteria** and **Fungi** breakdown the proteins to release ammonia. A second important group of bacteria, **Nitrifying Bacteria**, convert the ammonia into nitrates. This is **Nitrification**.

2. **Nitrogen Fixing Bacteria** convert nitrogen gas into nitrates. These bacteria can be found in root nodules or in the soil. The process of converting nitrogen from the atmosphere into nitrates is called **Nitrogen Fixation.**

3. **Denitrifying Bacteria** convert nitrates into atmospheric nitrogen. This is a wasteful and undesirable process. Denitrifying bacteria are anaerobic and are most commonly found in waterlogged soils. This is **denitrification**.



B1.3- Human Activity and Its Effects on the Environment

1.3.1 carry out studies or analyse data to monitor environmental changes (w – (ii)b), to include:

– biotic data, for example lichens as indicator species of air pollution and blood worms as indicator species of water pollution caused by eutrophication; and
– abiotic data, for example carbon dioxide levels;

1.3.2 understand the need for monitoring of environmental change (for example monitoring levels of carbon dioxide in the air);

- **Biotic Data-** the number and distribution of plants and animals can also provide information about environmental change. **Lichens** are simple plants that grow on roof tiles of house and also on the bark of trees. Lichens are often yellow or light grey. Most lichens will not grow in high levels of **air pollution** and are rare in industrial areas but abundant in rural areas. By monitoring the number of lichens over time, it is possible to monitor pollution levels.
- **Water Pollution** can be measured by the number of **bloodworms** present. These worms are called bloodworms due to their red colour and they are particularly common in polluted water. They are a good indicator of **Eutrophication** as they are abundant in water with low oxygen levels. Both of these are **Indicator** species.

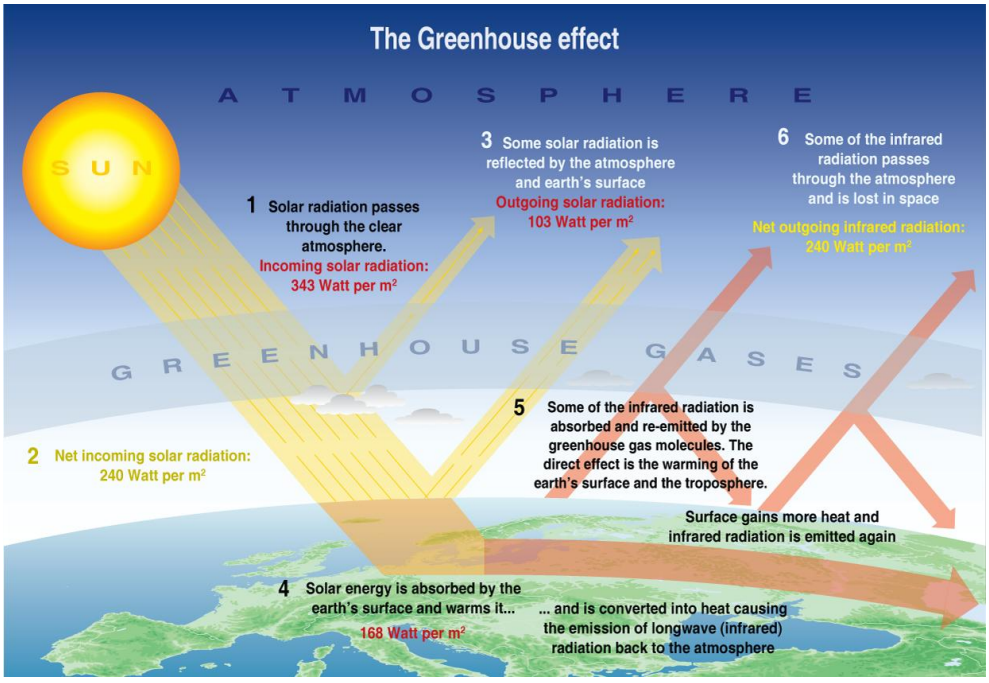
- **Abiotic Data-** these are physical or environmental factors which can be measured to determine certain theories. For example, **Carbon Dioxide** can be measured to determine the rate of which global warming is occurring. **Polar Ice Fields, Ice Density and Sea Levels** can also be monitored.

1.3.3 understand that collaborative scientific research suggests that an increase in levels of carbon dioxide leads to global warming and understand the problems associated with this, and realise that there is controversy associated with the recording, sources, modelling and possible solutions to this problem;

- Over the last 150 years there have been major changes to the Carbon Cycle-
  - Increased **combustion of fossil fuels** has added more carbon dioxide to the atmosphere.
  - Increased **deforestation** has removed many forests meaning that less carbon dioxide can be taken out of the atmosphere by photosynthesis.
- This has led to an increase in the level of carbon in the atmosphere and means the carbon cycle is now unbalanced.

The Link between increased Carbon Dioxide and Global Warming

- Carbon Dioxide and some other gases form a greenhouse blanket around the Earth, trapping the heat from the Sun within the atmosphere. It is thought that the increase in Carbon Dioxide is increasing the Greenhouse Effect.



- **Effects of Global Warming-**
  - **Climate Change-** more weather extremes such as droughts and severe storms
  - **Polar Ice Caps** melt
  - Increasing **Flooding**
  - More land becomes **desert**
- **Reducing Global Warming-**
  - Plant more **trees**
  - **Reduce** deforestation
  - **Burn less fossil fuels** by using alternative fuels and becoming more energy efficient

1.3.4 explain how sewage disposal and fertiliser run-off can cause eutrophication in terms of:

– nitrates stimulating growth of aquatic plants and algae;
– the death of aquatic plants and algae due to shading;
– the role of aerobic microorganisms in the decomposition of plants and algae; and
– the consequences of oxygen depletion on other aquatic vertebrates and invertebrates

- Due to the increased number of factories in our country and an increased number of farmers using artificial fertilisers, the level of water pollution in rivers and lakes has increased dramatically. This has also increased due to the draining of sewage into rivers.

- This adds nitrates to the water which causes growth of aquatic plants faster than normal. This blocks the light for the plants below.

- When these plants die they are decomposed by bacteria which use all the oxygen in the water leading to the death of fish and other animals. This is **Eutrophication**.

1.3.5 outline the role of international treaties in combating pollution

Kyoto Agreement 1997-

- Kyoto was a summit that produced a widespread agreement on approaches to reduce the problems associated with climate change.
- A key agreement was that countries would reduce their pollution levels to the extent that levels produced in 2010 would be no more than the levels in 1990.
- Much of the focus was on Carbon Dioxide and a pollution credit system was proposed. The effect was to reduce pollution at a global level with high levels of carbon dioxide pollution in some countries being compensated for lower levels in others.
- There has been conflict over commitment by some countries which was highlighted when USA withdrew from the treaty in 2003. LEDC's have also argued that MEDC's should not be trying to halt the progress of developing countries.

European Nitrates Directive-

- This directive ensures that farmers have adequate storage facilities for farmyard manure and slurry and that some types of fertilisers are not used during winter months.
- There is a closed season for the application of farmyard manure and artificial fertilisers. This ensures that fertilisers are only added at times when plants are growing.

B1.4- Photosynthesis and Plants

1.4.1 investigate how light, carbon dioxide and chlorophyll are needed for photosynthesis:

– how and why a plant is destarched;
– the steps involved in testing a leaf for starch;
– the production of oxygen;
– using a variegated leaf to illustrate the role of chlorophyll in the chloroplast in trapping light; and
– deriving the word equation for photosynthesis

$$\boldsymbol{Carbon\ Dioxide + Water \rightarrow Glucode + Oxygen}$$

- Plants create energy to survive by converting the raw materials carbon dioxide and water to glucose. The glucose is usually converted immediately into starch.
- This process is known are **Photosynthesis** and takes part in the green parts of the plants, particularly in the leaves.
- The green pigment **chlorophyll** is an important part of the photosynthesis as it traps the light energy from the sun that is needed for the process. Oxygen is produced as a waste product.

The Starch Test-

- A leaf is removed from a plant and placed in boiling water for at least 30 seconds. This kills the leaf and ensures no further reactions take place.
- The leaf is then placed in boiling ethanol which removes the chlorophyll from the leaf. The ethanol is heated using a water bath as ethanol is flammable and will catch fire if exposed to flame.
- The lead should then be dipped in boiling water. This will make the leaf soft.
- The leaf is spread out on a white tile and iodine is added to the leaf.
- If starch is present then iodine will turn starch blue-black otherwise the iodine remains a yellow-brown colour.

Investigating that Light, Carbon Dioxide and Chlorophyll are needed for Photosynthesis-

- To carry out these experiments it is necessary to **destarch** the leaves of the plants first. Leaves can be destarched by placing the plant in the dark for 48 hours. This ensures any starch in the plant is removed as the plant uses it for energy when photosynthesis cannot be carried out.

- **Light-**
    - A leaf is partially covered with black paper or light-proof foil. After a period of time the leaf is tested for starch as described above.

- **Carbon Dioxide-**
    - To show that carbon dioxide is an essential raw material for photosynthesis it is necessary to compare a leaf deprived of carbon dioxide with a leaf that has a good supply of carbon dioxide.
    - Sodium Hydroxide is placed in a flask along with a leaf still attached to the plant. This will remove all carbon dioxide from the flask therefore depriving the leaf of oxygen. Another flask is prepared with only water, meaning this leaf has a good supply of carbon dioxide.

- **Chlorophyll-**
    - Some plants have leaves that are part green and part white. These leaves are described as **variegated.** If a variegated leaf is tested for starch it will be apparent that starch is only produced in the green parts of the leaves. This shows that chlorophyll, the substance that gives leaves there green colour, is needed for photosynthesis.

1.4.2 explain how a plant uses the products of photosynthesis;

- The products of photosynthesis are used in a variety of ways-
    - **Respiration-** the glucose is used in respiration to provide energy
    - **Storage-** in many plants the glucose is converted into starch and oils for storage
    - **Useful Substances-** the glucose can be converted into a range of products including **cellulose, chlorophyll and protein for growth**.

1.4.3 investigate the factors affecting the rate of photosynthesis (light intensity, temperature and concentration of carbon dioxide) and interpret data on the rate of photosynthesis in terms of limiting factors

- **Light Intensity-** As light intensity increases, the rate of photosynthesis increases up to a point where the graph begins to level off and form a plateau. At the plateau there must be another factor limiting the rate of photosynthesis.
- **Temperature-**As the temperature increases, the rate of photosynthesis increases up until a point at which light intensity becomes a limiting factor.
- **Concentration of Carbon Dioxide-** Again as Carbon Dioxide levels increase, the rate of photosynthesis increases up until light intensity in the limiting factor.

1.4.4 using secondary sources of data, investigate the economic implications in commercial crop production of enhancing environmental factors (artificial lighting, carbon dioxide enrichment and fertilisers)

- To maximise profits it is important that all the factors are at their optimum rate of photosynthesis. However if any of these factors- lighting, carbon dioxide or fertilisers, are brought above their optimum then money is wasted providing these extra factors.

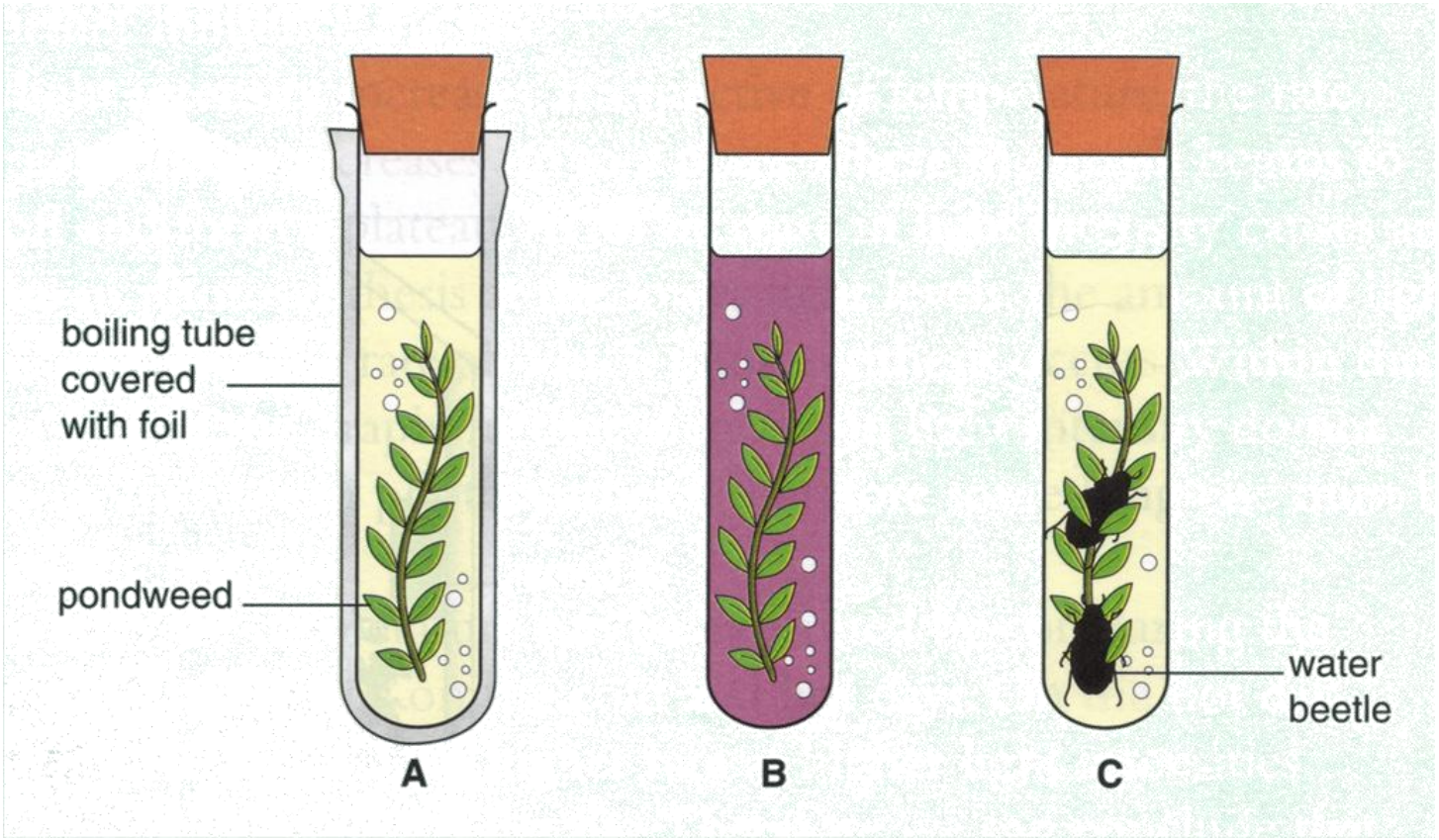
1.4.5 investigate (using hydrogencarbonate indicator) the relationship between photosynthesis and respiration in plants, to include knowledge of the colour changes of hydrogencarbonate indicator (high CO_2 – yellow, normal CO_2 – red, low CO_2 – purple)

- In plant respiration the glucose produced in photosynthesis is broken down to release energy. Plants require oxygen to respire and they produce carbon dioxide as a waste product.
- During the night when there is no light for photosynthesis, respiration will be the only process involving gas exchange taking place.
- When light intensity is high, the rate of photosynthesis will be greater than that of respiration. When this happens carbon dioxide enters the leaves and oxygen moves out.
- During periods of low light (dawn and dusk), the rate of photosynthesis and respiration will be equal and there will be no overall gas exchange. This is the **compensation point**.

