I.C.T ACADEMY

ORDINARY LEVEL COMBINED SCIENCE

Compiled by the One on One Tutor

M.R. Muchenje (+263 785 094 369)

SECTION A: BIOLOGY

TOPIC 1: STRUCTURE AND FUNCTION OF A CELL

INTRODUCTION

- All living organisms are made up of single units which are known as cells.
- These cells are the basic units of the structure and function of all living organisms.
- Cells have the ability to reproduce, as a result all existing cells come from other pre-existing cells through the process of cell reproduction.
- Cells are microscopic therefore one would need a microscope in order to view cells.

IDENTIFYING PARTS OF A CELL AND THEIR FUNCTIONS

- When it comes to living organisms there are two main types of cells, there are animal cells and plant cells.
- These cells have some similarities and at the same time they have some differences between them, these can be observed when we compare and contrast the features of both cells.
- The following are the common features of a cell, these can be found in both plant and animal cells.

Cytoplasm.

- The cytoplasm looks like a thick liquid full of tiny particles, in plant cells it may be seen to be moving around inside the cell.
- The particles inside the cytoplasm include food droplets or granules of starch.
- A lot of chemical reactions take place inside the cytoplasm keeping the cell alive by providing it with energy as well as other substances that the cell needs.
- Liquid part of cytoplasm is 90% water, inside this liquid part molecules of salts and sugars can be found as well as dissolved nutrients like fats (lipids) and proteins which are used to build cell structures.
- Some of the proteins inside the cytoplasm are *enzymes,* these control the rate and type of chemical reactions happening inside the cell.

Cell Membrane

- This is a thin membrane around the cytoplasm, it stops contents of the cell from escaping or leaving the cell, it also controls substances which are allowed to enter the cell or leave it depending on the situation.
- Generally, oxygen, food and water are allowed to enter the cell by the membrane whilst waste material like carbon dioxide and other harmful substances are allowed to leave the cell or kept out.
- Basically the cell membrane maintains the structure and chemical reactions of the cytoplasm

Nucleus

- Usually this is seen as a round structure covered by a membrane and planted within the cytoplasm, when drawing cells, the nucleus is usually shown darker than the cytoplasm this is because it takes up stains more strongly than the cytoplasm.
- Most cells have a nucleus, its function is to control the type and quantity of enzymes produced by the cytoplasm, by doing this, the nucleus controls or regulates the chemical changes taking place inside the cell.
- Basically the nucleus decides what type of a cell the cell will be for example will it be a red blood cell, a liver cell etc.
- The nucleus also controls cell division, any cell without a nucleus cannot reproduce.

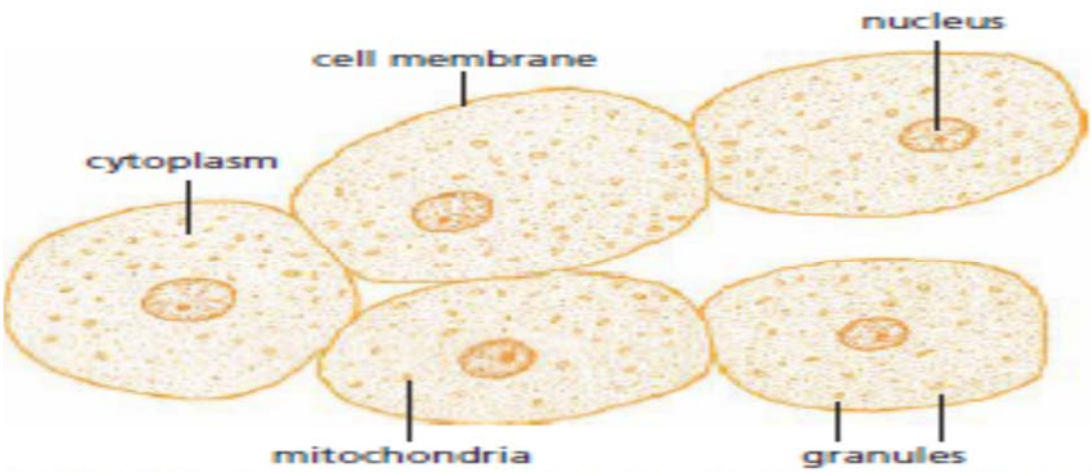


Figure 2.4 A group of liver cells. These cells have all the characteristics of animal cells.

- Plant cells however are different from animal cells, study the diagram below and point out the main differences between plant and animal cells.

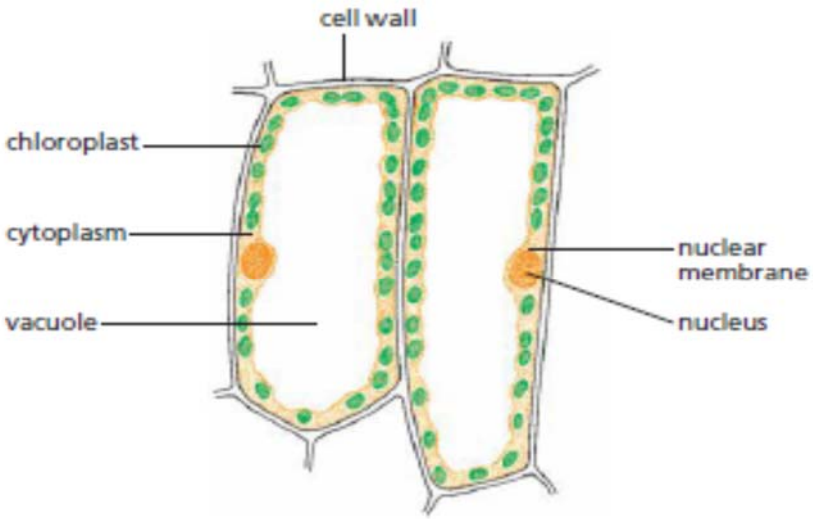


Figure 2.6 Palisade cells from a leaf

COMPARING PLANT AND ANIMAL CELLS

- Plant cells are different from animal cells in a number of ways which we will lok at now:

1. Outside the cell membrane plant cells have another layer which is known as the cellulose cell wall. The cellulose cell wall is non-living and it allows all substances to pass through, it is not as selective as the cell membrane.
2. Most mature plant cells contain a large fluid filled space which is known as the vacuole. It contains cell sap a watery solution of sugars and salts and in some cases pigments. The vacuole is large and central in such a way that it pushes the cytoplasm aside so that it forms a thin strip just along the cell wall. It is the outward pressure of the vacuole on the cytoplasm which makes plant cells firm.
3. Cytoplasm of a plant cell contains many organelles which are called *plastids,* these cannot be found in animal cells, in plants these organelles have different types, if they contain the green pigment chlorophyll they are known as *chloroplasts,* colourless plastids usually contain starch which is a food store

	Name of part	Description	Where found	Function (supplement only)
Animal and plant cells	cytoplasm	jelly-like, with particles and organelles in	enclosed by the cell membrane	contains the cell organelles, e.g. mitochondria, nucleus site of chemical reactions
	cell membrane	a partially permeable layer that forms a boundary around the cytoplasm	around the cytoplasm	prevents cell contents from escaping controls what substances enter and leave the cell
	nucleus	a circular or oval structure containing DNA in the form of chromosomes	inside the cytoplasm	controls cell division controls cell development controls cell activities
Plant cells only	cell wall	a tough, non-living layer made of cellulose surrounding the cell membrane	around the outside of plant cells	prevents plant cells from bursting allows water and salts to pass through (freely permeable)
	vacuole	a fluid-filled space surrounded by a membrane	inside the cytoplasm of plant cells	contains salts and sugars helps to keep plant cells firm
	chloroplast	an organelle containing chlorophyll	inside the cytoplasm of some plant cells	traps light energy for photosynthesis

SPECIALISED CELLS

- We now understand that plants and animals are built up of small units known as cells, this makes cells the basic unit of life.
- Cell differentiation takes place when a cell becomes specialised
- What this means is that the cell now does only one particular job, in order to fulfil this special function, the cell develops a distinct shape which differentiates it from other cells, apart from that some chemical changes also take place in its cytoplasm.
- Changes in shape as well as the chemical changes within the cytoplasm allow the cell to better perform its specialised function.

- There are quite a number of specialised cells here are a few examples:

Red blood cell

- Red blood cells look like tiny round flat disks, thicker at the edges than in the middle.
- They are very flexible, allowing them to squeeze through thin blood vessels without breaking.
- Red blood cells contain a pigment called haemoglobin which carries oxygen.
- Oxygen is needed by cells for the process of respiration.

(f) red blood cells

Muscle cells

- These are made up of strings of cells which are called muscle fibres.
- These muscles are attached to the skeleton to help you move around.
- When you move around the nerves stimulate the muscles causing them to contract, this creates movement.
- Muscles pull on a bone to create movement.
- Skeletal muscles are always arranged in pairs, this means that when one muscle contracts the other relaxes and that is how movement is basically created.