Using Hydrogencarbonate Indicator-

- The movement of carbon dioxide and oxygen into and out of plants can be determined using hydrogencarbonate indicator.

Tube	Colour at start	Colour at end	Reason for Change
A- This tube contains pondweed but is covered by foil so no light can pass through.	Red	Yellow	The foil strip stops light from entering and photosynthesis does not occur. Respiration increases carbon dioxide levels.
B- This test tube contains pondweed and no other substances.	Red	Purple	Both photosynthesis and respiration are occurring in the pondweed. As the rate of photosynthesis is faster than the rate of respiration more carbon dioxide enters the plant than is produced.
C- This test tube contains pondweed and water beetles.	Red	Yellow	The water beetles produce more carbon dioxide in respiration than the pondweed takes in for photosynthesis.


boiling tube covered with foil
pondweed
A
B
water beetle
C

B1.5- Nutrition and Health

1.5.1 by carrying out food tests, investigate the idea of a balanced diet by using food samples and food test reagents, including:

– reducing sugar (Benedict's);
– starch (iodine solution);
– amino acid/protein (Biuret);
– fats (ethanol); and
– Vitamin C (DCPIP)

Food	Name of Test	Method	Positive Result
Starch	Iodine Solution	Add iodine to food	**Yellow-Brown** to **Blue-Black**
Reducing Sugar	Benedict's Test	Add Benedict's solution to the food in a test tube and heat in a water bath	**Blue** to **Brick Red**
Protein	Biuret Test	Add sodium hydroxide to the food solution, then add cooper sulphate and shake	**Blue** to **Purple**
Fats	Ethanol	Mix the fat with ethanol	Turns from **clear** to **white emulsion**
Vitamin C	DCPIP	Draw up some of the solution and start adding to DCPIP solution in a test tube, drop by drop. Continue until the DCPIP turns from blue to colourless showing Vitamin C is present.	**Blue** to **Colourless**

1.5.4 understand how human health is affected by:

– inherited factors;
– environmental factors – obesity can be caused by energy intake being higher than energy used in exercise; and
– healthy food choices – limited intake of sugar, salt and fat and the benefit of fruit and vegetables;

- **Inherited Factors-** These are features that are inherited from both parents during Meiosis. These factors are part of our gene make up and are an important factor in certain diseases and conditions. For example, a person is more likely to have heart problems if high blood pressure or heart attacks run in the family.
- **Environmental Factors-** These are features that are not part of our genetic makeup. This includes such things as eating too much unhealthy food, eating too little food or lack of exercise. It is important to make **Healthy Food Choices** to combat these factors such as eating the right number of fruit and vegetables and reducing the intake of salt and sugar.

1.5.5 understand the contribution of an unhealthy diet to obesity, heart disease, strokes, high blood pressure and diabetes

- **Obesity-** caused by taking in more energy (sugar, starch or fat) than the body burns. The body turns this energy into fat for storage leading to people being overweight.

- **Heart Disease-** caused by high cholesterol and other fatty substances being present in high levels in the blood. This cause the restricting of blood vessels, making it hard for blood to flow through them, possibly resulting in a heart attack.

- **Strokes-** poor diet can damage the circulatory system in other parts of the body. If a build up of fat and subsequent blockage is near the brain, this could lead to a stroke.

- **High Blood Pressure-** the heart works harder to pump blood around the body leading to greater wear and tear of the heart and the damage of blood vessels. Poor diet can lead to high blood pressure due to the narrowing of blood vessels, making it harder to pump blood.

- **Diabetes-** a poorly balanced diet can lead to Type 2 diabetes. This means that insulin can no longer control the blood sugar levels due to a “sugar overload”.

B1.6- Enzymes and Digestion

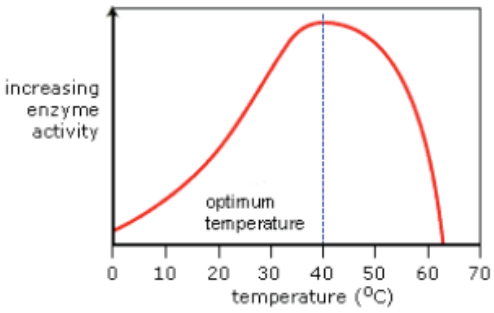
1.6.1 investigate the actions of enzymes as proteins that are biological catalysts which speed up the rate of reactions, to include amylase, and interpret the results in terms of the lock and key model illustrating substrate specificity

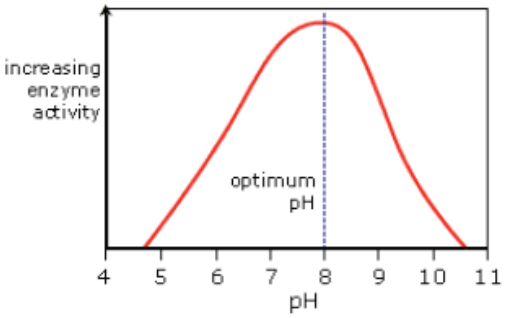
- Enzymes are biological catalysts that speed up the rate of reactions, which are very important in digestion to break down large molecules.

Lock and Key Model-

- Enzymes work by the substrate fitting snugly into the active site of the enzyme. This tight fit then enables the enzyme to catalyse the reaction and split the substrate into its products.
- This action is known as the **Lock and Key Model** due to the importance of the tight fit between the active site and substrate.
- This explains **Enzyme Specificity** which describes that each enzyme will only work a specific substrate. For example, only starch will fit into the active site of amylase.

1.6.2 investigate and interpret the effects of temperature, pH and enzyme concentration on the action of enzymes

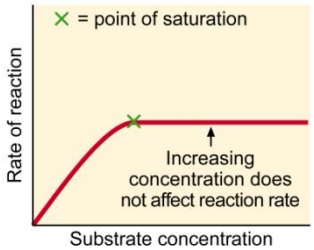




- **Temperature-** At low temperatures the reduced kinetic energy of the enzymes and substrates lead to reduced rates of collision. The maximum rate is the optimum rate and at increasingly higher temperatures denaturation occurs leading to reduced rate of reaction.

- **pH-** Each enzyme has an optimum pH, at either side of the optimum pH they work less well because the incorrect pH changes the shape of the active site.

- **Enzymes-** the more enzymes there are, the faster the enzyme reaction. This is because there are more actives sites for substances to attach to. This applies up to a limit, when the rate levels off because there are not enough substrate molecules to react with the extra enzymes.



1.6.3 understand that enzymes are needed to break down (digest) large, insoluble molecules into small, soluble ones:

– in biological washing powders, as an example of commercial use; and
– in the digestion of food, which can then be absorbed into the bloodstream, in the body, for example proteases in acid conditions in the stomach and proteases, lipases and amylases in the small intestine;

Commercial Uses of Enzymes-

- Biological Washing Powders contain enzymes for breaking down difficult-to-remove stains. These enzymes are thermostable meaning they work over a range of temperatures. They operate by breaking large, complex and insoluble stains into small, soluble molecules that dissolve in water.

Digestion of Large Molecules-

- During digestion, large, insoluble food molecules are broken down into small, soluble molecules which can be absorbed into the bloodstream.

1.6.4 understand that the small intestine is adapted for digestion and absorption by having a large surface area (length, folds and villi) for digestion and absorption, and a good blood supply for absorption;

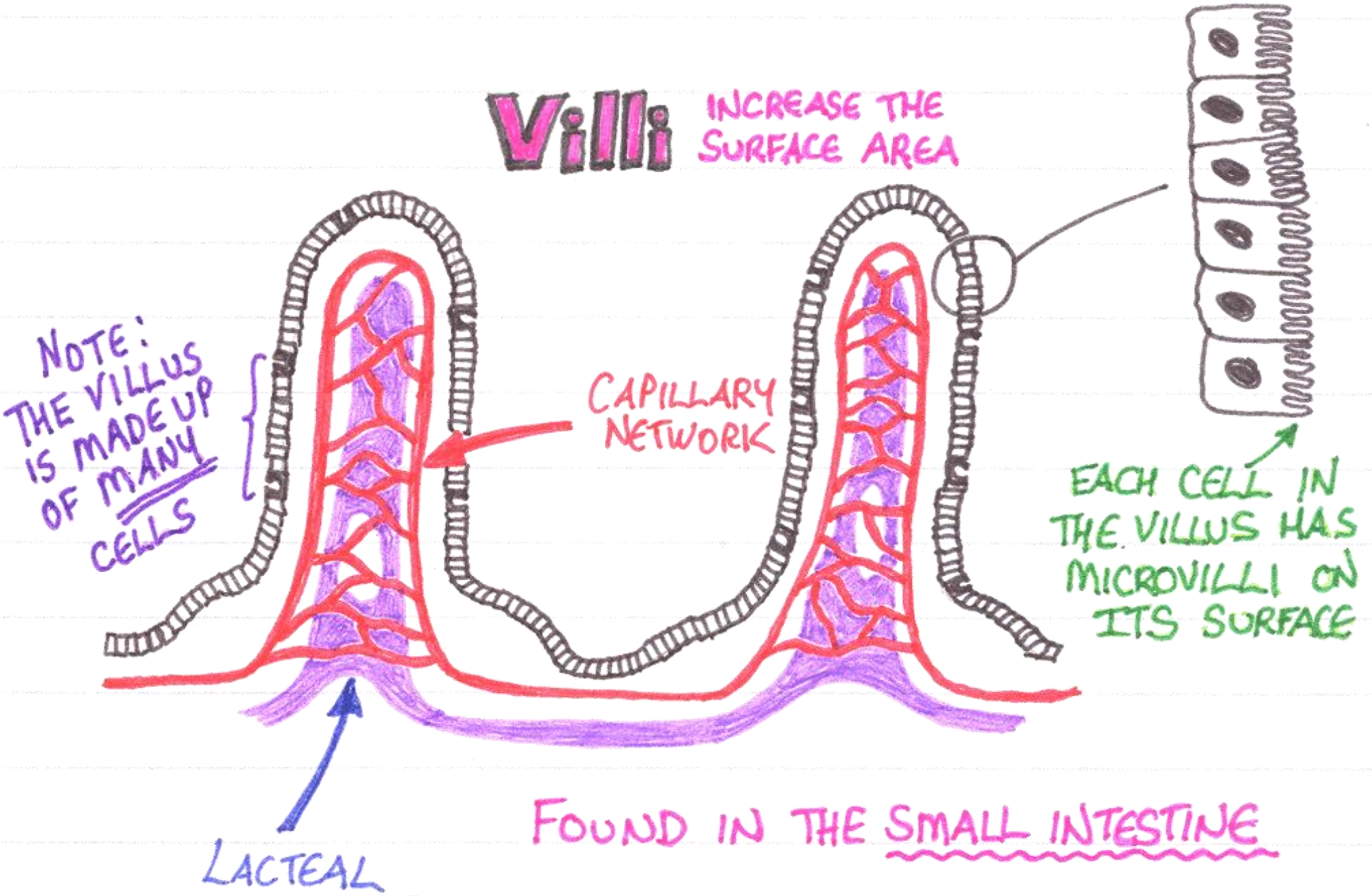
- The small intestine is the main site for absorption especially the **ileum**, although some digestion takes place here.
- It is adapted in many ways including its **great length** (6 metres) and the **presence of folds** which increase the **surface area** for absorption. There is also a **good blood supply** and a **thin, permeable membrane**.

1.6.5 explain how the structure of a villus (finger-like shape, single layer of surface cells, capillary network and lacteal) is adapted for the efficient absorption of digested food molecules.

- The presence of **villi** on the inner surface further increases the surface area of the ileum.
- The villi have **excellent blood supply** due to the large capillary network which runs through the ileum. This means that food can constantly be absorbed from the ileum after digestion.
- **Lacteal** absorbs and breaks down fat molecules before putting them back into the blood.
- The villi are **thin** and have a **permeable surface** meaning that absorption from the ileum to the blood is easier and quicker.
- Each villus contain thousands of **microvilli** which further increase the surface area for absorption.

Villi

INCREASE THE SURFACE AREA



FOUND IN THE SMALL INTESTINE

B1.7- Respiration

1.7.1 explain the adaptations of respiratory surfaces in plants and animals, to include large surface area, thin, moist, permeable, good blood supply and diffusion gradient

- **Large Surface Area-** there are many alveoli in each lung and each alveolus has a large surface area. Together this gives a gas exchange surface of many metres squared in humans.

- **Thin Walls-** there are only two layers of cells separating the oxygen in the alveolus from the blood. This means a there is a short diffusion distance.

- **Moist Walls-** these help the gases to pass through the respiratory surfaces because the gases dissolve in the moisture.

- **Permeable Surface-** the moist, thin walls make the respiratory surface permeable allowing the passing of gases between the blood and lungs.

- **Good Blood Supply-** alveoli are surrounded by capillaries to ensure than any oxygen diffusing through is carried around the body. This maintains the concentration gradient allowing constant diffusion of carbon dioxide out of the blood and oxygen into the blood.

- **Diffusion Gradient-** the process of breathing ensures that there is a large diffusion gradient that encourages oxygen to diffuse into the blood and carbon dioxide to diffuse out of the blood.
    - When fresh air is breathed in, the concentration of oxygen in the alveoli increases making it higher than the concentration of oxygen in the blood. This means oxygen moves from higher concentration in the alveoli into the blood where it is in lower concentration.

1.7.2 recall the word equation for aerobic respiration; glucose + oxygen → carbon dioxide + water + energy

$$\boldsymbol{Glucose + Oxygen \rightarrow Carbon\ Dioxide + Water + Energy}$$

1.7.3 investigate the energy released from food in respiration by burning food samples, calculate the results and compare their data with data from food labels, evaluating the methods of data collection and their reliability and validity

The energy content of food can be calculated by burning the food over a test tube of water. The rise in temperature of the water will give an indication of the amount of energy in the food. The following equation can be used to work out energy released-

$$\boldsymbol{Energy\ Released\ in\ Joules = Mass\ of\ Water\ (g) x\ Rise\ in\ Temperature\ x\ 4.2}$$

1.7.4 compare and contrast aerobic and anaerobic respiration in mammalian muscle and yeast, to include the word equations for mammalian muscles and yeast.

	Aerobic Respiration	Anaerobic Respiration
Definition:	Aerobic respiration uses oxygen.	Anaerobic respiration is respiration without oxygen
Cells that use:	most cells	yeast, prokaryotes, muscle cells
Production of lactic acid:	Does not produce lactic acid	Produces lactic acid
Amount of energy released:	High	Low
Products:	Carbon dioxide, water, ATP	Lactic Acid Fermentation - lactic acid, energy Alcoholic Fermentation - alcohol, energy, carbon dioxide
Reactants:	glucose, oxygen	glucose
Site of reactions:	Cytoplasm and mitochondria	Cytoplasm

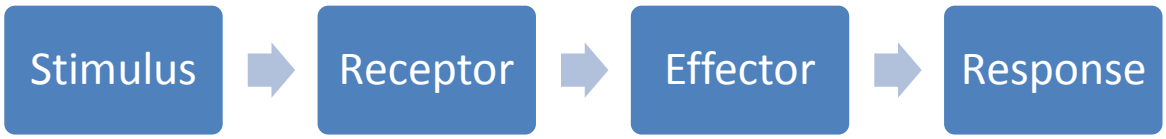
B1.8- Nervous System and Hormones

1.8.1 compare and contrast the two communication systems in the human body (nervous system and hormonal system), to include the speed and nature of the response

Nervous System	Hormone System
Signal is a nerve impulse- electrical	Signal is release of hormones- Chemical
Nerve Impulses transmitted by neurones	Hormones transmitted by blood stream
Signal transmitted rapidly	Signals transmitted slower
Responses are rapid	Responses are slower
Responses short term	Responses long term- until hormone broken down
Response local in specific effectors only	Response more widely spread
Effectors are muscles or glands	Effectors target cells with specific receptors
Response is contraction or secretion	Response is a chemical change (e.g. Glucose to Glycogen)
Response is not permanent	Response often a permanent change
Controls specific rapid responses to rapid changes in the environment	**Controls more longer duration responses to changes in the environment e.g. Blood sugar regulated by Insulin**

1.8.2 know that the brain and spinal cord form the central nervous system that controls and coordinates the responses between the receptors and effectors

- Anything that we respond to in the environment is a **stimulus**. In animals each type of stimulus affects a **receptor** in the body. There are many types of receptors e.g. touch, sight.
- If a receptor is stimulated it may cause **effectors** to produce a **response**.



- In reality the receptors and effectors are linked by a **co-ordinator**. This is usually the **Brain** or **Spinal Cord**. Together they are known as the **Central Nervous System**.
- **Nerve Cells (Neurones)** link the receptors and effectors to the co-ordinator. A neurone carries information as small electrical charges called **Impulses**.
- The brain acts as a filter and determines which receptors link up with which effectors.
- The overall total of our responses to the environment around us is described as our **behaviour**.

1.8.3 understand that hormones, to include insulin, are chemical messengers that travel in the blood to a target organ, where they act (w – (iii)a):

– insulin is produced by the pancreas in response to increasing blood glucose levels and acts in the liver; and
– insulin lowers blood glucose levels by converting glucose to glycogen or respiring more glucose in the liver;

- Hormones are chemicals produced by special glands that release them into the blood. Hormones travel around the body in the blood; however they only affect certain organs.
- Hormones usually act more slowly than the nervous system and over a longer period of time.
- The sex hormones Oestrogen and Testosterone bring about changes over many years.

Insulin-

- Insulin is the hormone that prevents blood glucose levels from becoming too high. Glucose is constantly needed by all cells from respiration and therefore must always be present at a sufficient concentration.
- However, too much sugar in the blood can damage the cells of the body as a result of water loss by osmosis.
- Insulin is produced in the Pancreas in response to increasing or decreasing blood glucose levels. The insulin acts to reduce blood glucose levels by converting excess glucose to glycogen which is then stored in the liver. Insulin also increases the rate of respiration.
- When blood sugar levels are low, less insulin is produced. This means the above process do not take place.

1.8.4 understand that:

– diabetes is a condition in which the blood glucose control mechanism fails;
– the symptoms of diabetes include high blood glucose, the presence of glucose in the urine, lethargy and thirst; and
– possible long-term effects of diabetes include eye damage, kidney failure, heart disease and strokes

- Diabetes is a condition where the body does not produce enough insulin to keep blood glucose levels at a normal level. The following symptoms are present in sufferers-
    - **Glucose in the urine**- as blood sugar levels are so high, some sugar is removed through the kidneys.
    - **Thirsty**
    - **Lethargic**
- Diabetes is treated by the injection of Insulin and by a carefully controlled diet. However, it is often difficult to control blood sugar levels accurately.

- If blood sugar levels drop too low, a hypoglycaemic attack may occur followed by unconsciousness. If blood sugar levels remain too high for a long period of time, serious medical complications may occur.

Long Term Effects-

- Those who have had diabetes for a long time, serious complications may arise. These include-
    - Eye Damage
    - Heart Disease & Strokes
    - Kidney Damage
- These are normally caused by the damage of capillaries by high blood sugar levels.

1.8.5 investigate and interpret evidence (secondary data) on how plants respond to external stimuli – phototropism in stems as a differential growth of cells caused by uneven distribution of the hormone auxin in response to light

- Plants respond to fewer types of stimuli than animals, and the response is slower. Plants respond to the environmental stimuli which have the greatest effect on their growth.
- For example, roots grow towards water and shoots grow towards light.

Phototropism-

- Plants tend to grow towards light allowing more photosynthesis to occur due to the increased amount of light available for the plant. This results in more growth
- This is caused by the hormone auxin present in the tip of a shoot. When a stem is illuminated from one side, this hormone tends to accumulate more on the non-illuminated side.
- As the effect of the hormone is increased growth, this leads to the non-illuminated side growing more rapidly than the side that is receiving light. The differential growth that occurs when one side grows faster than the other side, leads to the stem bending in the direction of light.

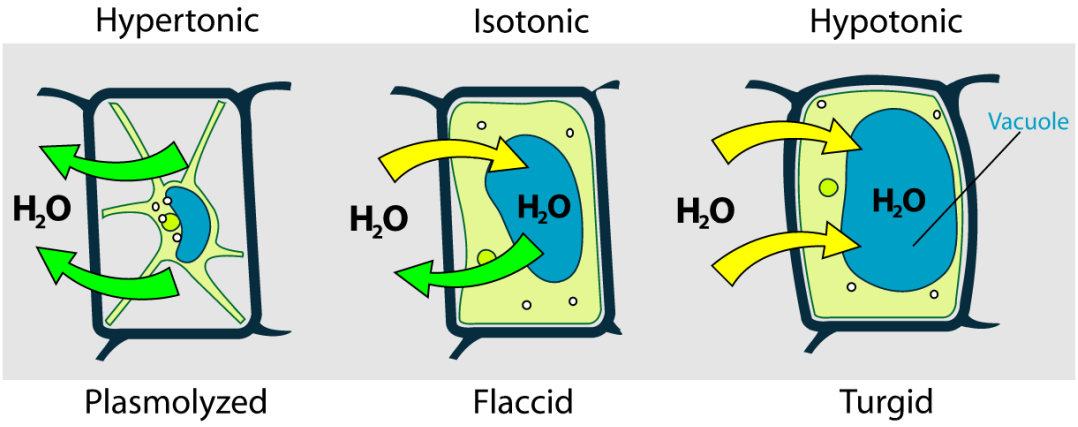
B2.1- Osmosis and Plant Transport

2.1.2 explain osmosis as diffusion of water from a dilute solution to a more concentrated solution, through a selectively permeable membrane;

- Osmosis is a special type of diffusion involving the movement of water through a selectively permeable membrane. The water will move from where it is in higher concentration to where water is in lower concentration.

2.1.3 explain how osmosis causes plant cells to become plasmolysed and turgid; 2.1.4 understand the role of the cell wall in limiting the entry of water;

- Water can move in and out of plant cells depending on the concentration of the solution surrounding the cells.
- When water moves into a plant cell, the vacuole increases in size, pushing the cell membrane against the cell wall.
- The cell wall prevents too much water entering and stops the cell from bursting unlike animal cells.
- The force of the extra water pushing against the cell wall makes it **Turgid.** This gives the plant structure and is essential in keeping plants upright. This is why wilting occurs when there is a lack of water. Cells that are not turgid are **Flaccid**.
- When too much water leaves plant cells plasmolysis occurs. During plasmolysis so much water leaves the cell that the cell contents shrink, pulling the cell membrane away from the cell wall.



2.1.5 understand that plants use water for support, transport, transpiration and photosynthesis;

2.1.6 use a potometer (bubble potometer and weighing method) to gain an understanding of the process of transpiration in plants;

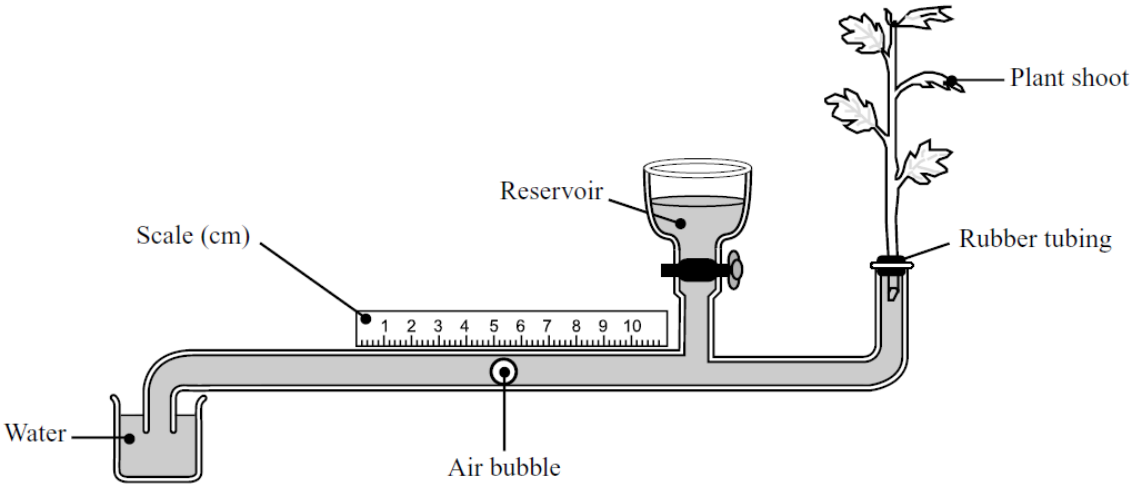
2.1.7 define transpiration as evaporation from leaf cells followed by diffusion through stomata; and

2.1.8 investigate the factors affecting the rate of transpiration (wind speed, temperature, surface area and humidity) and analyse data collected to calculate the rate of transpiration.

Transpiration-

- Transpiration is the loss of water from the leaves of the plant by evaporation. Evaporation takes place through the stomata of the leaf. A constant stream of water through the plant (Transpiration Stream) is very important for three reasons-
    - Supply of water for **photosynthesis**
    - **Transport** of minerals through the **xylem** system and into leaves
    - Water enters cells by osmosis to provide **support**
- To conserve water the stomata can close stopping water loss and gas exchange.