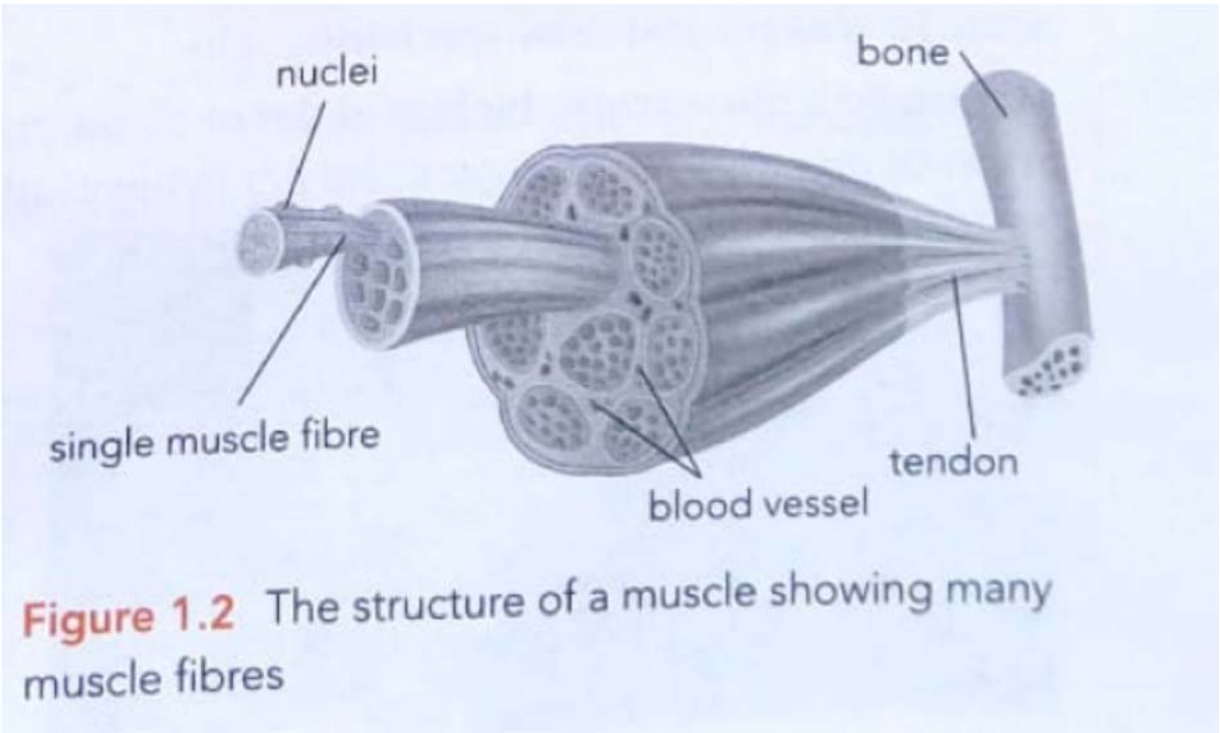
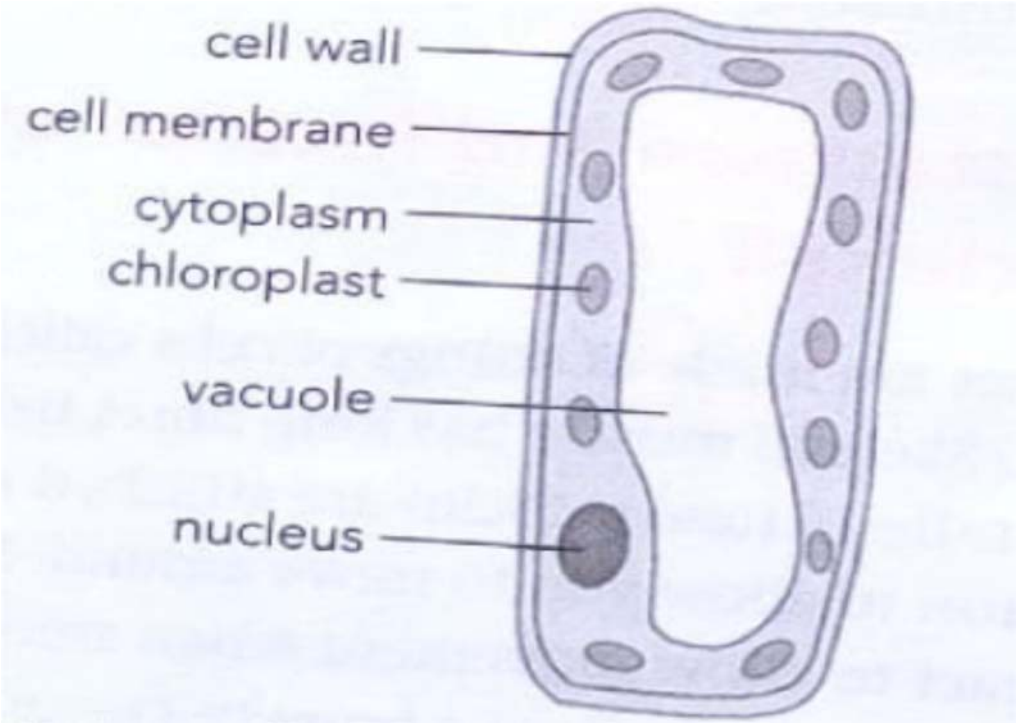


Figure 1.2 The structure of a muscle showing many muscle fibres

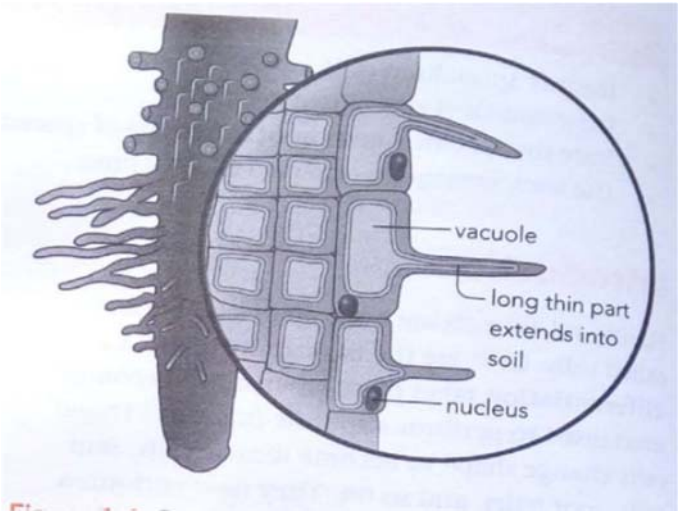
Palisade cell

- All leaves have a palisade layer of cells which can be found just below the upper epidermis.
- The main function of the palisade cell is photosynthesis.
- Palisade cells are long and shaped like cylinders, this allows them to be packed tightly close together so that space within the leaf is used efficiently.
- The palisade cell itself has a large surface area which basically increases the area for gaseous exchange.
- Palisade cells have a large vacuole which keeps the cell rigid and supports the whole leaf.
- The most unique thing about palisade cells is that they contain chloroplasts, which carry the green pigment chlorophyll for trapping the sun's energy for photosynthesis.



Root hair cell

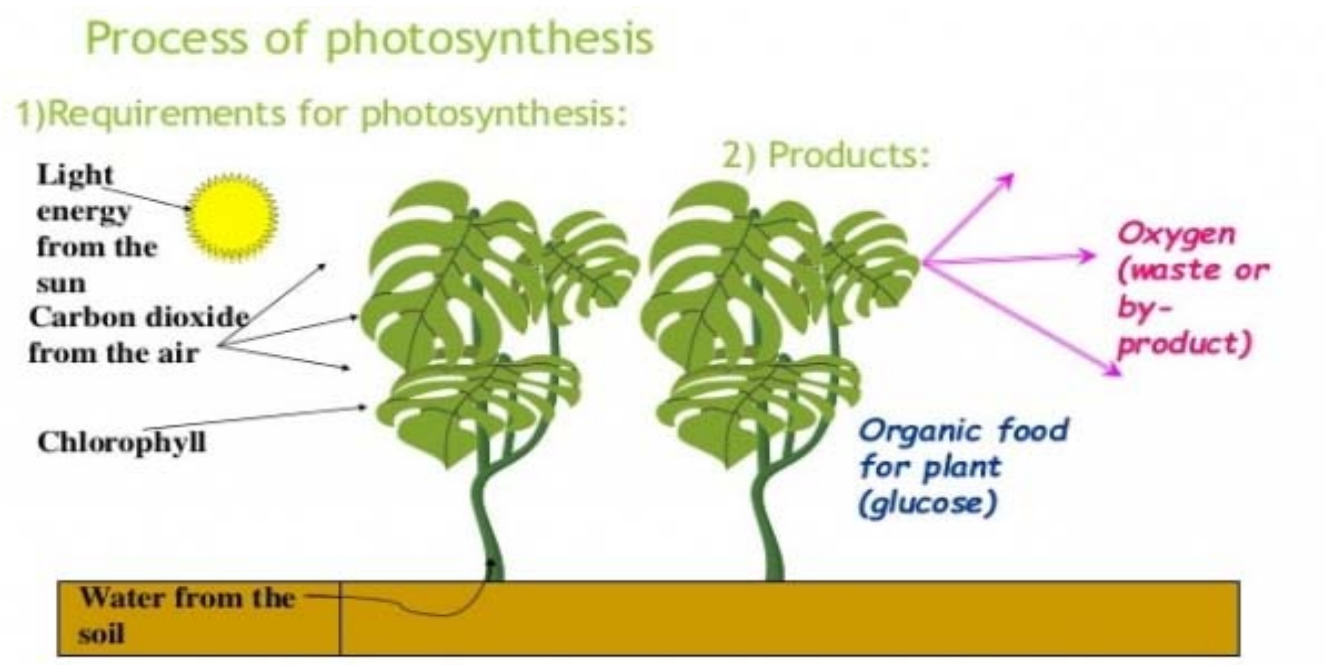
- These are tiny cells found on the surface of roots in plants.
- Their main function is to increase the surface area allowing the root to absorb more water and minerals from the soil.
- They have long thin parts that reach outwards into the soil, this increases the surface area of the root which comes into contact with the soil.
- Root hair cells have very thin walls to allow water and minerals to pass into the root quickly.



TOPIC 2: PLANT NUTRITION

PHOTOSYNTHESIS

INTRODUCTION

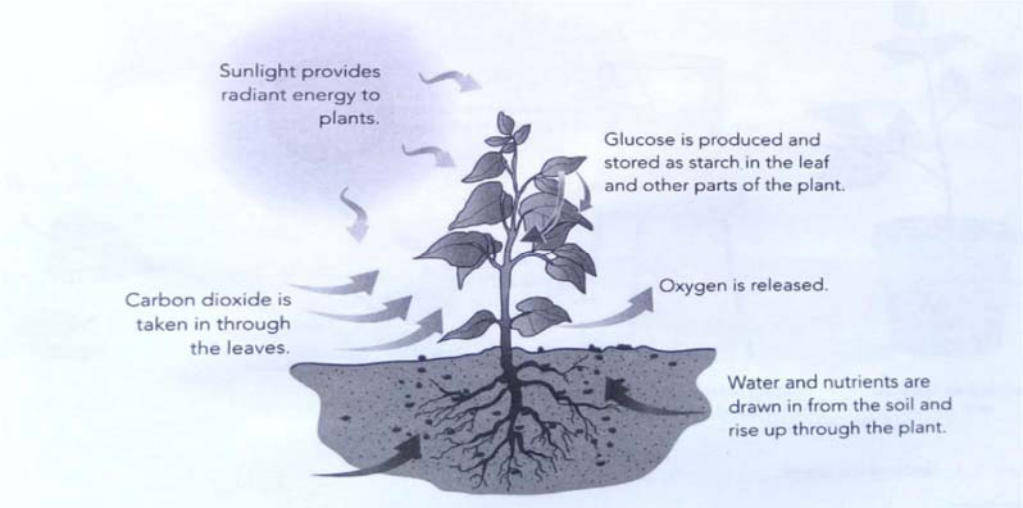


- Plants make their own food using simple inorganic compounds like carbon dioxide and water.
- Animals then feed on the plants because animals cannot make their own food in this way, therefore we can say green plants are the producers and animals are the consumers.
- The food making process in plants is called photosynthesis. We want to study the process of photosynthesis and also look at how the leaf is suited for photosynthesis.
- Photosynthesis is the process whereby green plants use carbon dioxide and water to make carbohydrates and oxygen in the presence of sunlight and chlorophyll.

- The word equation for photosynthesis is as follows:

$$\text{Carbon dioxide + water} \xrightarrow[\text{chlorophyll}]{\text{sunlight}} \text{glucose + oxygen}$$

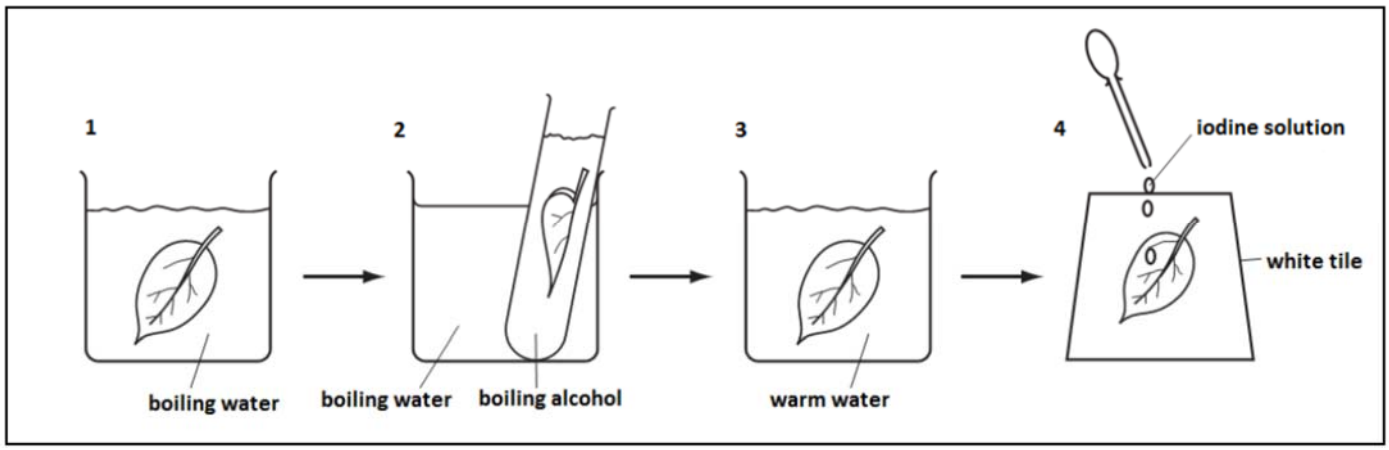
- Green plants are considered as the producers of the world this is because they are the only organisms that can make food, therefore they are known as producers. Animals on the other hand are known as consumers this is because they cannot make food they can only consume what has been produced already.