Measuring water uptake using a Potometer-



- The bubble potometer measures the water uptake of a leafy shoot. As water is evaporates from the leaves of the cut shoot, the shoot sucks water up through the potometer. The distance the air bubble moves in a period of time can be used to calculate the rate of water uptake.
- The reservoir allows the apparatus to be reset so that replicate results can be recorded or the water uptake can be measured in different environmental conditions. It is important that the apparatus is sealed properly to prevent unwanted air bubbles entering the equipment.

Factors Increasing Water Uptake-

- The potometer can be used to measure how environmental conditions affect the uptake of water. The following factors mainly affect water uptake-
    - Wind Speed
    - Temperature
    - Humidity
- Higher temperature, higher wind speed and low humidity will INCREASE rate of evaporation.
- Lower temperature, lower wind speed and high humidity will DECREASE rate of evaporation.

(i) Give **one** precaution you should take when setting up this apparatus.

_____ [1]

(ii) Describe how you would use this apparatus to investigate the effect of wind speed on the rate of water uptake by the shoot. You will be assessed on the quality of written communication in this question.

_____

_____

_____

_____

_____

_____ [4]

Quality of written communication [2]

(iii) Describe what would happen to the air bubble at the higher wind speed.

_____ [1]

(iv) Explain these results.

_____ [1]

(v) Name **one** other factor that could be investigated using the potometer.

_____ [1]

B2.2- Circulatory System

2.2.1 understand the role of the circulatory system as the transport of materials and protection against disease;

- The Circulatory System has three main components- the blood, blood vessels and the heart. It has two main functions-
    - Transport of Blood Cells, absorbed food, hormones, urea etc.
    - Protection Against Disease

2.2.2 understand that the circulatory system transports blood cells (red blood cells carrying oxygen) and materials such as digested food products, carbon dioxide, hormones and urea around the body;

- The blood is composed of many different materials and acts as a solute for the transport of substances around the body. It is essential for gas exchange and respiration as it carries food particles, oxygen and carbon dioxide.

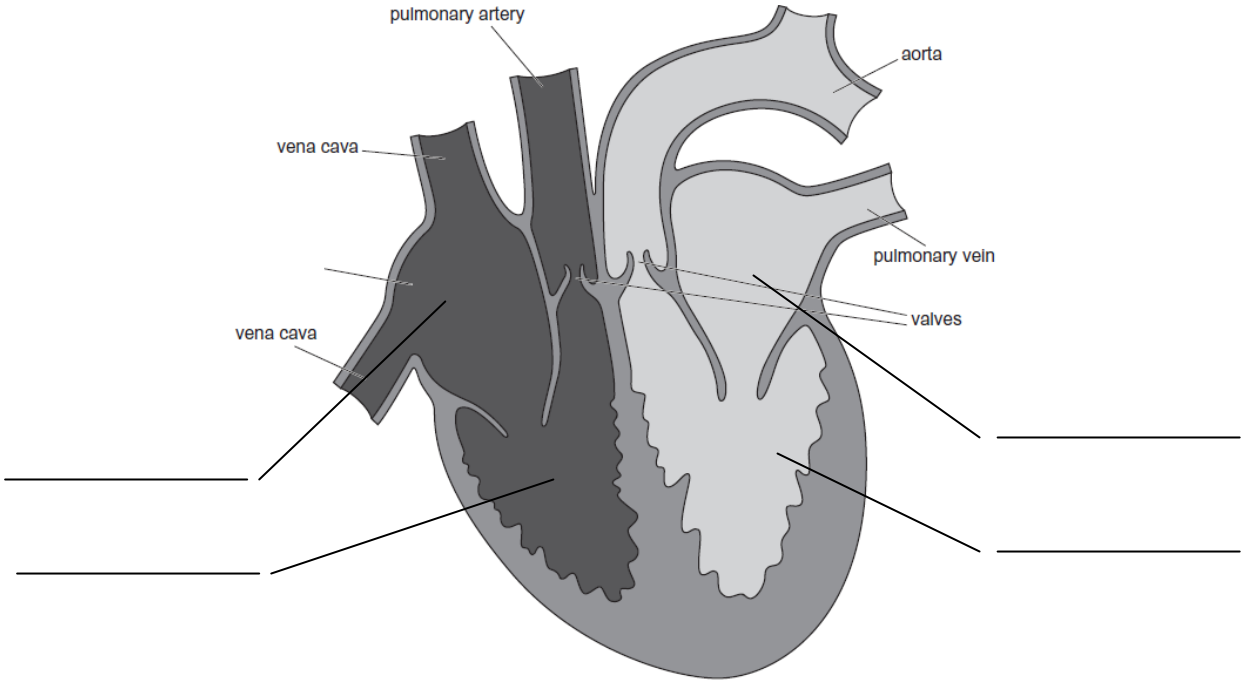
Composition of Blood-

- **Red Blood Cells-** the function of these cells is to carry oxygen around the body. It is the haemoglobin which enables them to do this. It has a large surface area due to the biconcave shape and does not contain a nucleus.
- **White Blood Cells-** the blood contains two types of white blood cell- Lymphocytes and Phagocytes. Lymphocytes produce antibodies while phagocytes engulf bacteria.
- **Platelets-** these are important in blood clotting and the formation of scabs.
- **Plasma-** this is the liquid part of the blood. The plasma is responsible for the transport of the blood cells, absorbed food molecules, carbon dioxide, hormones and urea.

2.2.3 through examining a heart:

– identify the four chambers of the heart;
– understand how its structure relates to the pumping action and sequence of blood flow in a double circulatory system;
– identify the four blood vessels associated with the heart – the vena cava and pulmonary vein carrying deoxygenated blood and the pulmonary artery and aorta carrying oxygenated blood; and
– identify the coronary blood vessels;

- The heart pumps the blood to the lungs and around the body. This is why the heart has two sides- the right hand side pumps the blood to the lungs while the left hand side pumps the blood to the body. This is why the left hand side is thicker, as more pressure is needed to pump the blood further.



Label the remaining parts of the Heart

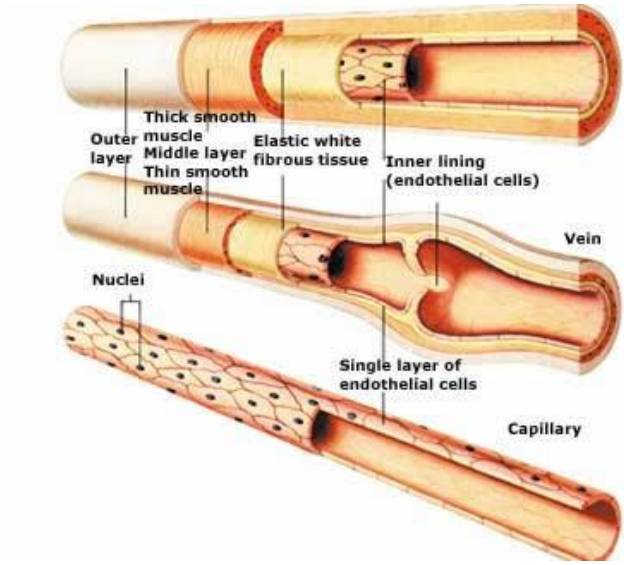
- The **right atrium** receives **deoxygenated blood** from the body. This passes into the **right ventricle** where it is pumped out in the **pulmonary artery** to the **lungs**.
- In the lungs the blood becomes **oxygenated** and returns to the **left atrium** through the **pulmonary vein**. The oxygen-rich blood passes into the **left ventricle** and is pumped into the **aorta** around the **body**.

- Humans have a double circulatory system which means that the blood travels through the heart twice in one circulation.
- The heart itself receives blood from the coronary arteries, which branch from the aorta immediately after leaving the heart. These are fine vessels which run over the surface.

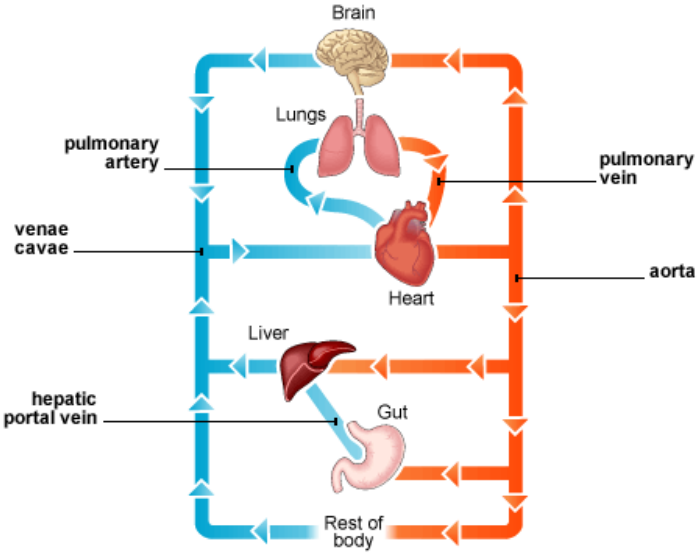
2.2.4 understand the role of the different types of blood vessels:

– arteries – carry blood under pressure away from the heart (usually oxygenated blood);
– veins – carry blood back to the heart and have valves which prevent the backflow of blood (usually deoxygenated blood); and
– capillaries – allow the exchange of material with tissues through permeable walls; and

Vessel	Direction of Flow	Thickness	Pressure	Valves
Artery	Away from Heart	Thick	High	None
Vein	Back to Heart	Thin	Low	Yes
Capillary	Links arteries and veins	Once Cell Thick	Low	None



2.2.5 identify the blood vessels entering and leaving the heart, lungs, liver and kidney, and their functions.



2.2.6 understand that:

– a blockage of the coronary vessels caused by the build up of cholesterol deposits restricts blood flow to the heart muscles, causing death of the heart muscle cells;
– a blockage in blood vessels to the brain leads to a stroke, causing brain cell death and reduced brain function;
– in both cases blockage leads to less oxygen and glucose reaching cells (heart muscle and brain) and less cell respiration; and
– certain factors increase or reduce the risk of heart disease and strokes, and interpret secondary data to evaluate these risk factors;

Heart Disease-

- Heart Disease is caused by cholesterol being present in high levels in the arteries. Over time this leads to narrowing of the arteries, making it difficult for blood to flow through them. This is particularly likely to happen in the coronary arteries, hence Coronary Heart Disease.
- Eventually the blood may be totally blocked stopping cells from receiving oxygen and glucose. This will lead to death of heart muscles and for the heart to stop beating; this is a heart attack.

Strokes-

- If a blockage occurs in the brain, a stroke may result. Again, cells are deprived of oxygen and glucose so die and this stops the brain from functioning correctly. This may lead to paralysis.

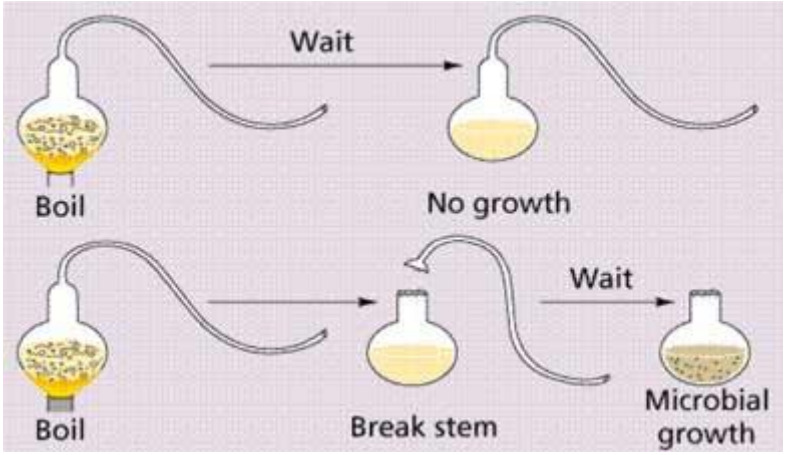
2.2.7 investigate the effects of exercise on the pulse rate and know how the circulatory system benefits from regular exercise – strengthened heart muscle and increased volume of blood pumped per beat at rest

- Regular exercise helps the body in many ways-
    - Helps reduce heart disease or strokes by burning fat which may clog up arteries.
    - Heart muscle will be strengthened allowing an increased output of blood.
    - Burns fat which may otherwise lead to obesity.
- When we exercise our body needs more energy and the heart has to pump more blood to our muscles so that they have enough oxygen for respiration.

B2.3- Microorganisms, Defence Against Disease, Medicines and Drugs

2.3.1 understand the role of Pasteur's Swan Neck experiment in refuting earlier theories about spontaneous generation;

- Previous to Pasteur's work it was assumed that microorganisms appeared from nowhere, this was known as **Spontaneous Generation**.
- Pasteur proved that microorganisms were not spontaneously created. Instead they were always present in the air. This is proved as juice open to the air would be contaminated while juice that was not directly open to the air would not be contaminated.



2.3.2 know the types of disease-causing microorganisms and how they are spread, prevented and treated, including:

– bacteria (gonorrhoea, chlamydia, salmonella and tuberculosis);
– viruses (HIV leading to AIDS, cold and flu, mumps, measles, polio and rubella); and
– fungi (athlete's foot); and

Microbe	Type	Spread	Prevention & Treatment
Gonorrhoea	Bacteria	Sexual Contact	Using a Condom; Antibiotics
Chlamydia		Sexual Contact	Using a Condom; Antibiotics
Salmonella		Contaminated Food	Cook Food thoroughly; Antibiotics
Tuberculosis		Airborne- Droplet Infection	BCG Vaccination; Treated with Drugs
HIV (AIDS)		Exchange of Body Fluids Infected Blood	Using a Condom; Not sharing needles; No Cure
Cold and Flu	Virus	Airborne- Droplet Infection	Vaccination
Mumps		Airborne- Droplet Infection	MMR Vaccination
Measles		Airborne- Droplet Infection	MMR Vaccination
Polio		Contaminated Drinking Water	Vaccination; Eradicated in UK
Rubella		Airborne- Droplet Infection	MMR Vaccination
Athlete's Foot	Fungi	Contact	Reduce contact with spores

2.3.3 understand the defence mechanisms of the body, to include:

– the skin, mucous membranes and blood clotting
– the production of antibodies by white blood cells (lymphocytes) in response to antigens
– the process of phagocytosis – engulfing and digesting microorganisms by white blood cells (phagocytes).

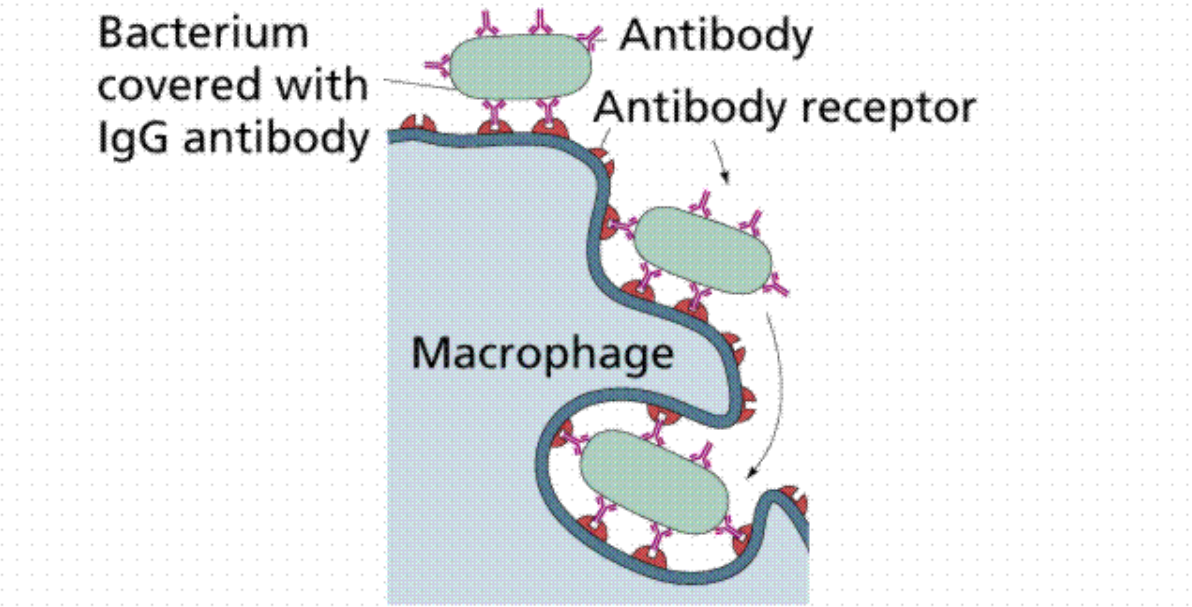
- The human body is well adapted to protect us against infection. The body is successful in preventing most microorganisms from gaining entry and it has effective defences if microorganisms do enter.
- **Skin-** The skin is an excellent barrier to microorganisms. Any openings in the skin such as the nose and respiratory system have a mucous membrane which traps microorganisms.
- **Clotting-** This stops blood from escaping but also stops microorganisms from entering through the cut in the skin.

Antigens and Antibodies-

- Invading microorganisms have chemicals on their surface that the body can recognise to be foreign. These are antigens and they cause lymphocytes to produce antibodies.
- Antibodies have a shape that is complimentary to the antigens. The antibodies join with the microorganisms and cause them to clump together. Once this happens, they are easily destroyed by phagocytes in a process known as phagocytosis.

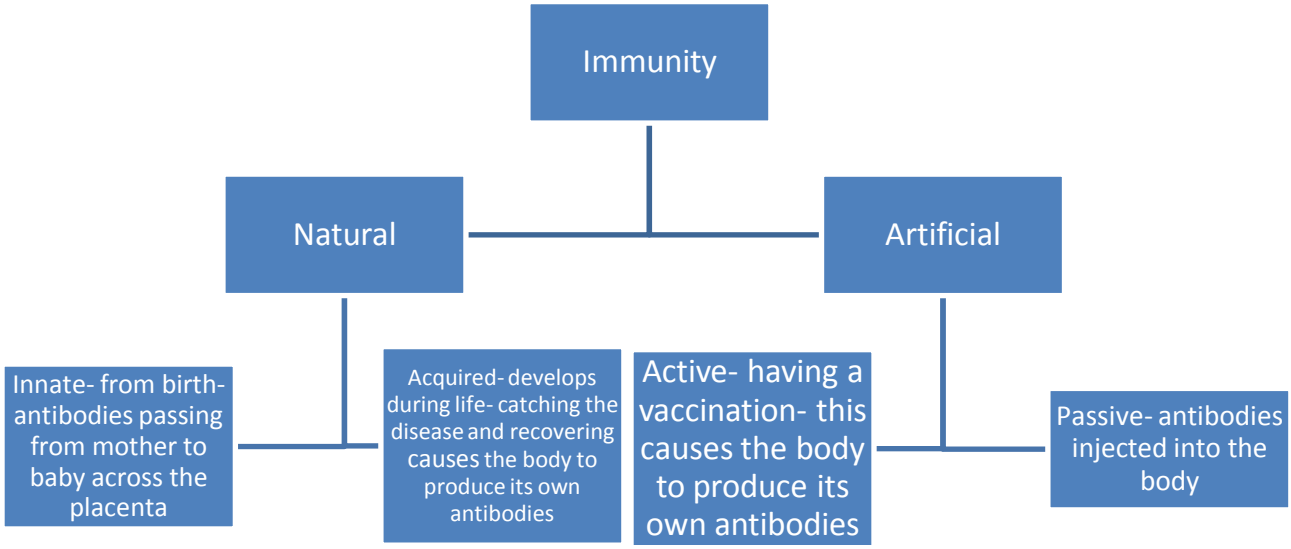
Phagocytosis-

- White Blood Cells can surround microorganisms and engulf them. Chemicals inside the phagocyte can then digest the microorganism.



2.3.4 understand that immunity to disease is produced by raised antibody levels in the blood and that immunity can be:

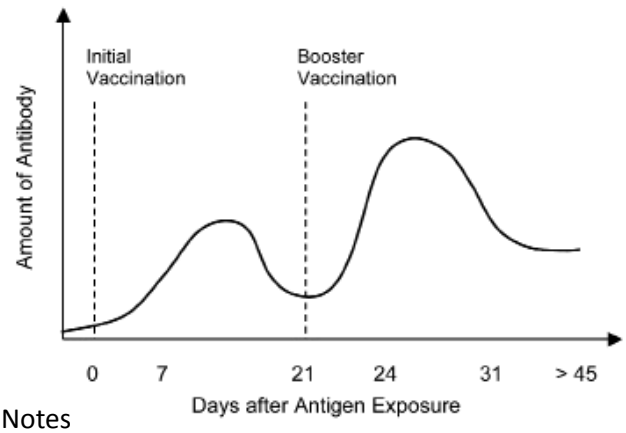
– natural – innate and acquired; or
– artificial – active and passive;



2.3.5 understand the role of vaccines, to include:

– the use of modified disease-causing organisms to produce raised antibody levels in the blood;
– the role of booster vaccinations and the interpretation of graphs of blood antibody levels;
– the development of the first vaccination by Jenner as an example of how scientific understanding and theories develop; and
– the importance of immunisation when travelling to certain countries (specific details of immunisation programmes are not required);

- Vaccinations involve the use of dead or modified pathogens that are injected into the body. The pathogens still have the antigens on their surfaces that cause the body to make antibodies at a high enough level to stop the individual becoming ill later.
- The process is exactly the same as if you actually caught the disease except you don't get sick. Sometimes boosters are needed to prolong the effect over a human lifetime.



Edward Jenner and the First Vaccination-

- Jenner noticed that milkmaids who had had the minor illness cowpox did not catch the serious illness smallpox. He concluded that having cowpox protected them from smallpox.
- He tested this by deliberately infecting a young boy with cowpox. After a period of time, he infected him with smallpox. The boy did not catch smallpox. As the cowpox was so similar to the smallpox microorganism, the boy had built up immunity to both.

Vaccination and Travel-

- People who travel to some foreign countries are required to be vaccinated against certain diseases. This is because some countries have pathogens that cause serious illnesses that do not exist in the British Isles.
- We will not have any antibody defences against these pathogens as we have not been in contact with their antigens before.

2.3.6 understand that antibiotics, for example penicillin, are chemicals which are used against bacterial diseases to kill bacteria or reduce their growth;

- These are chemicals which can damage and kill living microbes. They can be used against bacterial infections. Antibiotics kill bacteria or stop their growth.
- Antibiotics combat a range of bacteria and they act in a different manner to antibodies.

2.3.7 understand the implications of the following on the health of the population (w – (iv)a):

*– **overuse of antibiotics leading to bacterial resistance, resulting in the development of 'superbugs' such as MRSA;** and*
– procedures used to reduce the incidence of 'superbugs' and why their eradication is difficult;

- Bacterial resistance to antibiotics is becoming a major problem and is making many antibiotics ineffective against various bacteria. The overuse of antibiotics is largely responsible and it is important that antibiotics are only used when necessary.
- Some bacteria have developed resistance to the extent that they are now referred to as **Superbugs**. These bugs are resistant to most types of antibiotic and can be a very serious problem in hospitals.
- The spread of Superbugs can be reduced by good hygiene and cleanliness. A greater care in administering antibiotics and only when necessary can also reduce the effect of Superbugs.

2.3.10 understand how drugs may be used or misused:

– alcohol and its effects on the individual and society: binge drinking; the effect of drinking on the development of the foetus; reasons why people drink; and evaluation of strategies for reducing alcohol intake;

– tobacco smoke: tar – cause of bronchitis (narrowing of bronchi and bronchioles), emphysema (damage to alveoli reducing the surface area for gas exchange) and lung cancer (abnormal cell division); nicotine – addictive and affects heart rate; and carbon monoxide – combines with red blood cells to reduce the oxygen-carrying capacity of the blood; and

– the effects of cannabis and cocaine on the individual and society;

Alcohol-

- Many people drink alcohol when socialising and are unlikely to suffer any serious harm if drank in moderation. However, many people, including many teenagers, drink too much and cause harm to themselves.
- **Why do teenagers drink too much?**
    - Peer Pressure
    - Experimentation
    - Escape from problems

- **Harm caused by alcohol-**
    - Violence
    - Absence from college or work
    - Family breakup
    - Breakdown in relationships
    - Drink-driving

- **Binge Drinking** is a particular problem. This occurs when a large amount of alcohol is drunk over a short period of time. The Government has tried to reduce this problem by increasing the length of time that alcohol can be served each day.

- **Reducing the harm caused by Alcohol-**
    - Drink less each time, drink low-alcohol drinks or drink more slowly
    - Drink on fewer occasions
    - Education on the effect of alcohol
    - Never drink or drive
    - Do not drink until the legal age limit of 18

Smoking-

- Smoking can seriously damage health and has been banned in many countries in certain situations.

Substance in Smoke	Harmful Effect
Tar	Causes bronchitis, emphysema and lung cancer
Nicotine	Addictive and affects heart rate
Carbon Monoxide	Combines with red blood cells to reduce the oxygen carrying capacity of blood

Illegal Drugs-

- **Cannabis-**
  - It is widely used throughout the UK, due to its availability and low cost.
  - When taking cannabis, people feel relaxed or "chilled out".
  - Cannabis can lead to mental health problems and to taking more damaging drugs.
- **Cocaine-**
  - Cocaine can give users a "high" and is very addictive.
  - It is short lived so users normally increase their dose.
  - Overdose can result in death.

- Both of these drugs are illegal. Cocaine is a Class A drug which is the most dangerous category while Cannabis is a Class B drug. There is a lot of debate about the classification of drugs for legal purposes.

B2.4- Chromosomes, Genes and DNA

2.4.1 identify and describe chromosomes as genetic structures in the nucleus of a cell;

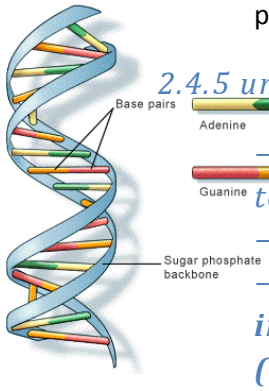
2.4.2 know that chromosomes occur as functional pairs (except in sex cells);

- Most living cells contain a nucleus. The nucleus is the control centre because it contains **chromosomes** that are subdivided into smaller sections called **genes.** There are hundreds of genes in each chromosome.
- Chromosomes occur in functional pairs.

2.4.3 identify and describe genes as sections of chromosomes that operate as functional units to control characteristics

2.4.4 know that genes are short lengths of DNA;;

- It is the genes in our body that control characteristics such as eye and hair colour. Inside genes and chromosomes there is a very important molecule that gives them their properties.
- **DNA** is deoxyribonucleic acid. Genes are short lengths of DNA that code for a particular protein or characteristic.



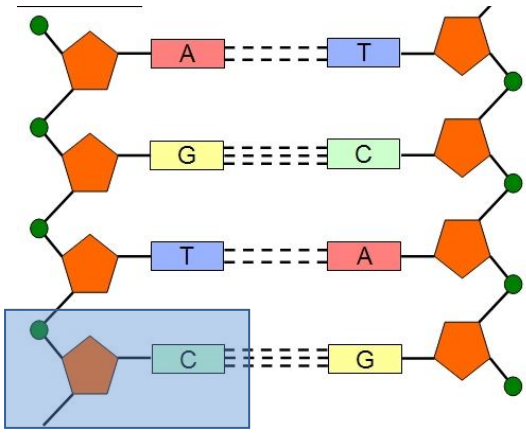
2.4.5 understand the structure of DNA, to include:

– a phosphate and sugar (deoxyribose) backbone with interlinking bases to form a double helix;

– base pairing rules and the unique nature of an individual's DNA; and

– the link between the DNA code and the building up of amino acids in the correct sequence to form protein – the base triplet hypothesis (transcription and translation not required);

- DNA consists of two phosphate and sugar strands held together by bases linked by hydrogen bonds. This unit is repeated along the length of the DNA molecule.