RAW MATERIALS OF PHOTOSYNTHESIS

- There are four factors that are necessary for photosynthesis to take place and these are:
  - Carbon dioxide- enters the leaves from the atmosphere through microscopic holes which are called stomata.
  - Water- is taken up from the soil via the roots.
  - Sunlight- solar energy is converted to chemical energy so that it can be used to make the carbohydrates.
  - Chlorophyll- this is the green pigment found in plants, it converts solar energy to chemical energy for use during the process of photosynthesis.
- Without any one of the above factors photosynthesis cannot take place.
- The best way to prove that photosynthesis was taking place is to take the plant leaves and test them for the presence of starch. The glucose that is made during photosynthesis is store as starch inside the plant, glucose and starch are both forms of carbohydrates.

EXPERIMENT 1: TESTING FOR THE PRESENCE OF STARCH.



	Action	Reason
1	Boil the leaf in water	To kill it/ to stop all chemical processes. And also to break open the cells.
2	Dip the leaf in boiling alcohol	To remove chlorophyll, so that colour changes may be clearly observed.
3	Place the leaf in boiling water	To soften it because alcohol makes it brittle
4	Place the leaf on a white tile and apply iodine solution.	To check whether starch is present or not.

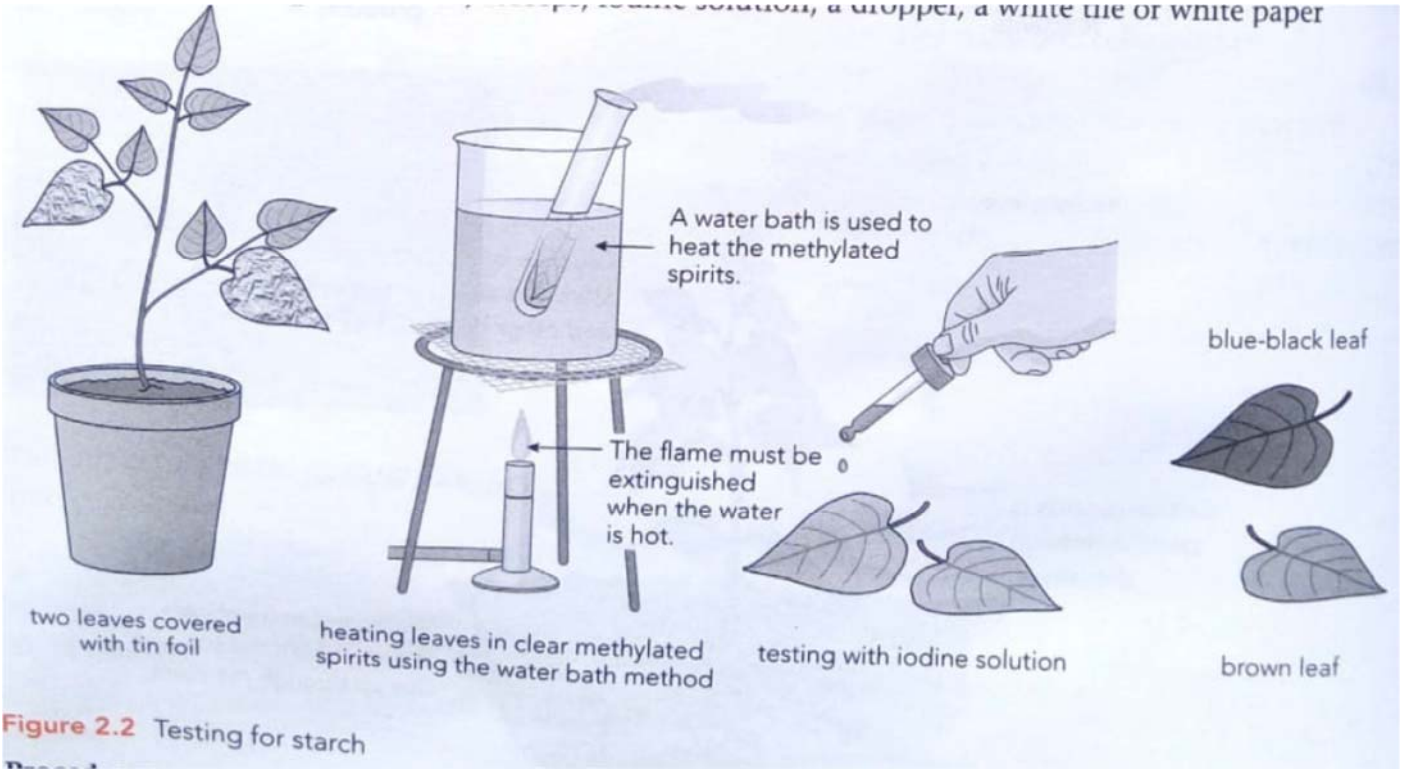


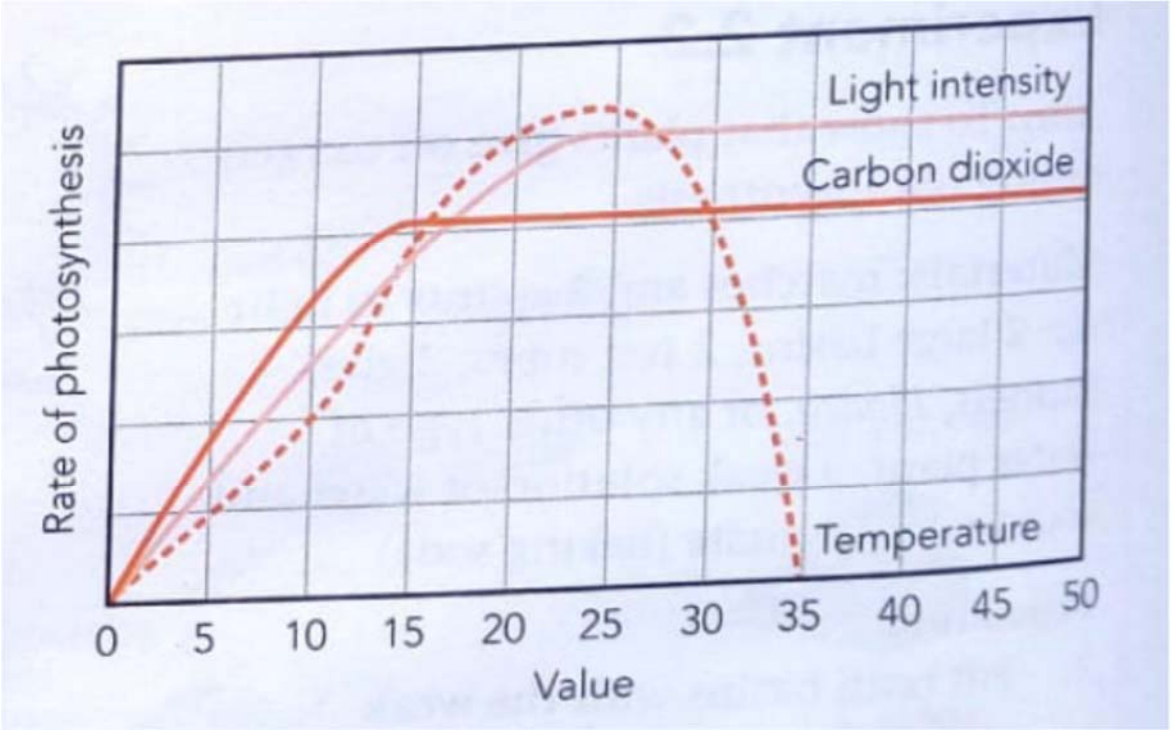
Figure 2.2 Testing for starch

- Iodine solution is the chemical that is used to test for the presence of starch, it is brown in colour.
- If starch is present iodine solution will change from brown to blue/black in colour.

- If starch is absent the iodine solution will remain brown in colour.
- It is important to note that there is a danger when it comes to testing for the presence of starch, step 2, alcohol is highly flammable as a result of that we use a water bath to boil it.

THE RATE OF PHOTOSYNTHESIS

- Whenever you speak about the rate of a process understand this: there is time involved.
- Basically when we say rate of photosynthesis we are considering how fast the process takes place.
- We can measure the rate of photosynthesis by looking at how much carbohydrates are produced over a certain period of time, in order to do this, we need to understand the factors that can affect the rate of photosynthesis.
    1. Light intensity- as light increases so does the rate of photosynthesis.
    2. Temperature – as temperature increases the rate of photosynthesis also increases. The process is controlled by enzymes; these allow the rate to reach an optimum level. However, if temperature exceeds or goes above the optimum level it damages the enzymes dropping the rate of photosynthesis.
    3. Carbon Dioxide concentration – as the concentration of carbon dioxide increases so does the rate of photosynthesis. If there is insufficient carbon dioxide it means the rate of photosynthesis will be lower. In order to increase production many farmers use greenhouses with a carbon dioxide rich atmosphere.
    4. Chlorophyll concentration- magnesium is an example of a micronutrient in plants, it is needed by plants for the formation of chlorophyll. Insufficient magnesium turns the leaves yellow, a condition known as Chlorosis. Lack of chlorophyll in leaves can negatively affect the rate of photosynthesis.



- There are different ways to measure the rate of photosynthesis, each investigation tends to depend on the amount of oxygen produced during the reaction/process.
- The following is a setup of an experiment that allows us to measure the rate of photosynthesis by counting the number of oxygen bubbles produced during the reaction.