- The four bases can combine only in the order
  - Adenine—Thymine
  - Guanine—Cytosine
- These are referred to as Base Pairings.
- One unit of sugar, phosphate and base is called a nucleotide.
- These bases form two separate strands which then join together with hydrogen bonds and twist into the double helix shape.

2.4.6 describe (in outline only) how the work of Chargaff, Franklin and Wilkins, and Watson and Crick, using different lines of evidence, led to the discovery of the structure of DNA

- **Erwin Chargaff-** In 1950 he discovered that although the arrangement of bases in DNA varied, there was always an equal amount of adenine and thymine. Similarly there was always an equal amount of guanine and cytosine.
- **Rosalind Franklin & Maurice Wilkins-** They used x-ray diffraction in which x-rays are fired into molecules of DNA and the ways in which the DNA scatters the x-rays provides information about its three-dimensional structure.
- **James Watson & Francis Crick-** They built on the work of the previous two scientists to deduce how the bases were arranged and also to conclude that the DNA molecule is arranged as a double helix.

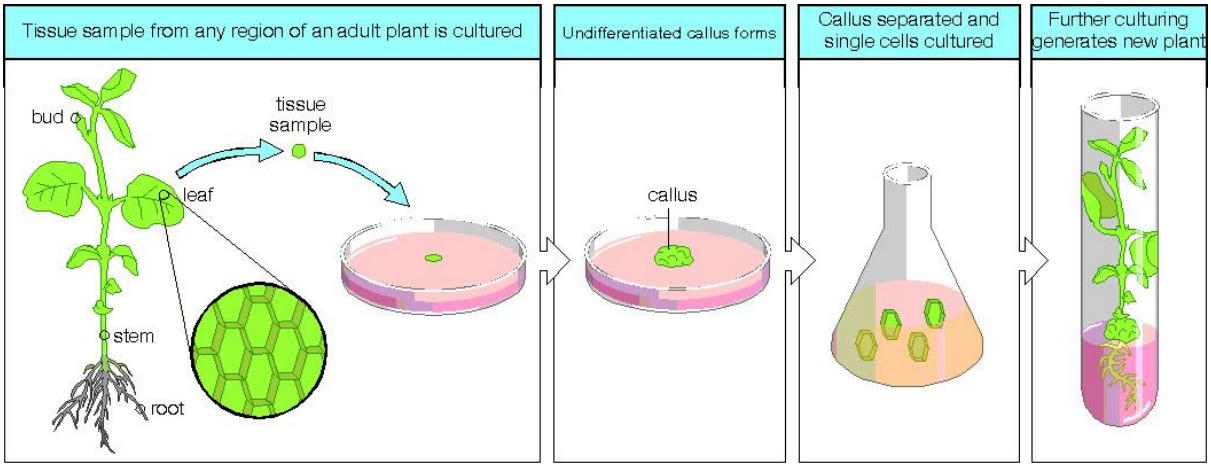
B2.5- Cell Division and Genetics

2.5.1 understand that mitosis allows organisms to grow, to replace worn out cells and to repair damaged tissue;

- Most living organisms grow by increasing their cell number. Cells double in number by splitting in half. It is important that the two new cells created are the exact same as the original cell- they are clones.
- This means every cell in the body has the same number and kind of genes and chromosomes.

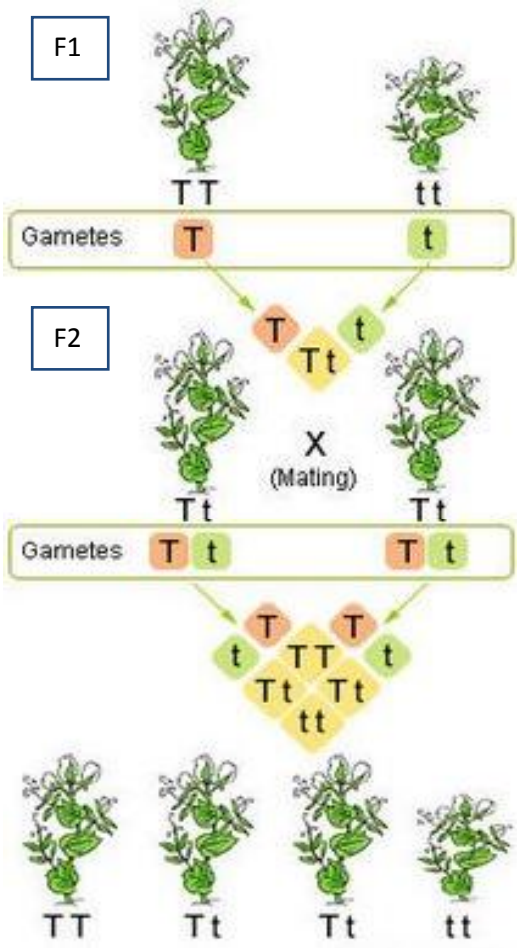
2.5.3 ***know that asexual reproduction in plants results in genetically identical offspring (clones) illustrated by tissue culture (in outline only);***

- Asexual reproduction produces genetically identical offspring. This is because gametes are not involved and the cells from the adult simply reproduce identical copies of themselves by mitosis to form a new individual
- Because new plants are identical, they are referred to as clones. The big advantage is that only one parent is needed.
- Advantages include the fast production of new plants and the fact that desirable qualities are passed down.
- However, because there is no variation, all of the plants are equally susceptible to a particular disease.



2.5.6 understand and interpret genetic diagrams consisting of a single characteristic controlled by a single gene with two alleles (monohybrid cross) in plants, animals and humans, to include:

- *dominant and recessive alleles;*
- *genotype, phenotype, gamete and offspring ratios and percentages;*
- *homozygous and heterozygous genotypes;*
- *Punnett squares to determine genotype frequencies; and*
- ***test (back) crosses to determine an unknown genotype;***



- Gregor Mendel discovered the basic rules of genetics by carrying out experiments with pea plants.
- He crossed tall plants with dwarf plants and allowed the seeds to develop. These seeds were then planted and new plants grew up. Plants are crossed by taking pollen from the anther of one plant to the stigma of the other plant.
- Each parent plant contains two genes for height, one on each of the pair of chromosomes.
    - Tall = TT
    - Dwarf = tt
- During Meiosis the pair of chromosomes separate and one goes into each gamete. So the gamete contains either one T gene or a t gene.
- During fertilisation the T and t genes are brought together, so the F1 offspring contain one T and one t gene. We call this Tt.
- The F1 (First generation) are all tall. This is because the T is ***Dominant*** and suppresses the t gene which is called ***Recessive.***
- The F1 offspring are inter-crossed and the resulting seeds formed are allowed to grow. This generation is known as the **F2 Offspring.**
    - The F1 offspring are crossed with each other to obtain the F2 offspring.
    - The F2 offspring are a mixture of tall and dward plants in the ratio of 3:1.
    - The TT plants are tall,
    - The Tt plants also are tall because T allele is dominant to the recessive t allele.
    - The tt plants are dwarf.

- If an individual has two genes coding for the **same allele** e.g. flower colour. They are said to be homozygous.
    - TT – Homozygous (Tall)
    - tt – Homozygous (Dwarf)
- If they have two genes coding for **different alleles**, they are said to be heterozygous.
    - Tt – Heterozygous

***Alleles**: These are different forms of the same gene, found at the same locus on a pair of homologous chromosomes E.g. the gene for height can have the alleles T or t.*

***Homozygous**: An organism is homozygous for a trait if it has 2 identical alleles, found at the same locus on a pair of homologous chromosomes. E.g. Tall (TT) and dwarf (tt).*

***Heterozygous**: An organism is heterozygous for a trait if it has 2 different alleles, found at the same locus on a pair of homologous chromosomes. E.g. Tt (Tall)*

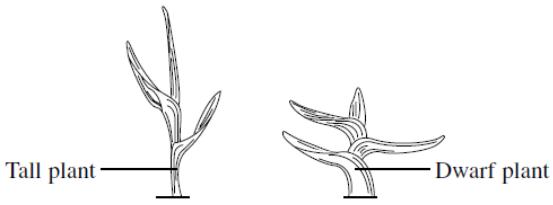
***Dominant**: A gene is dominant if it produces the same trait whether it is present in the homozygous or heterozygous condition. E.g. The genes for tall can be TT or Tt.*

***Recessive**: A recessive gene is only expressed when it is present in the homozygous condition. E.g. a gene for dwarf is tt.*

***Genotype**: This is the genes the organism has for a particular trait. E.g. the trait for tall has the genotype TT or Tt.*

***Phenotype**: This is the physical expression of the genotype. E.g. the genotype TT gives a tall individual*

(a) Maize plants have a gene (allele) for height that comes in two forms.
The tall gene (allele) is represented by T.
The dwarf gene (allele) is represented by t.



A farmer crosses two heterozygous plants.

(i) What is the genotype of a heterozygous maize plant?

_____ [1]

(ii) Use a Punnett square to show the possible genotypes of the offspring of this cross.

2.5.7 understand how sex is determined in humans.

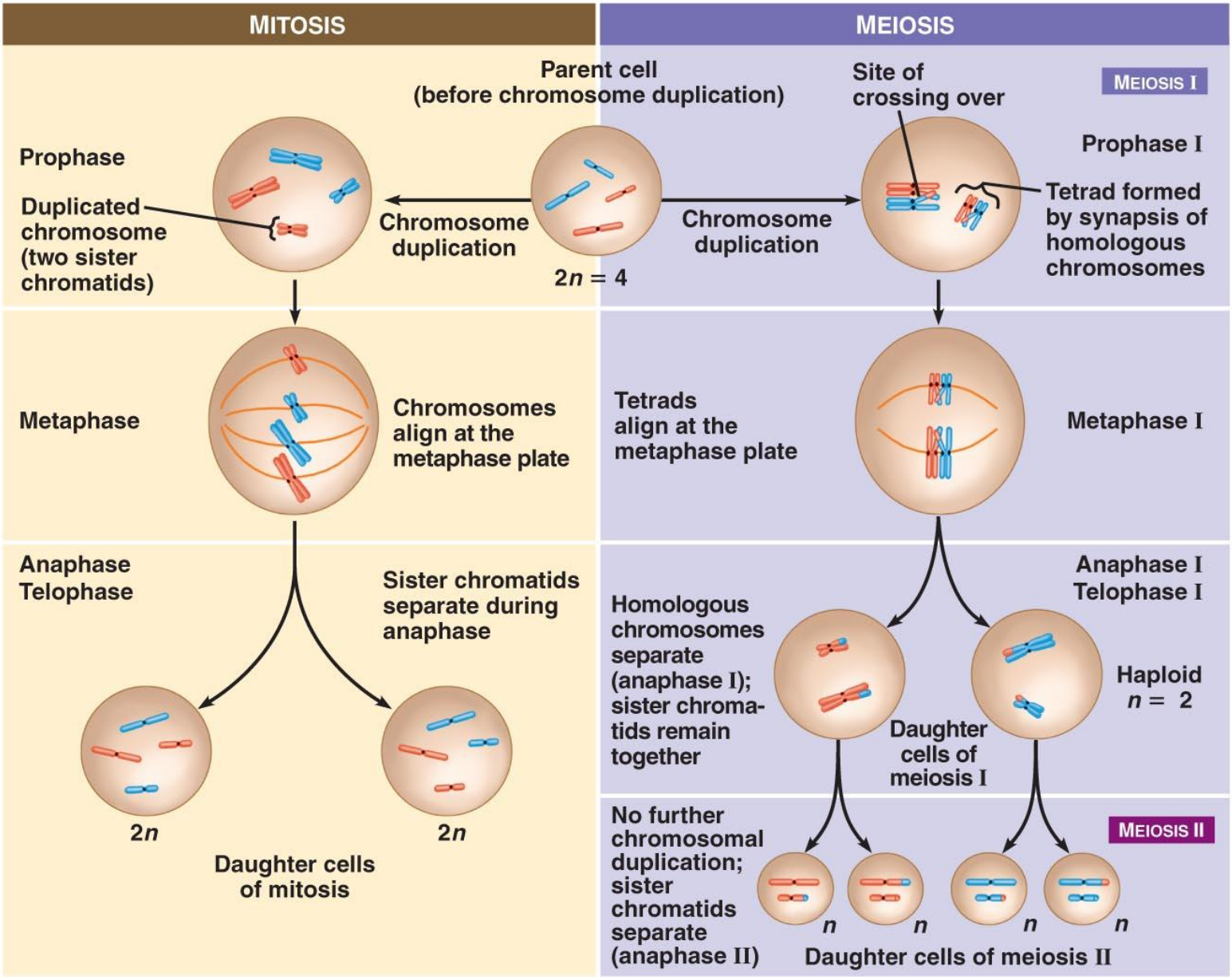
- Humans have 22 pairs of normal chromosomes and one pair of sex chromosomes. The male sex chromosomes are XY and females have two XX chromosomes.
- As the sex chromosomes act in the same way as in other genetic crosses, we can see that equal amount of males and females are produced when using a punnet's square.