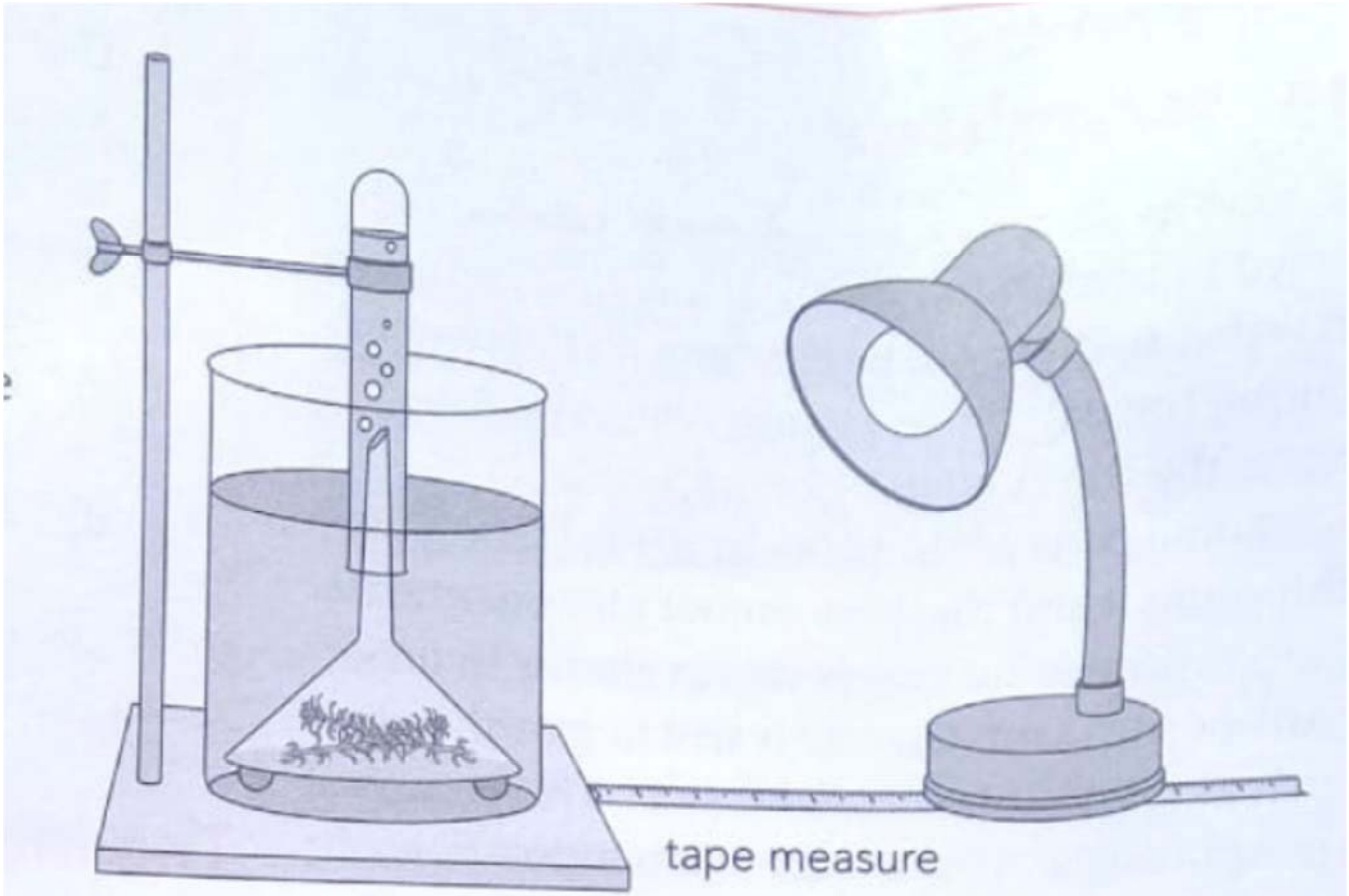


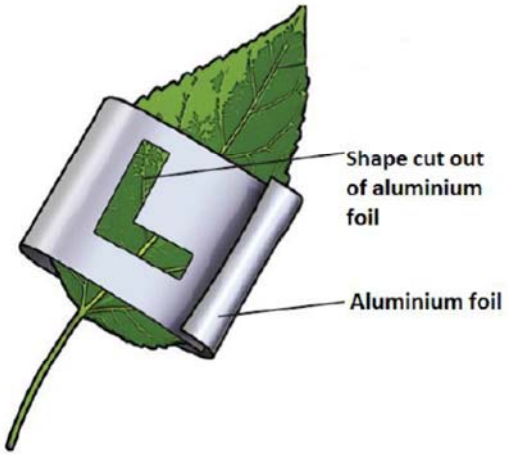
Figure 2.5 Measuring the rate of photosynthesis

- For this experiment we use a pond weed that is called elodea.
- Cut the stems of elodea at an angle and then crush the stems then place them as shown in the diagram.
- Look for a stream of bubbles coming out at the end of the stem, count how many bubbles are produced in one minute, repeat for a second minute and so on.

EXPERIMENTS ON FACTORS AFFECTING PHOTOSYNTHESIS

- The following experiments are to test whether sunlight, chlorophyll and carbon dioxide are really necessary for the process of photosynthesis.
- In each of the experiments before we begin we start by de-starching the plant.
- To de-starch is to remove all the starch in the plant itself and this is done by placing it in a dark place for 24 hours.
- The following experiments are known as controlled experiments.
- A controlled experiment is set up in 2 parts, one set up has all the conditions necessary for the process to take place, and this is called the control experiment whilst the second set up has all the conditions necessary except for the factor being tested at that particular time.

1. THE NECESSITY OF SUNLIGHT



- De-starch a potted plant.
- Partly cover one leaf with aluminium foil/ cardboard.
- Place the plant in light for a few hours.
- Test the leaf for starch.

[The exposed part of the leaf is the control. It has all the conditions that are required for photosynthesis]

Results

- The part that was covered turns brown [starch absent].
- The part that was formerly exposed to sunlight turns blue/black [starch present].

Conclusion: Sunlight is necessary for photosynthesis to take place.

THE NECESSITY OF CHLOROPHYLL

- De-starch a potted plant with variegated leaves
- Before the experiment begins test one leaf for starch to make sure that it has been properly de-starched.
- Place the plant in sunlight for a few hours.
- Test one leaf for the presence of starch.

A variegated leaf:

- The white part is the experiment [it has everything except chlorophyll]
- The green part is the control. All factors necessary are present.

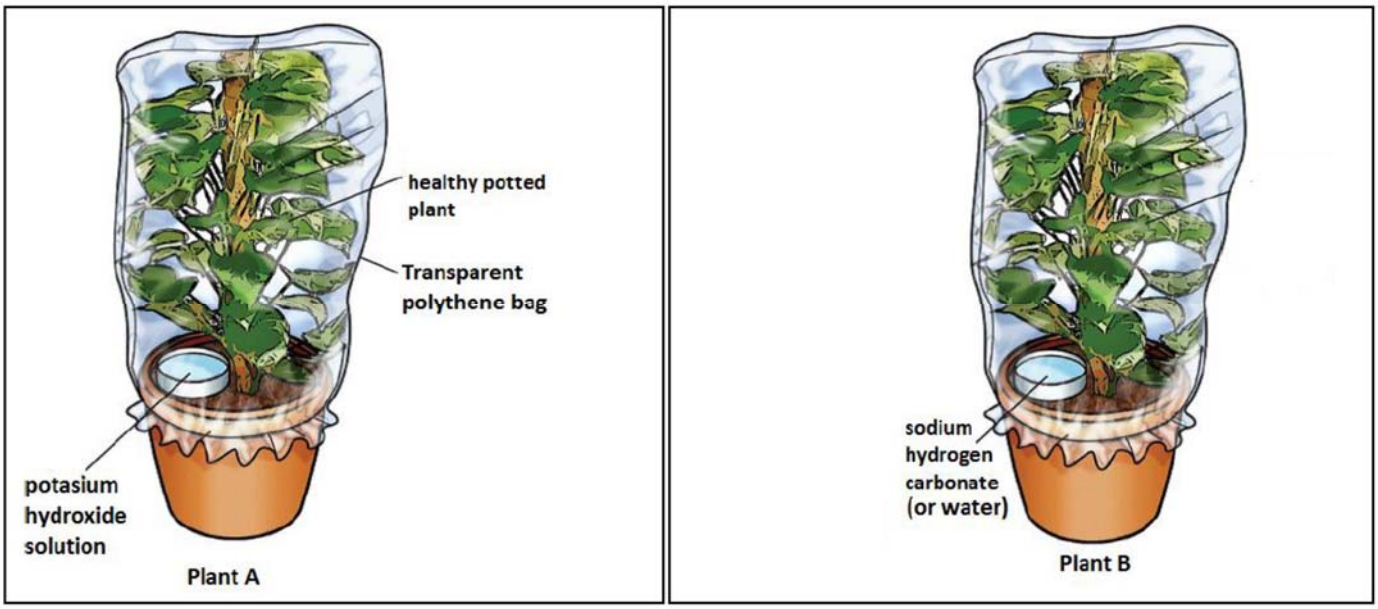
Results

- White part turns brown.
- Green part turns blue/black.

Conclusion: Chlorophyll is necessary for photosynthesis to take place.

NECESSITY OF CARBON DIOXIDE

- For this experiment it is easier to use two different plants, but you can still set it up using one plant.
- De-starch 2 potted plants.
- Set up the plants covering them with transparent polythene bags.
- In one bag place potassium hydroxide solution, this plant is the actual experiment because potassium hydroxide solution also known as soda lime absorbs carbon dioxide.
- Do not place anything in the other polythene bag, this is the control experiment.
- Leave the plants in sunlight for a few hours
- Test a leaf from each plant for starch.



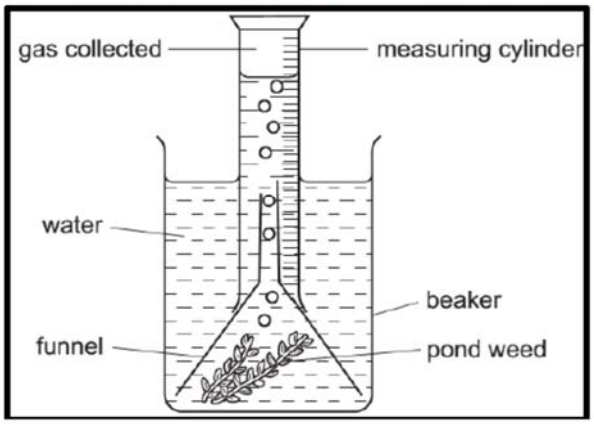
- The leaf from plant A turns brown meaning photosynthesis did not take place, the leaf from plant B turns blue/black showing that photosynthesis was taking place.
- The conclusion is simple; carbon dioxide is indeed necessary for the process of photosynthesis.

FATE OF THE END PRODUCTS OF PHOTOSYNTHESIS

- During photosynthesis green plants manufacture food in the form of carbohydrates, they also give out oxygen as a by-product of the process. These are what we call the products of photosynthesis as a process.
- Once oxygen has been created it diffuses out of the leaf and into the atmosphere to be breathed in by human beings and other animals which require oxygen.
- There are microscopic holes/pores on the lower side of the leaf, these allow for gaseous exchange between the leaf and the surrounding air i.e. carbon dioxide in and oxygen out.
- The carbohydrate molecules produced by the process of photosynthesis are transported to other parts of the plant, some parts of the plant may not have chlorophyll as a result these parts cannot photosynthesise so carbohydrate molecules are transported to these parts of the plant to allow for growth and development.
- These carbohydrate molecules are transported in the form of simple sugars, this means that for plants that produce starch, once starch is produced it is then converted into simple sugars.
- Simple sugars are easier to transport because they are soluble, they travel to the other parts of the plant in solution, using microscopic tubes, and this movement of carbohydrate molecules is called translocation.
- Once they reach these other parts of the plant the carbohydrate molecules can be used as an immediate source of energy for the plant or they can be stored for later use.

- In order for them to be stored they have to be in the form of starch, starch can be stored in leaves and in other special organs e.g. roots (potatoes, sweet potatoes).
- Carbohydrate molecules can also be converted into a structural compound which will be used to make up cell walls in the plant and to give the plant support, this structural compound is called cellulose.
- Cellulose is the carbohydrate molecule that makes up the fibrous parts of plants for example mangoes.
- Cellulose is important for a human diet.

EXPERIMENT: TO SHOW THAT THE GAS PRODUCED DURING PHOTOSYNTHESIS IS OXYGEN



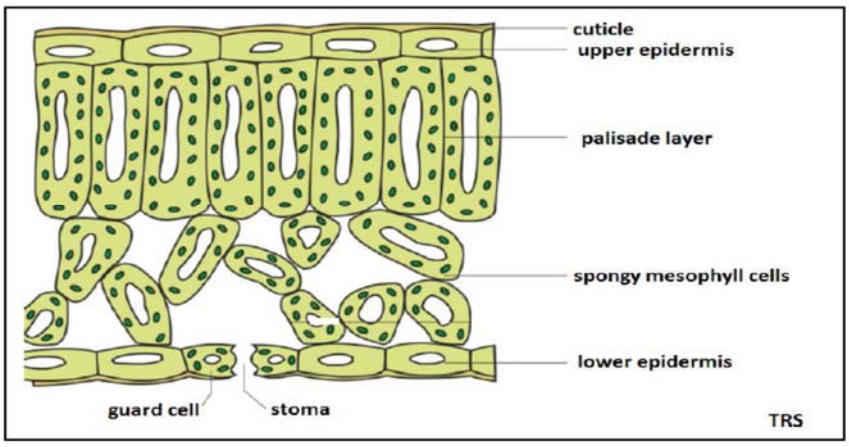
- A water plant is set up as shown.
- Sodium hydrogen carbonate is dissolved in the water to increase the concentration of carbon dioxide.
- A water plant, such as elodea, is used because it is adapted to photosynthesise under water.

The set-up is left in the sun and the gas produced is collected as shown.

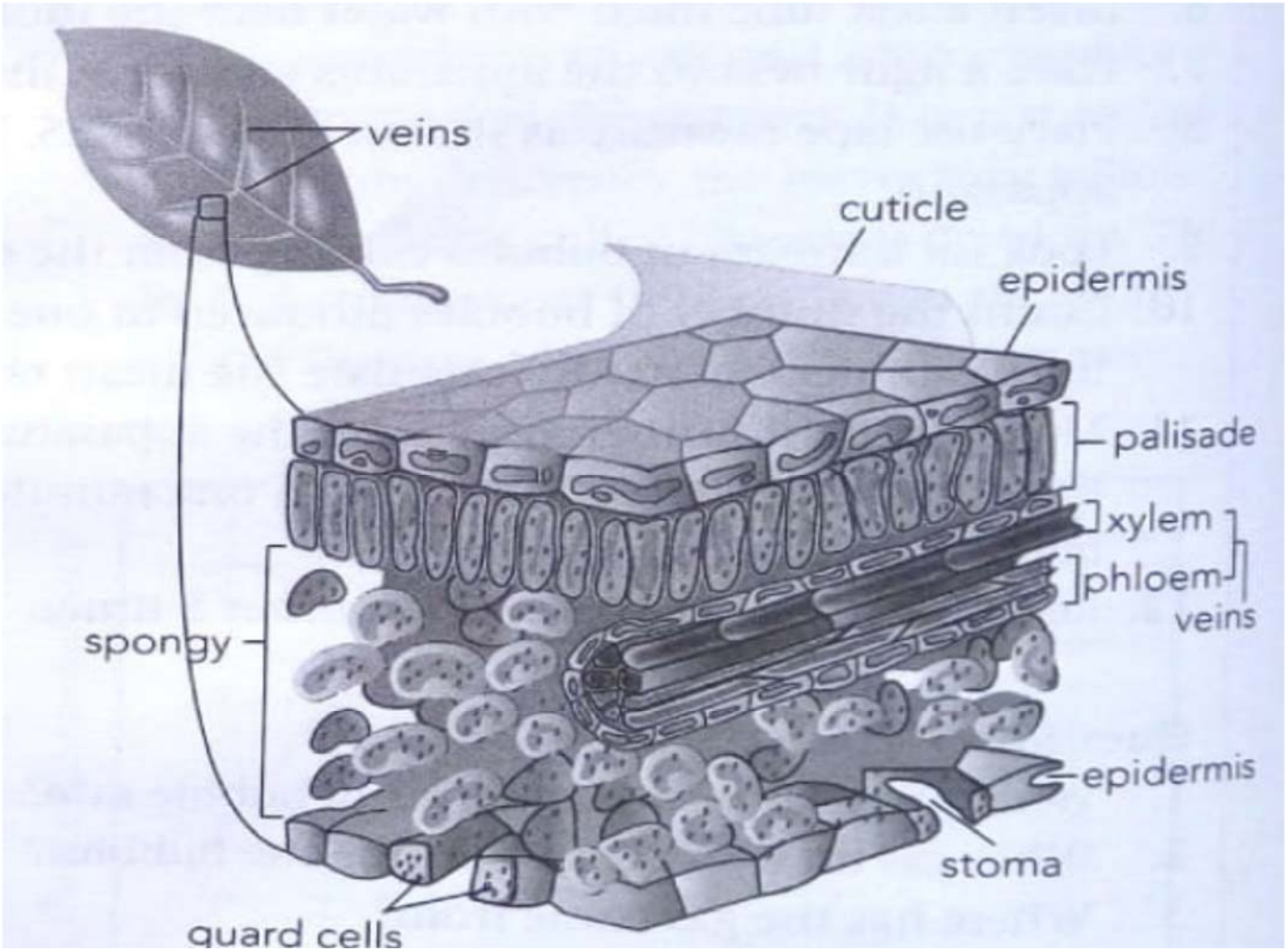
- In order to prove that the gas produced during photosynthesis we use a glowing splint, oxygen re-lights a glowing splint

INTERNAL STRUCTURE OF A LEAF

THE CROSS-SECTIONAL STRUCTURE OF A LEAF



- Much of the photosynthesis takes place in the palisade cells.
- The spongy layer has a lot of air spaces to allow easy diffusion of gases through the leaf.
- Gases enter and leave the leaf through microscopic holes called stomata.
- The cuticle is waterproof so as to prevent excessive water-loss



- **Cuticle**: a thin waxy layer that protects the leaf against water loss by evaporation as well as parasitic fungi.
- **Upper Epidermis**: a single layer of cells that contain no chloroplasts and are transparent allowing light to pass straight through.
- **Palisade Layer**: contains palisade cells which have chloroplasts, most of the chlorophyll is found in this layer, this is where most of the photosynthesis takes place.
- **Vein**: contains microscopic tubes, the xylem and the phloem. Xylem brings water and mineral salts to the leaf while the phloem transports dissolved foods from the leaf to other parts of the plant.
- **Spongy Layer**: contains irregularly shaped cells with large airspaces between them allowing for maximum gaseous exchange. It can also be called mesophyll layer.
- **Lower Epidermis**: this layer contains cells and microscopic pores at regular intervals to allow for gaseous exchange with the surrounding air.

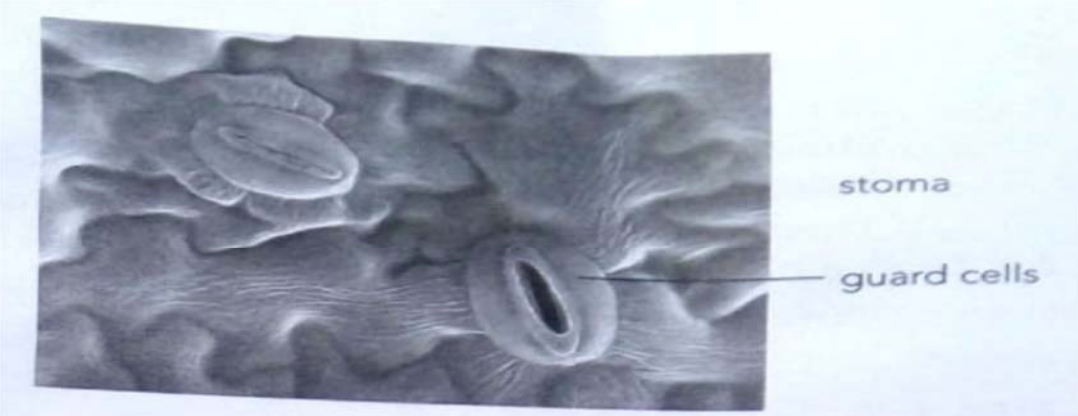


Figure 2.7 The guard cells surrounding a stoma

LEAVES AND ADAPTATION FOR PHOTOSYNTHESIS

- Leaves have a number of features that make them the most suitable organ for the process of photosynthesis. Here is a list of these features:
  1. The flattened surface of the leaf provides a large surface area for trapping and absorbing light from the sun.
  2. The cells in the upper and lower epidermis are transparent to allow light to reach the palisade cells.
  3. The presence of stomata allows gases to enter and leave the leaf. The opening and closing of the stoma is controlled by guard cells this helps to regulate the exchange of gases.
  4. Leaves have a thin shape to allow for efficient diffusion of carbon dioxide entering the palisade cells where photosynthesis takes place.
  5. The palisade cells are packed tightly, their shape and arrangement ensure that more cells are exposed to sunlight.
  6. Palisade cells contain chloroplasts which produces chlorophyll, chlorophyll converts light energy into chemical energy for the process of photosynthesis.
  7. Large air spaces within the spongy mesophyll allows carbon dioxide to diffuse rapidly into all photosynthesising cells.
  8. The presence of many veins in the leaf. Veins are made up of the xylem and the phloem. The xylem transports water and mineral salts to all parts of the plant including the palisade cells whilst the phloem carries food manufactured during the process of photosynthesis from the leaves to all parts of the plant.

TOPIC 4: HUMAN NUTRITION

INTRODUCTION

- Humans need food to survive, it gives us energy and allows us to replace cells in our bodies.
- The food that we eat is in the form of large insoluble molecules, these large insoluble molecules are broken down into smaller soluble molecules by the digestive system.
- It is these small soluble molecules that are used by the body for growth, repair and energy.
- it cannot be used by the body as it is, for it to benefit the body it first has to be broken down into smaller soluble molecules which can be absorbed by the body.
- The process of breaking down food into smaller soluble molecules is known as digestion, and the structures that carry out this process are known collectively as the alimentary canal.