	X (from egg)	X (from egg)
X (from sperm)	XX	XX
Y (from sperm)	XY	XY

2.5.2 outline mitosis in terms of the exact duplication of chromosomes producing daughter cells that are genetically identical to parent cells (clones) – names of phases and details of DNA replication not required;

2.5.4 understand meiosis as reduction division (one cell producing four genetically different, haploid daughter cells) ***and as a process which, through independent assortment, reassorts the chromosomes to provide variation (crossing over and the stages of meiosis are not required)****;*

2.5.5 understand fertilisation as a means of restoring the diploid number and combining different sets of chromosomes;



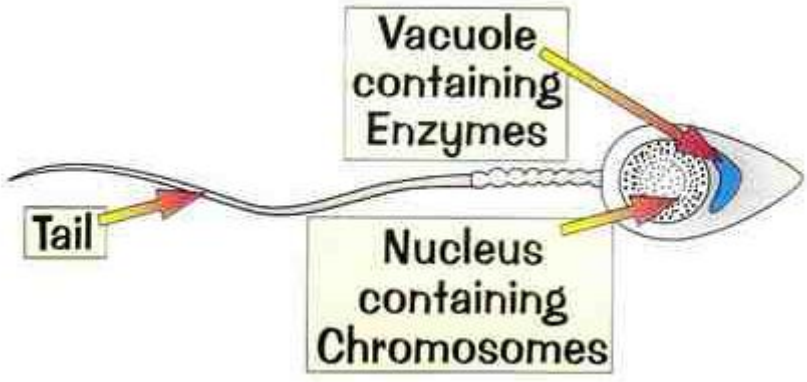
B2.6- Reproduction, Fertility and Contraception

2.6.1 know that:

– sperm cells are specialised cells formed by meiosis, followed by differentiation in the testes under the influence of the hormone testosterone;
– sperm cells are adapted to their function by having a haploid nucleus and a tail for swimming;
– fertilisation takes place in the oviducts when the sperm and the haploid egg nucleus fuse to give a diploid zygote;
– the zygote divides by mitosis many times to form a ball of cells as it travels down the oviduct to the uterus;
– after implantation in the uterus lining it then differentiates to produce a variety of tissues and organs;
– the placenta is adapted for diffusion by having a large surface area for exchange of dissolved nutrients, oxygen, carbon dioxide and urea;
– these substances are carried to or from the foetus in the blood vessels in the umbilical cord; and
– the amnion and amniotic fluid cushion the foetus;

The Sex Cells-

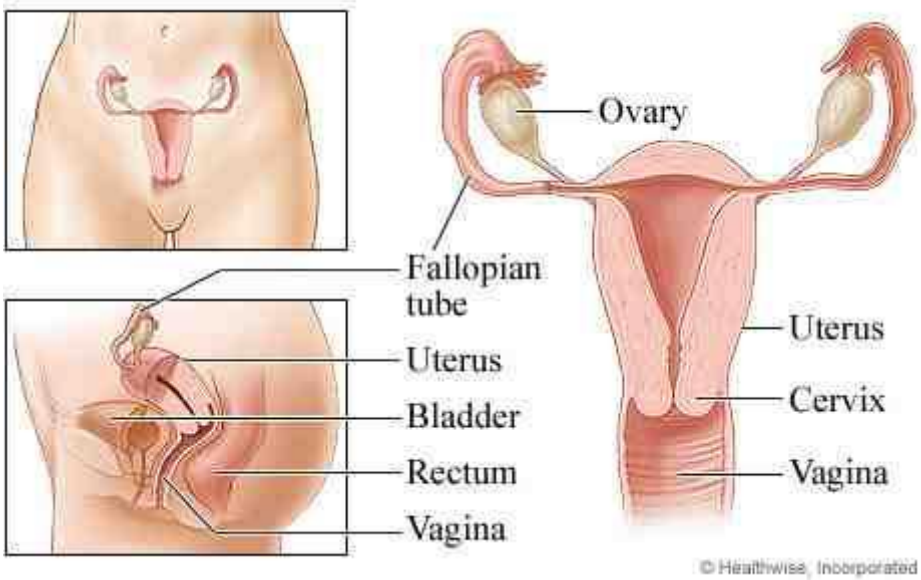
- Sperm and Egg cells are **gametes**. They are haploid- meaning they only have half the number of chromosomes than normal body cells.



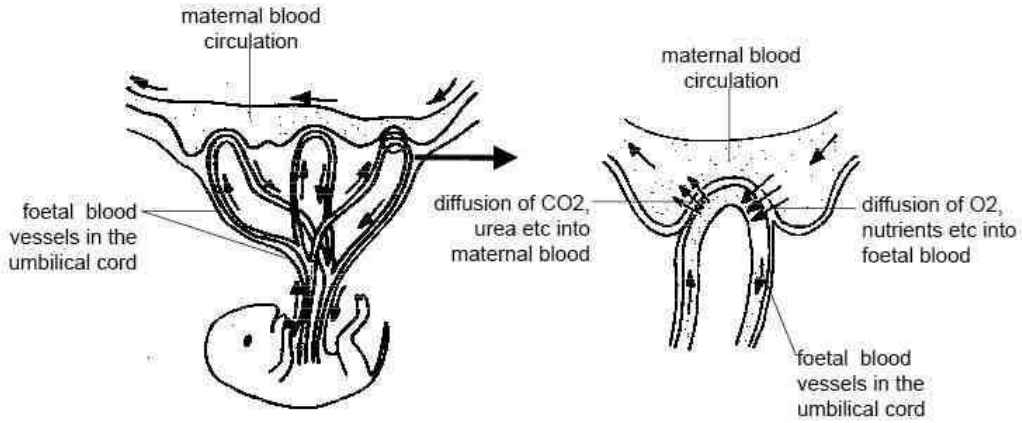
Fertilisation-

- If a sperm and egg meet and fuse in the oviduct, fertilisation will result. Fertilisation involves the haploid nuclei of the sperm and egg fusing and restoring the diploid number of chromosomes.

- The fertilised cell becomes the first cell of the new individual, the **zygote.** This cell then divides by mitosis and grows into a bunch of cells as it travels down the oviduct.
- The bunch of cells then becomes an **embryo** and is implanted on the wall of the **uterus**. At this point the uterus has developed a thick lining that holds and nourishes the embryo.



- At the point where the embryo begins to develop in the uterus lining, the **placenta** and **umbilical cord** form. A protective membrane, the **amnion**, develops around the embryo. The cushions the embryo, which soon develops into a **foetus** which has features more recognisable as a baby.
- During pregnancy useful materials including oxygen and glucose pass from the mother to the foetus through the placenta and umbilical cord. Also, waste materials pass from the foetus back to the mother.

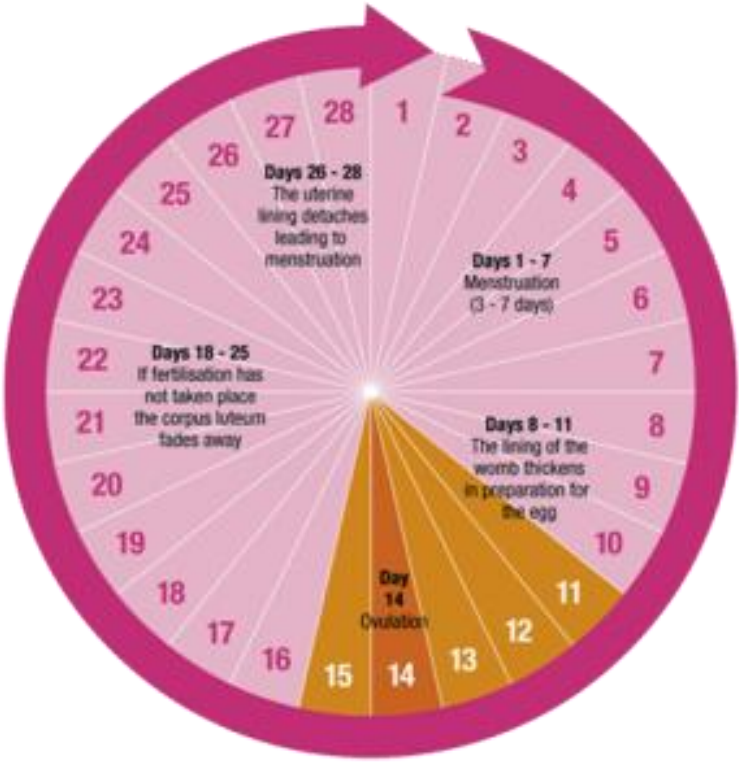


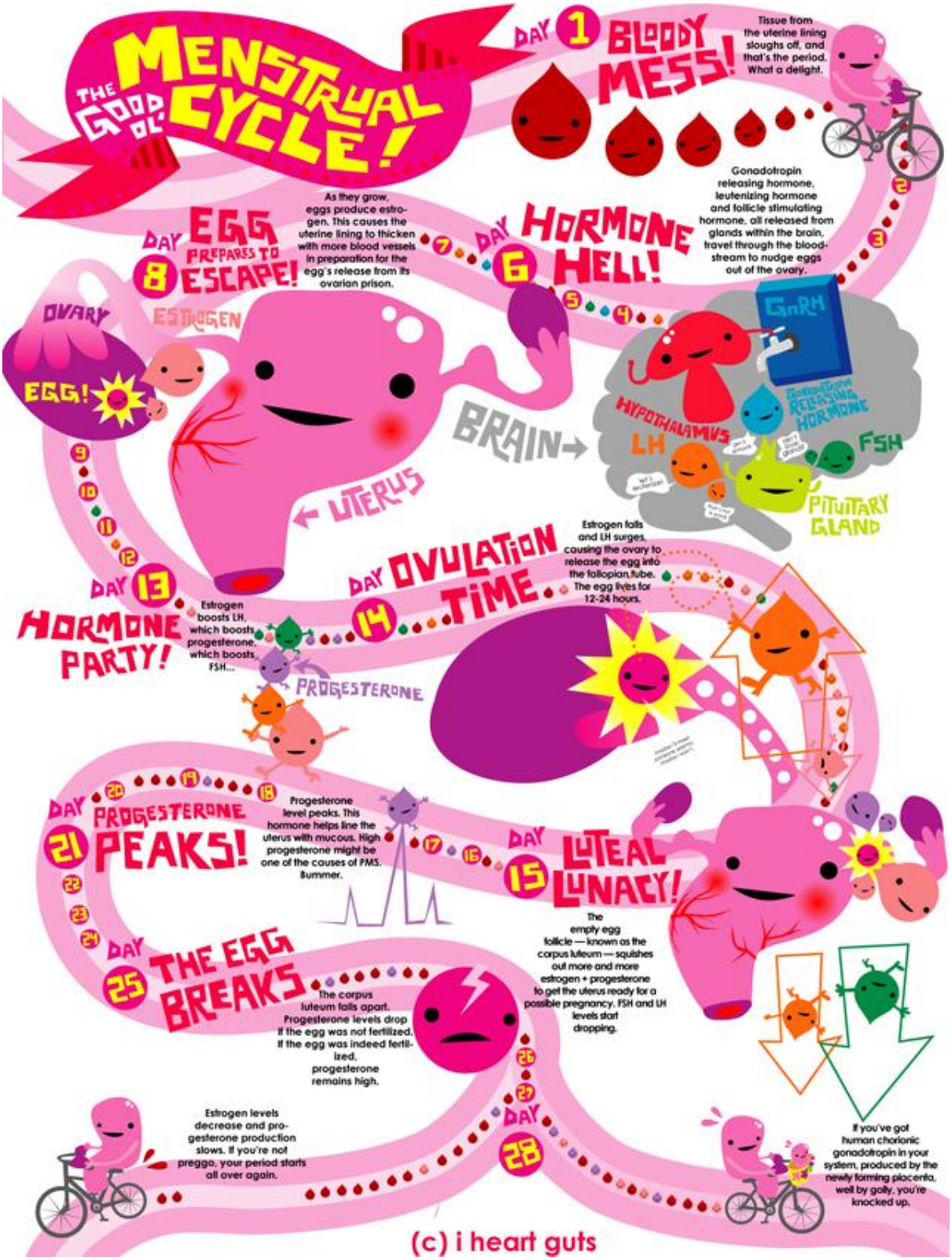
2.6.2 know that testosterone (produced by the testes) and oestrogen (produced by the ovaries) are sex hormones and recall the secondary sexual characteristics they cause to develop;

Males	Females
Body hair and pubic hair develops	Hair grows in pubic regions and in the armpits
Sexual organs enlarge	Sexual organs enlarge and breasts develop
Body becomes more muscular	Pelvis and Hips widen
Voice Deepens	Menstruation begins
Sexual awareness and drive increases	Sexual awareness and drive increases

2.6.3 describe the events of the menstrual cycle – menstruation, ovulation and the period when fertilisation is most likely to occur;

- The menstrual cycle occurs in females from puberty until the end of reproductive life. The purpose of the menstrual cycle is to prepare the reproductive system for pregnancy by controlling the monthly release of an egg and renewing and replacing the uterine lining.