PARTS OF THE HUMAN ALIMENTARY CANAL

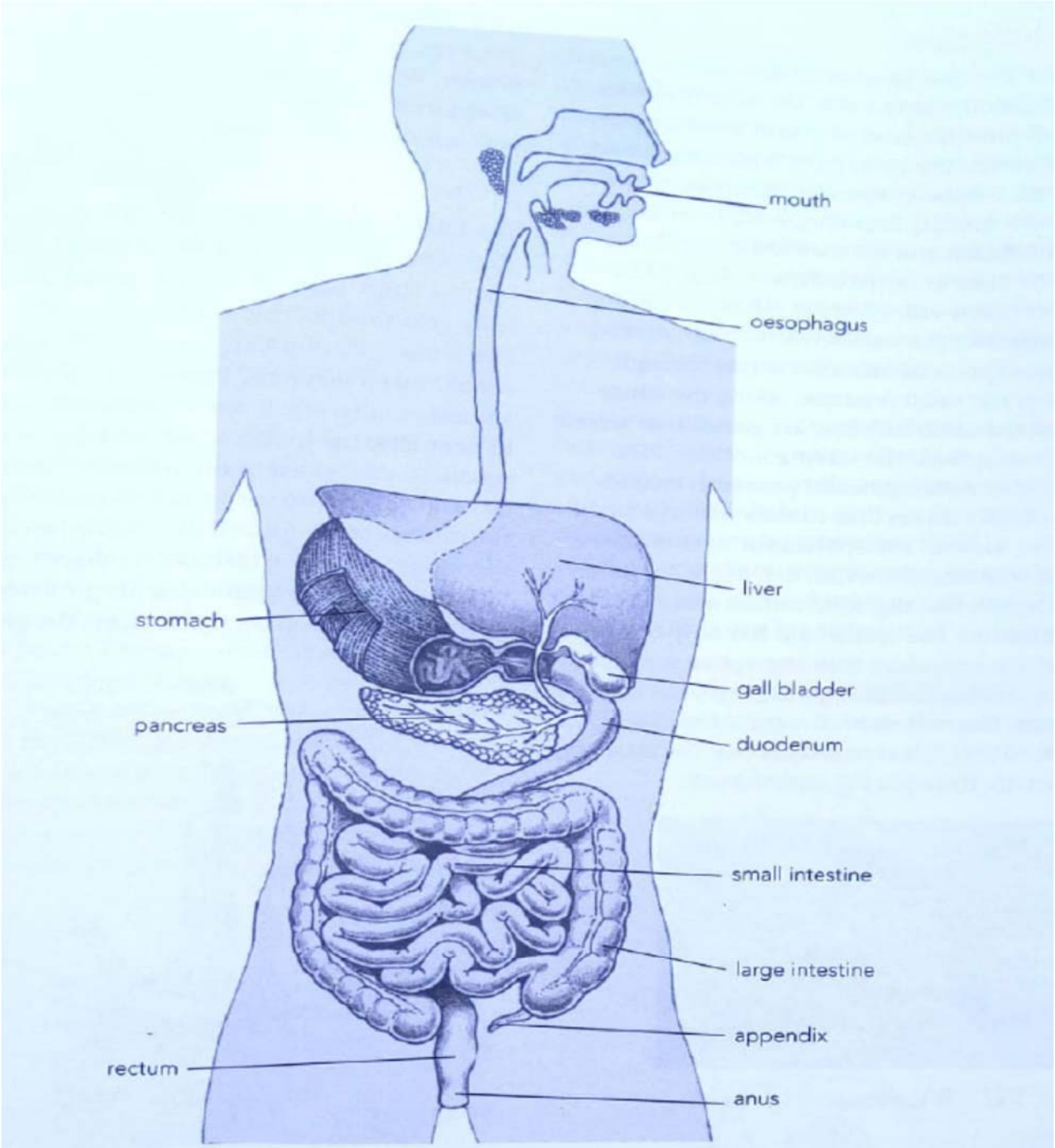


Figure 3.2 The digestive system

- The alimentary canal is a long hollow tube that begins in the mouth and ends at the anus.
- It is made up of the following organs; mouth, oesophagus, stomach, small intestines and the large intestines.
- As food moves from the mouth to the anus the various accessory organs of the alimentary canal or the digestive system produce substances that help facilitate the process of digestion.

THE MOUTH

- Is made up of lips in the front, cheeks on the side and the upper and lower jaws.
- On each jaw there is a set of teeth.
- The lips and the teeth prevent food from falling out whilst it is in the mouth.

- The lower jaw moves to facilitate the process of chewing (upper jaw does not move at all).
- The function of teeth is to tear, chew and grind food before it can be swallowed.
- During the process of chewing saliva from the salivary glands is mixed with the food.

THE OESOPHAGUS

- This is the tube that connects the mouth and the stomach.
- Whenever we swallow food the muscles of the oesophagus contract and relax in waves to push the food bolus down the alimentary canal.
- This movement of food is known as peristalsis.
- The muscles at the top of the food bolus contract forcing food bolus to go down, simultaneously the muscles at the bottom of the food bolus relax creating an opening for the food bolus to go down the oesophagus.

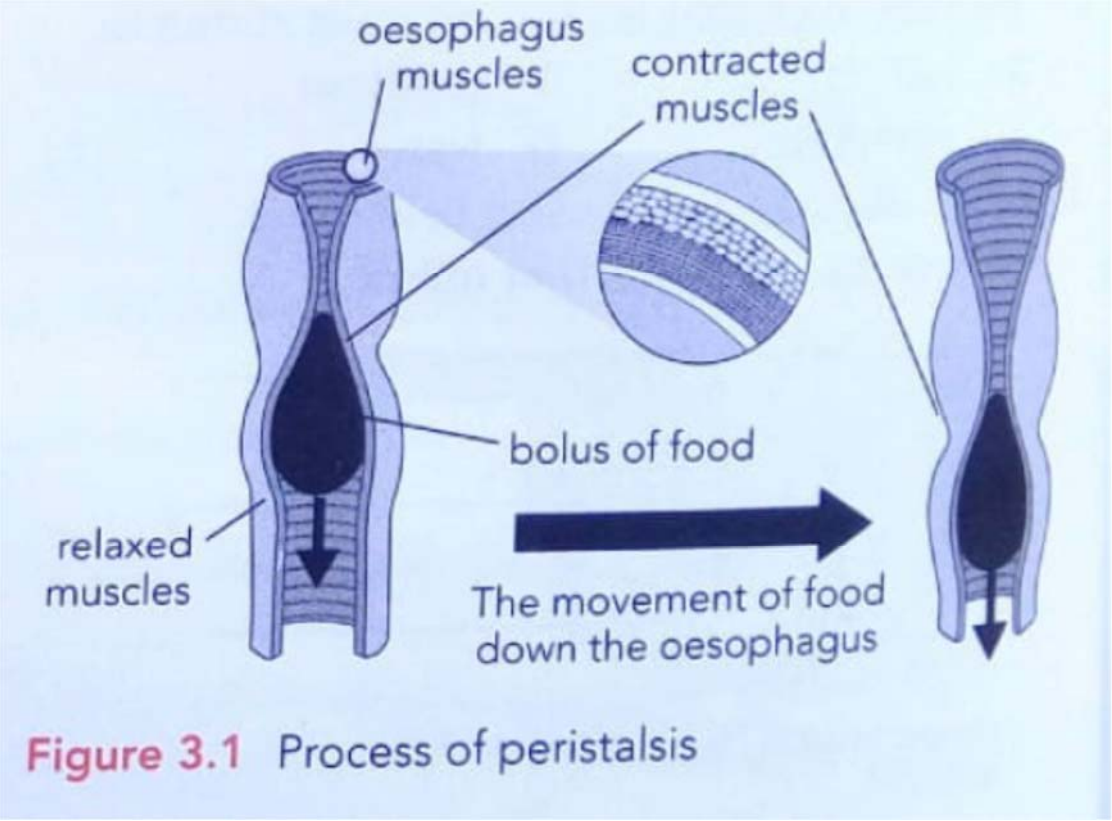


Figure 3.1 Process of peristalsis

THE STOMACH

- The stomach is an organ that is shaped like a bag, it has thick muscular walls.
- The walls are elastic and this allows the stomach to increase its volume three times or more during a large meal.
- The muscular walls mix the food with digestive juices during the process of digestion, this process of mixing the food with digestive juices is known as churning.
- Inside the stomach the gastric glands are stimulated to produce some juices known as gastric juices, these juices are made up hydrochloric acid and when food enters the stomach this hydrochloric acid kills any bacteria.
- At the same time the acid in the stomach changes inactive pepsinogen into active pepsin.
- Pepsin is an enzyme that digests proteins into polypeptides.
- Hydrochloric acid also hydrolyses sucrose into glucose and fructose that is its other function.
- The food is liquidised into a thick fluid during the process of peristalsis, this thick fluid is called chime.

THE SMALL INTESTINES

- The small intestines connect the stomach to the large intestines.
- In an adult the small intestine is approximately 5 m long.
- It is divided into 3 regions and these are the duodenum, the jejunum and the ileum.
- two ducts from accessory digestive organs enter the duodenum and these are:
    - the bile duct which brings bile from the liver and the gall bladder.
    - The pancreatic duct which brings pancreatic juices from the pancreas.
- Finger like projections can be found on the walls of the small intestine, these projections are known as villi (singular villus).
- Almost all the absorption of digested food nutrients occurs through these microscopic villi.
- Along the length of the small intestine there are some glands that continue to secrete digestive enzymes.
- The waving motion of the finger-like microscopic villi along with the segmental peristalsis ensures that all the chyme comes into contact with the surface of the small intestine, this increases the surface area for absorption.
- The epithelium layer of the villi also contains micro villi; these help to increase the surface area for absorption.
- The epithelium is one cell thick providing a thin absorptive surface meaning that digested food can pass into the capillaries quickly.
- The villi are well supplied with a network of blood capillaries so that the absorbed nutrients are quickly carried away immediately after absorption.