THE GOOD OL' MENSTRUAL CYCLE!
DAY 1 BLOODY MESS!
Tissue from the uterine lining sloughs off, and that's the period. What a delight.
DAY 6 HORMONE HELL!
Gonadotropin releasing hormone, leutenizing hormone and follicle stimulating hormone, all released from glands within the brain, travel through the bloodstream to nudge eggs out of the ovary.
DAY 8 EGG PREPARES TO ESCAPE!
As they grow, eggs produce estrogen. This causes the uterine lining to thicken with more blood vessels in preparation for the egg's release from its ovarian prison.
OVARY
EGG!
ESTROGEN
BRAIN
UTERUS
GnRH
HYPOTHALAMUS
LH
FSH
PITUITARY GLAND
DAY 13 HORMONE PARTY!
Estrogen boosts LH, which boosts progesterone, which boosts FSH...
PROGESTERONE
DAY 14 OVULATION TIME
Estrogen falls and LH surges, causing the ovary to release the egg into the fallopian tube. The egg lives for 12-24 hours.
DAY 21 PROGESTERONE PEAKS!
Progesterone level peaks. This hormone helps line the uterus with mucous. High progesterone might be one of the causes of PMS. Bummer.
DAY 15 LUTEAL LUNACY!
The empty egg follicle — known as the corpus luteum — squishes out more and more estrogen + progesterone to get the uterus ready for a possible pregnancy. FSH and LH levels start dropping.
DAY 25 THE EGG BREAKS
The corpus luteum falls apart. Progesterone levels drop if the egg was not fertilized. If the egg was indeed fertilized, progesterone remains high.
DAY 28
Estrogen levels decrease and progesterone production slows. If you're not preggo, your period starts all over again.
If you've got human chorionic gonadotropin in your system, produced by the newly forming placenta, well by golly, you're knocked up.
(c) i heart guts

2.6.4 explain some of the causes of infertility and developments in fertility treatment (w – (iv)a):

– the use of hormones to produce multiple ova;
– in vitro fertilisation; and
– the transfer of several embryos into the uterus; and

Reasons for fertility problems include-

- Failure of ovary to produce eggs
- The oviducts may be blocked or twisted, possibly due to infection
- Complications of some sexually transmitted infections
- The lining of the uterus does not develop properly to enable implantation to occur
- The vagina may be hostile to sperm entering e.g. lining may be too thick or acidic
- Males may not produce enough sperm or the sperm may not be healthy
- Impotence

Fertility Drugs-

- These are given to the woman to increase production of eggs. This may solve the problem if low egg production is the issue but if there are other problems such as blocked ovaries, in vitro fertilisation may be needed.

In Vitro Fertilisation-

- The woman is given fertility drugs so that several eggs are produced. These are collected from the ovaries surgically.
- Sperm is donated and the sperm and eggs are mixed in the laboratory.
- Successful embryos are placed in the mother's uterus (making sure the lining is thick enough). If the process is successful an embryo will implant in the uterus lining.
- Usually only a small number of embryos are placed in the mother's uterus to give balance between ensuring a successful pregnancy and avoiding multiple births.

2.6.6 examine how different methods of contraception work and evaluate the advantages and disadvantages of each (w – (iv)a, (iv)b), to include:

– mechanical – the condom as a barrier to prevent the passage of sperm and also prevent the spread of sexually transmitted infections, some of which can lead to infertility if left untreated (gonorrhoea, chlamydia and HIV leading to AIDS);
– chemical – the contraceptive pill that changes hormone levels and stops the development of the ovum;
– surgical – male and female sterilisation to prevent the passage of sperm and ova respectively; and
– an awareness that contraception can raise ethical issues for some people.

Type	Example	Method	Advantage	Disadvantage
Mechanical	Condom	Acts as a barrier to prevent the sperm entering the woman	Easily obtained and also protects against STD's	Unreliable if not used properly
Chemical	Contraceptive Pill	Taken regularly by the woman and prevents the ovaries from releasing eggs by changing hormone levels	Very reliable	Can cause some side effects such as weight gain and may increase risk of blood clots
Surgical	Vasectomy	Cutting or tying the sperm tubes, preventing the sperm from entering the penis	Virtually 100% reliable	Very difficult or impossible to reverse
	Female Sterilisation	Cutting or tying the oviducts preventing the ova from moving through the oviduct and being fertilised	Virtually 100% reliable	Very difficult or impossible to reverse

B2.7- Applied Genetics

2.7.1 recall that cystic fibrosis is an inherited disease;

- Cystic Fibrosis is caused by a recessive allele. Individuals with cystic fibrosis must have both alleles- cc. If two parents are carriers (Cc) there is a 25% probability that a child will be homozygous and have cystic fibrosis.

2.7.2 understand that mutations are random changes in the:

– number of chromosomes (Down Syndrome); or
– structure of genes
and can be triggered by environmental factors, such as UV light causing skin cancer; and

- This condition is not caused by a recessive allele but by an error in the formation of the parental gametes.
- In this condition a malformed gamete of 24 chromosomes combines with a normal gamete of 23 chromosomes. The affected individual has 47 chromosomes in all cells in their body and this causes Down Syndrome.

2.7.3 understand the principles of genetic screening during pregnancy and be aware of the ethical issues it raises

Genetic Screening-

- Genetic screening may be used to reduce the incidence of diseases or conditions caused by problems with our chromosomes or genes. It involves testing people for the presence of a particular allele or genetic condition.
- **Screening for Down Syndrome-** Cells are taken from the amniotic fluid surrounding the baby in the womb and they are then allowed to multiply in laboratory conditions. The chromosomes in the cells can then be examined to see if the developing foetus has the condition. This genetic screening is offered to pregnant women in Britain.

Ethical Issues-

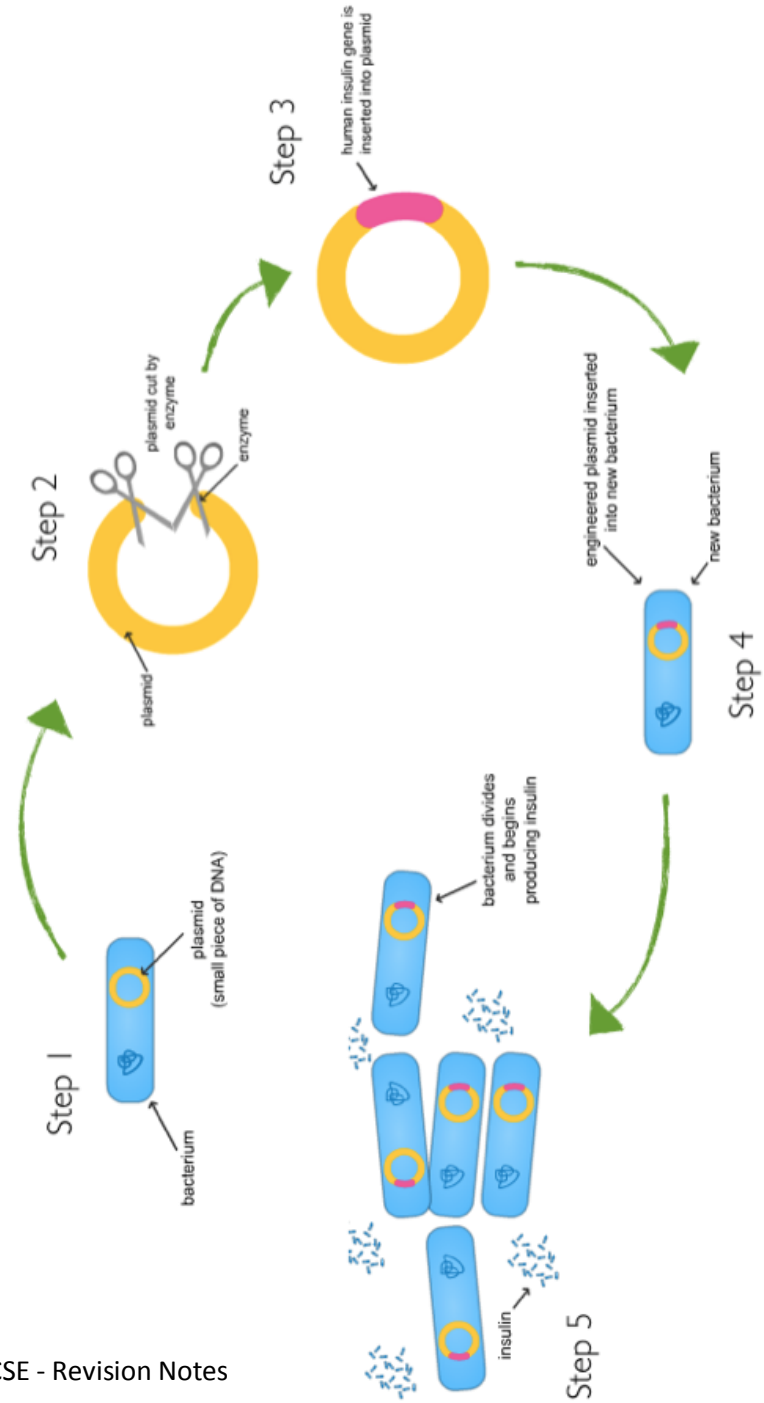
- It is possible that if Down Syndrome is detected that the mother may choose to have an abortion. This is a view taken by many people against Genetic Screening and they see it as going against nature.

2.7.4 understand genetic engineering, to include:

– the basic techniques used to produce human insulin (for the treatment of diabetes) – transfer of a human insulin gene into a plasmid of a bacterial cell to form a genetically modified bacterium which then multiplies and produces human insulin; and

– the advantages of producing human insulin (and other products) by this method

- In genetic engineering a piece of DNA can be taken from one organism and incorporated into another organism. Typically a gene that makes a useful product is incorporated into bacteria and the bacterium becomes a factory that makes the desired product.
- An example is making human insulin for the treatment of people with diabetes-



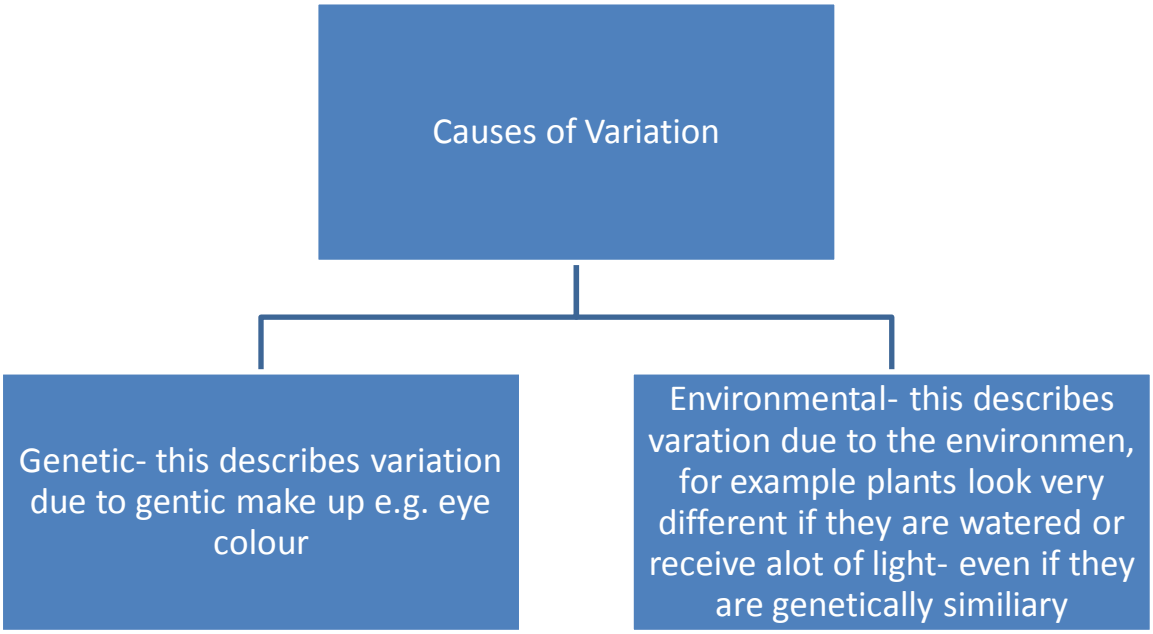
B2.8- Variation and Selection

2.8.1 investigate variation in living things, display data using appropriate graphical techniques, and evaluate the validity and reliability of the data, to include:

– height and mass as examples of continuous variation (histogram); and
– tongue rolling as an example of discontinuous variation (bar chart);

Variation	Explanation	Examples
Continuous	Gradual change in a characteristic across a population with no distinct categories; most individuals will be average with fewer at both extremes	Height, weight, reaction time
Discontinuous	Individuals can be grouped into distinct groups with no overlap	Tongue Rolling, blood group

2.8.2 understand that variation in living organisms has both a genetic and an environmental basis (for example height in humans); and



2.8.3 understand how variation and selection may lead to evolution or extinction, to include:

– natural selection as variation within phenotypes and competition for resources often leading to differential survival, for example antibiotic resistance;
– survival of the fittest in terms of those best adapted being more likely to survive to reproduce and pass on their genes to the next generation, using this model to explain secondary data;
– the possibility of failure to adapt resulting in extinction of a species over time; and
– the relationship between natural selection and evolution as a continuing process which leads to gradual changes in organisms over time.

- If the members of a species vary then some will be better adapted to survive than the other. This means that the best adapted or fittest survive which is the basis for **evolution**. Small changes over time can mean that organisms change as particular characteristics are favoured.
- Sometimes entire species may not be well enough adapted to survive in a changing world and they no longer survive. This leads to **extinction** of a species.

Charles Darwin and Natural Selection-

- Charles Darwin concluded that natural selection was the driving force for evolution. His main points were-
    - There is variation among the individuals in a population
    - If there is a competition for resources there will be a struggle for existence
    - The better adapted individuals survive this struggle which leads to survival of the fittest and these individuals are more likely to pass their genes onto the next generation.
- Below are two examples of natural selection-

Antibiotic Resistance in Bacteria- When treated when an antibiotic some bacteria may be resistance. These bacteria survive as the rest are killed. The resistant bacteria survive to breed and soon become the dominant type in the population.	**Peppered Moth-** The peppered moth exists in two forms- light coloured and dark. In non-polluted areas the light form is well camouflaged on the bark of trees whereas the black form is easily spotted and eaten. In these areas the light form is common. In industrial areas where the trees are black with pollution the black forms are better adapted and survive better and increase in number.