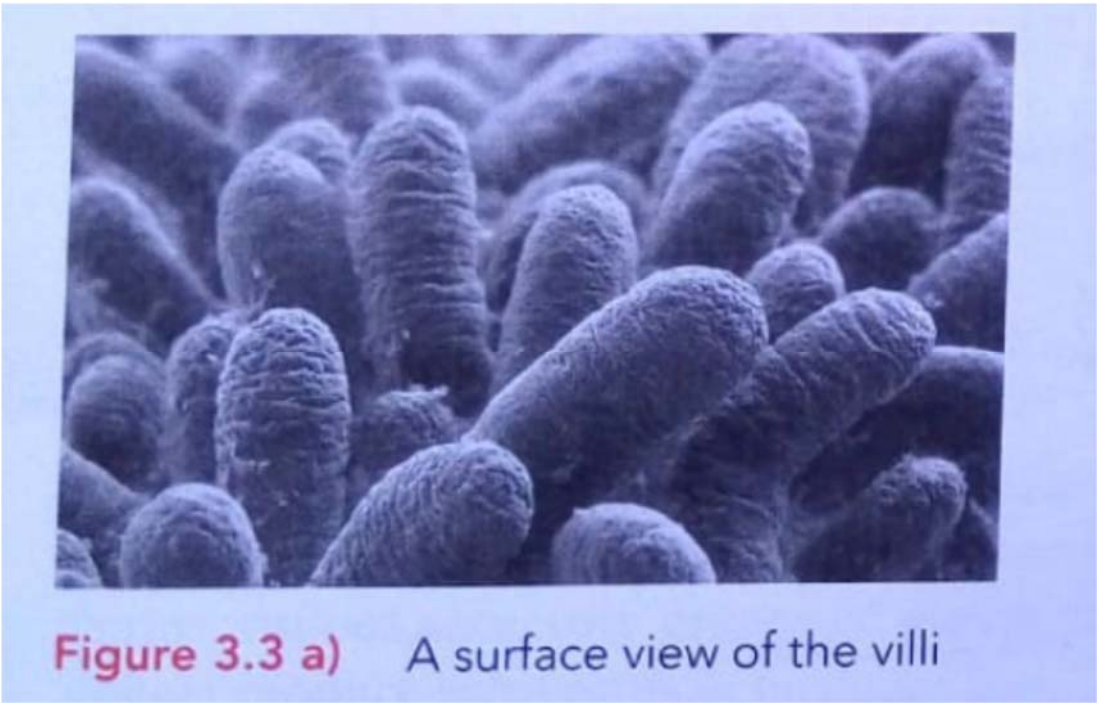


Figure 3.3 a) A surface view of the villi

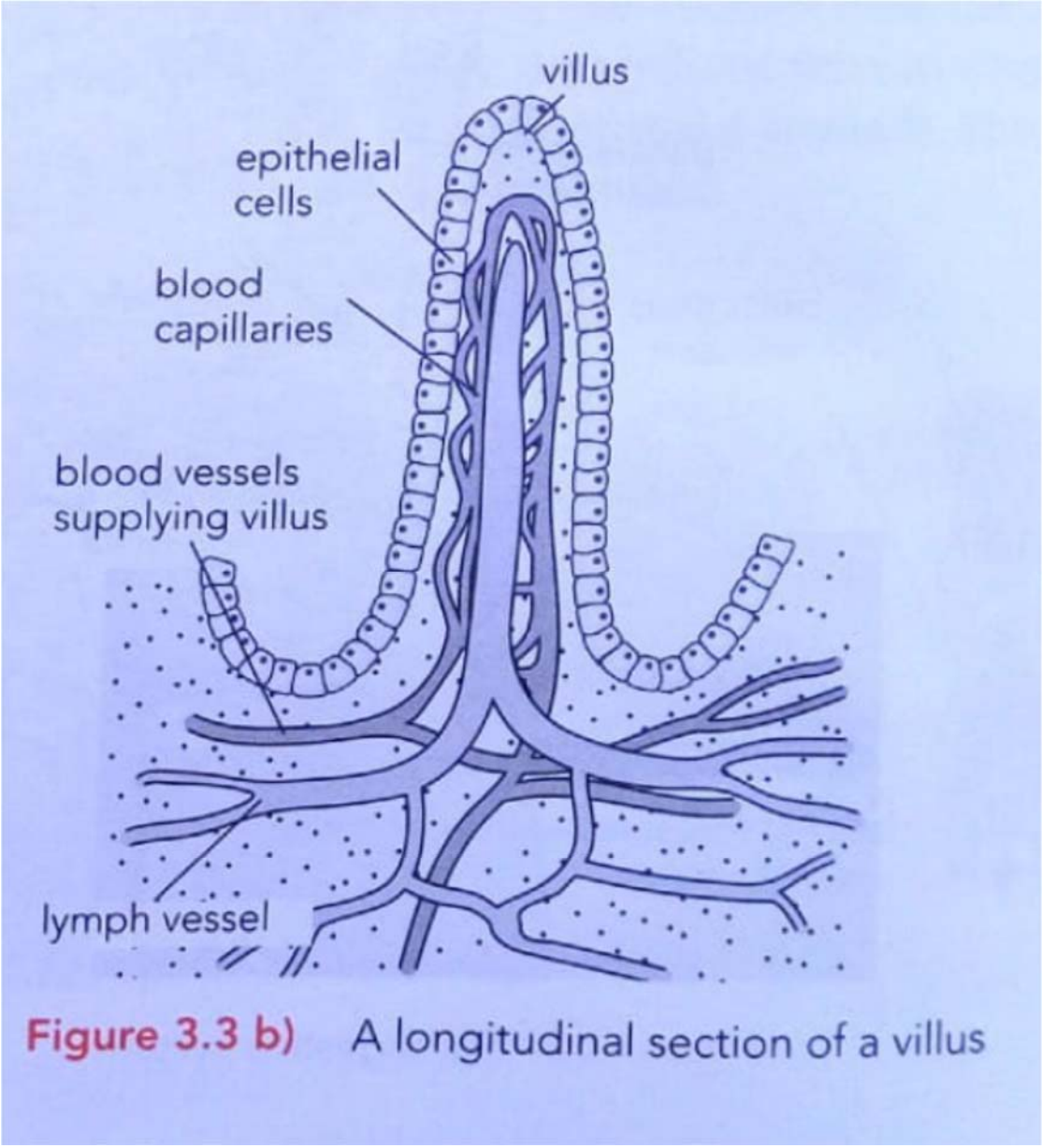


Figure 3.3 b) A longitudinal section of a villus

LARGE INTESTINE

- An adult's large intestine can be about 1.5 m long.
- It is made up of an ascending section, a transverse section and a descending section.
- Function of the large intestine is to absorb water and minerals into the blood stream.
- The area at the end of the colon is called the rectum and it opens to the exterior at the anus.
- A circular muscle known as the anal sphincter surrounds the anus its function is to open and close the anus.
- Waste products and solid undigested food are stored in the rectum as feaces and pushed out via the anus.

THE LIVER

- It lies in the upper right hand corner of the abdomen partially covering the stomach.
- The liver has two lobes, a larger right lobe and a smaller left lobe.
- The cells in the liver produce the liquid called bile and then it is stored in the gall bladder. Bile is made up water, bile salts, bile pigments from broken down red blood cells and also cholesterol and other salts.
- The function of bile is to emulsify fats and to neutralise hydrochloric acid from the stomach.

- Liquid fats are broken down into very small droplets by the process of emulsification, this increases the surface area for the fat digesting enzyme (lipase) to act on the fats.

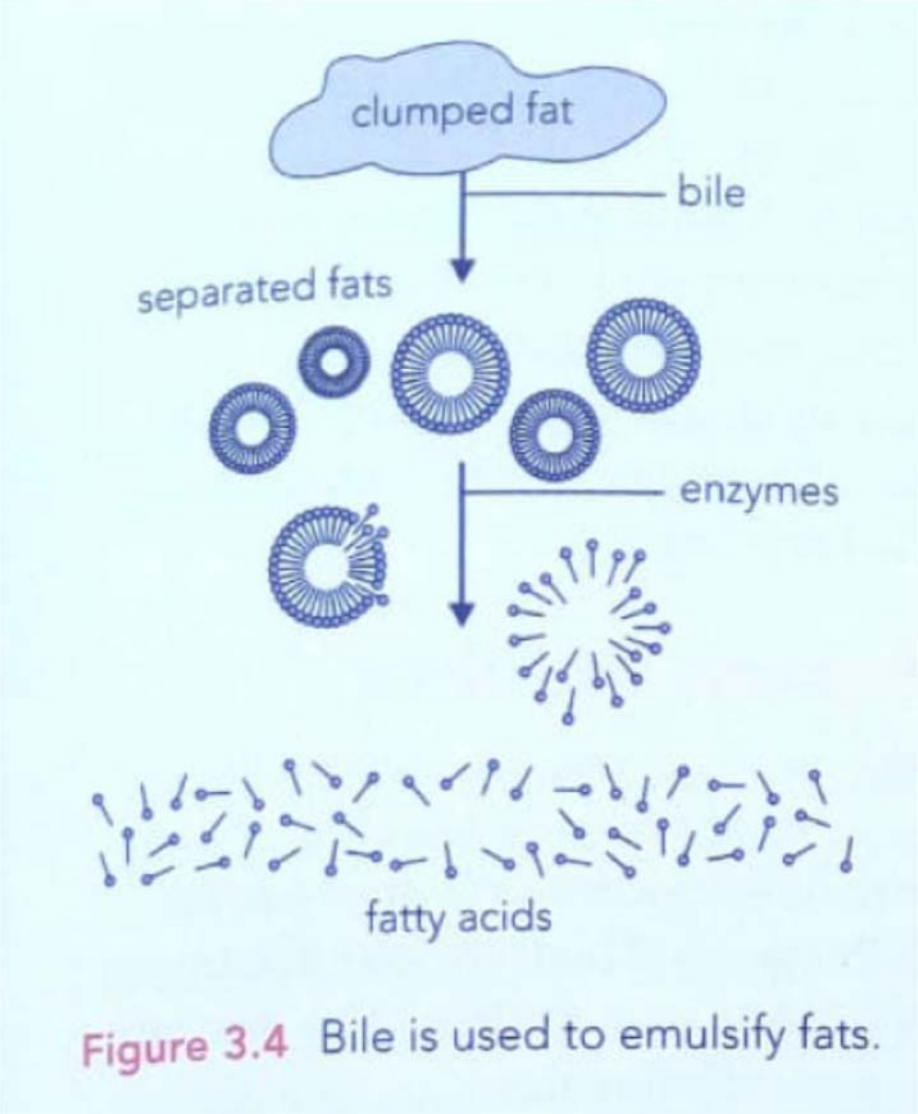


Figure 3.4 Bile is used to emulsify fats.

- In the liver excess amino acids (proteins) are deaminated into glucose and urea.
- The glucose is converted to glycogen and the urea is taken to the kidneys for excretion.
- Poisonous substances such as insecticides, alcohol and food preservatives are absorbed and neutralised in the liver.

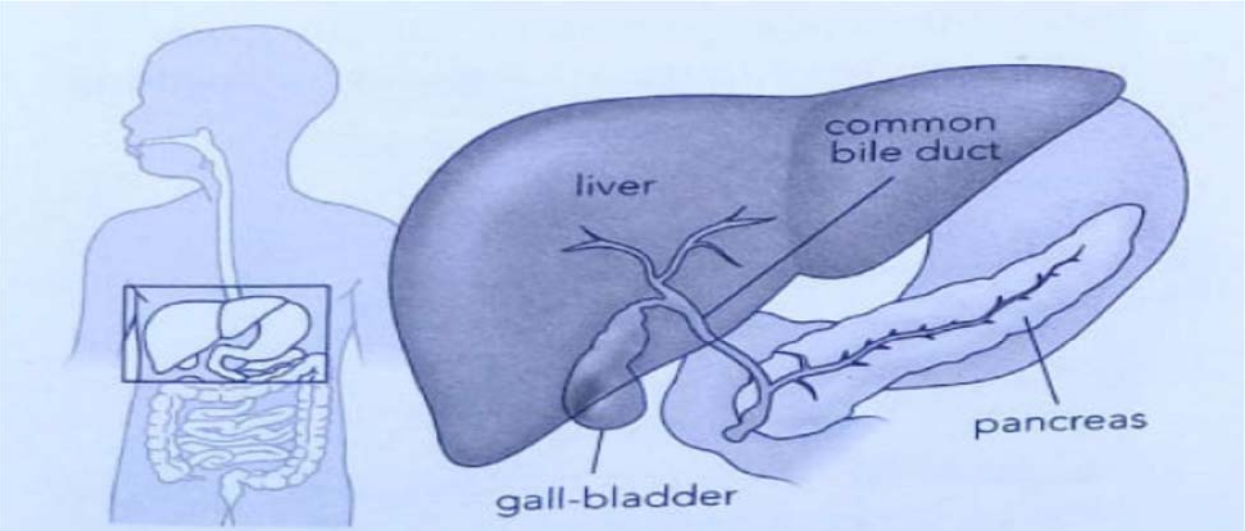


Figure 3.5 The position of the liver, the gall-bladder and the pancreas

GALL BLADDER

- It is a bag attached to the lower surface of the liver.
- It stores bile that has been produced in the liver, bile is continuously channelled into the gall bladder from the liver via the bile duct.
- When large amounts of bile are required for digestion the bile duct contracts forcing bile through the common bile-pancreatic duct into the duodenum.
- The gall bladder has only two main functions, storing bile until it is needed and absorbing water and ions to concentrate bile.

PANCREAS

- The pancreas has both exocrine and endocrine functions.
- It is an exocrine organ in the sense that it secretes enzyme rich pancreatic juice into the duodenum to help with the process of digestion.
- It is an endocrine organ in the sense that it secretes the hormones insulin and glucagon directly into the blood stream, these help to control glucose levels in the blood stream.
- Pancreatic juice contains the following enzymes:
    - Lipase – hydrolyses lipids to glycerol and fatty acids.
    - Amylase – hydrolyses any remaining starch into maltose.
    - Trypsin- hydrolyses poly peptides into tripeptides and dipeptides.

PROCESSES INVOLVED IN NUTRITION

- There are quite a number of processes involved when it comes to the digestion of food and its movement within the alimentary canal.
- Large insoluble molecules are broken down into smaller soluble molecules so that they can be absorbed into the blood stream, this whole process of taking in and using food substances is known as nutrition.
- In human's nutrition occurs in 5 stages:
    1. Ingestion: food is put into the mouth where it is chewed into smaller pieces by the teeth and also mixed with saliva before being swallowed.
    2. Digestion: food is broken down into simpler soluble substances inside the body.

3. Absorption: soluble food substances are taken up into the blood stream in the small intestines.
4. Assimilation: soluble food substances are delivered to individual cells and then incorporated into cell structures meaning used up by the cells.
5. Egestion: undigested food substances and waste products (faeces) are passed out from the body. This can also be called defecation.

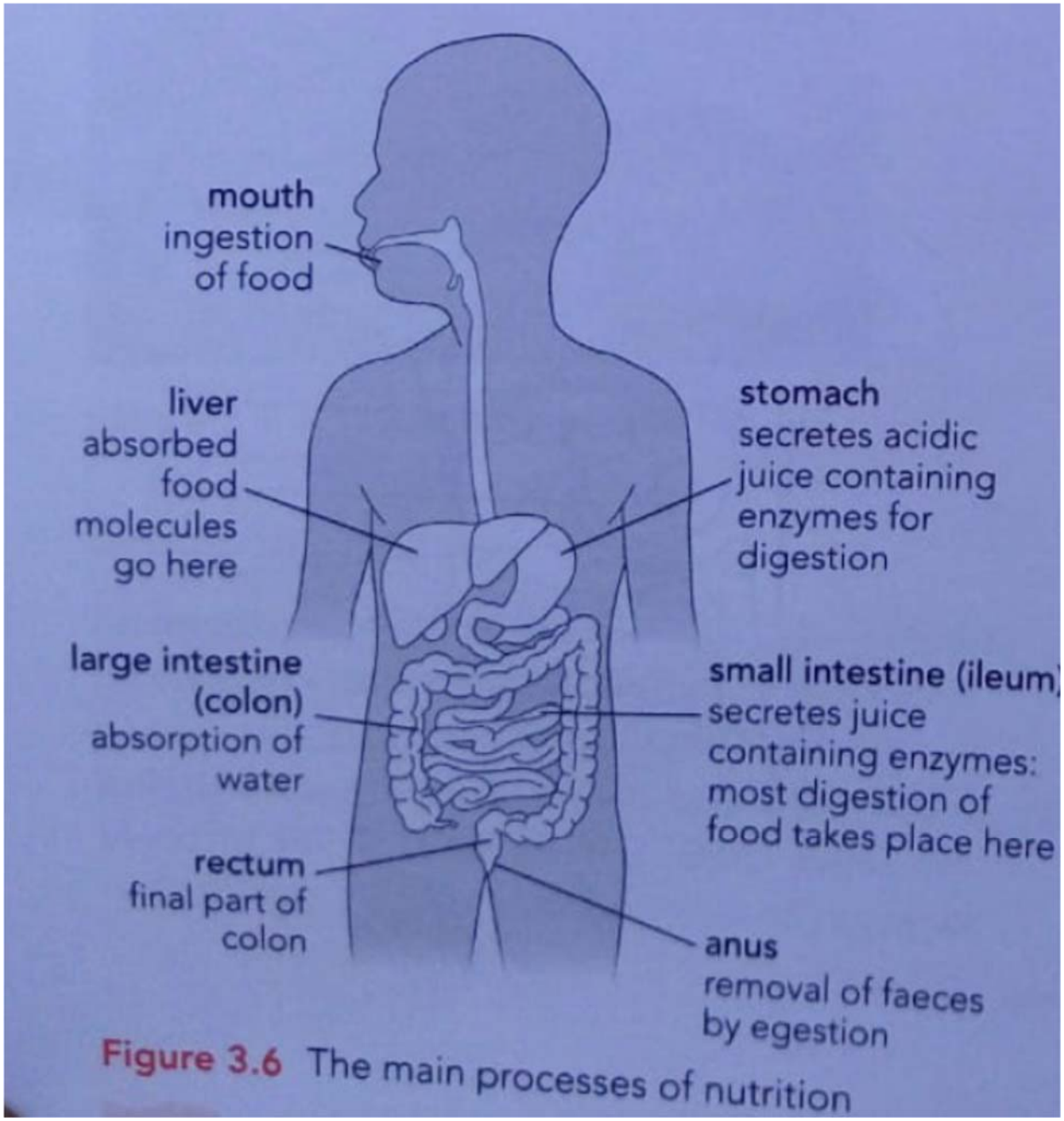


Figure 3.6 The main processes of nutrition

TYPES OF TEETH AND THEIR FUNCTIONS

- Mainly teeth are used to bite, tear, grind and crush food into smaller soluble molecules.
- There are four main types of teeth when it comes to human beings and each type is different from the other in terms of appearance and also function.

1. Incisors (i): these are the 4 front teeth located on both the upper and lower jaw. They are chisel shaped and are used for biting and cutting food.
2. Canines (c): these are single teeth in each half jaw found next to the incisors, they are pointed and are used for gripping and tearing food.

3. Premolars (pm): there are two of them just behind the canines on both the lower and upper jaw. Together with the molars they form the cheek-teeth. They have flat surfaces for crushing and grinding food.
4. Molars (m): there are 6 molars found at the back of both the lower and upper jaw.they have flattened surfaces for crushing and grinding food.

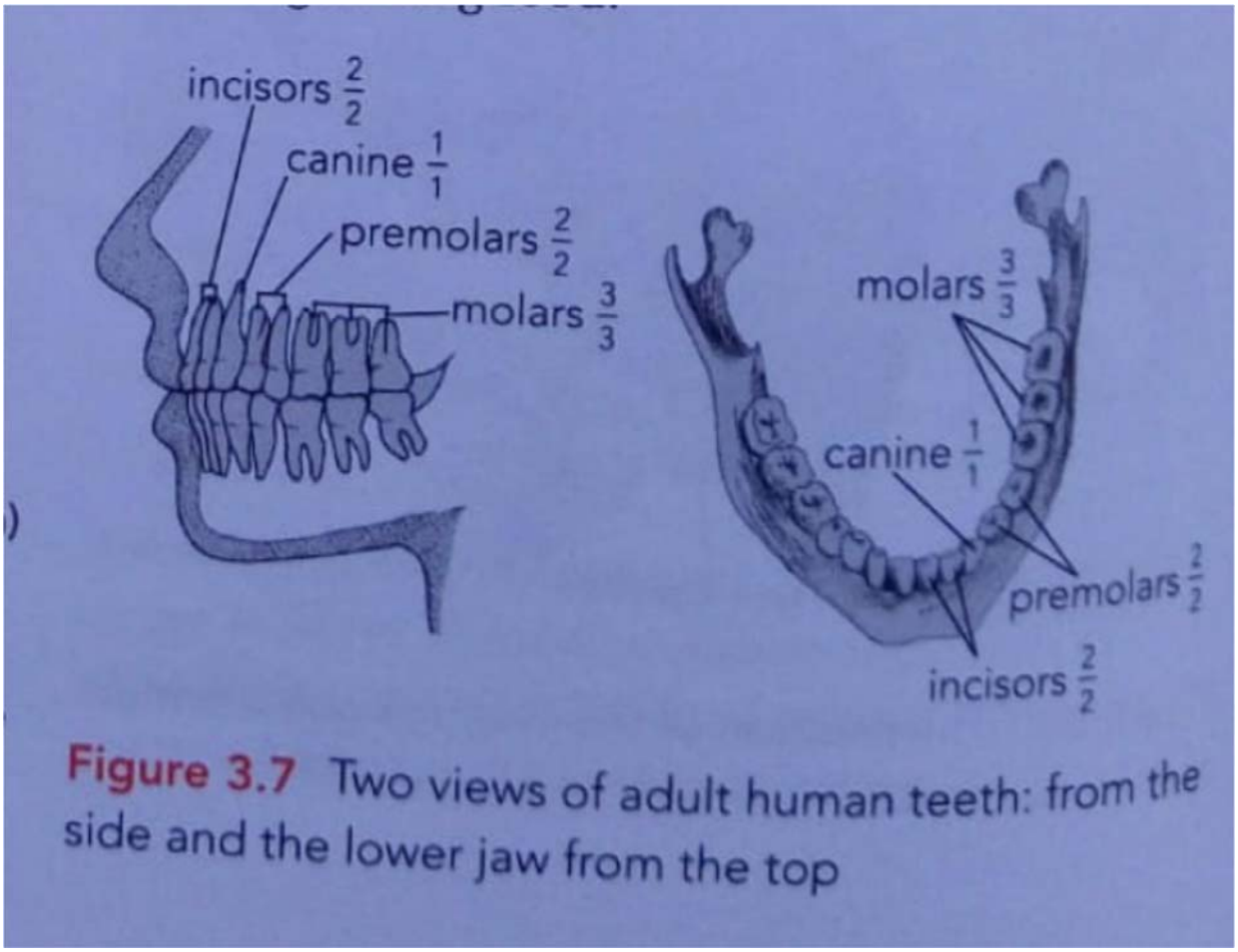


Figure 3.7 Two views of adult human teeth: from the side and the lower jaw from the top

DIGESTION

- Is the breaking down of large insoluble food molecules into smaller soluble ones that can be used by the body.
- Digestion can be divided into two, there is mechanical digestion and chemical digestion.

MECHANICAL DIGESTION

- Involves the use of teeth to chew (masticate) food into smaller pieces that are easier to swallow. Chewing food also helps to increase the surface area for enzymes to act on the food during chemical digestion.
- The stomach and intestine muscles also mix the food mechanically by contracting and relaxing, this movement is called peristalsis.

CHEMICAL DIGESTION

- This is the breakdown of insoluble food molecules into soluble molecules by the action of enzymes.
- An enzyme is defined as a biological catalyst which speeds up a chemical reaction.

- The process begins in the mouth; saliva contains the enzyme amylase which digests starch.
- The stomach and small intestines also contain enzymes which help to catalyse the breaking down of large insoluble food molecules into smaller soluble molecules that can dissolve in water and pass into the blood stream.

THE FUNCTION OF ENZYMES IN DIGESTION

- Starch, proteins and lipids are broken down by enzymes during chemical digestion.
- We defined enzymes as biological catalysts that speed up the digestive process within the alimentary canal.
- When it comes to digestion, enzymes are extremely efficient as they tend to work only on specific nutrients.
- Enzymes that act on:
    - Proteins are called proteases
    - Carbohydrates are called carbohydrases
    - Lipids (fats) are called lipases

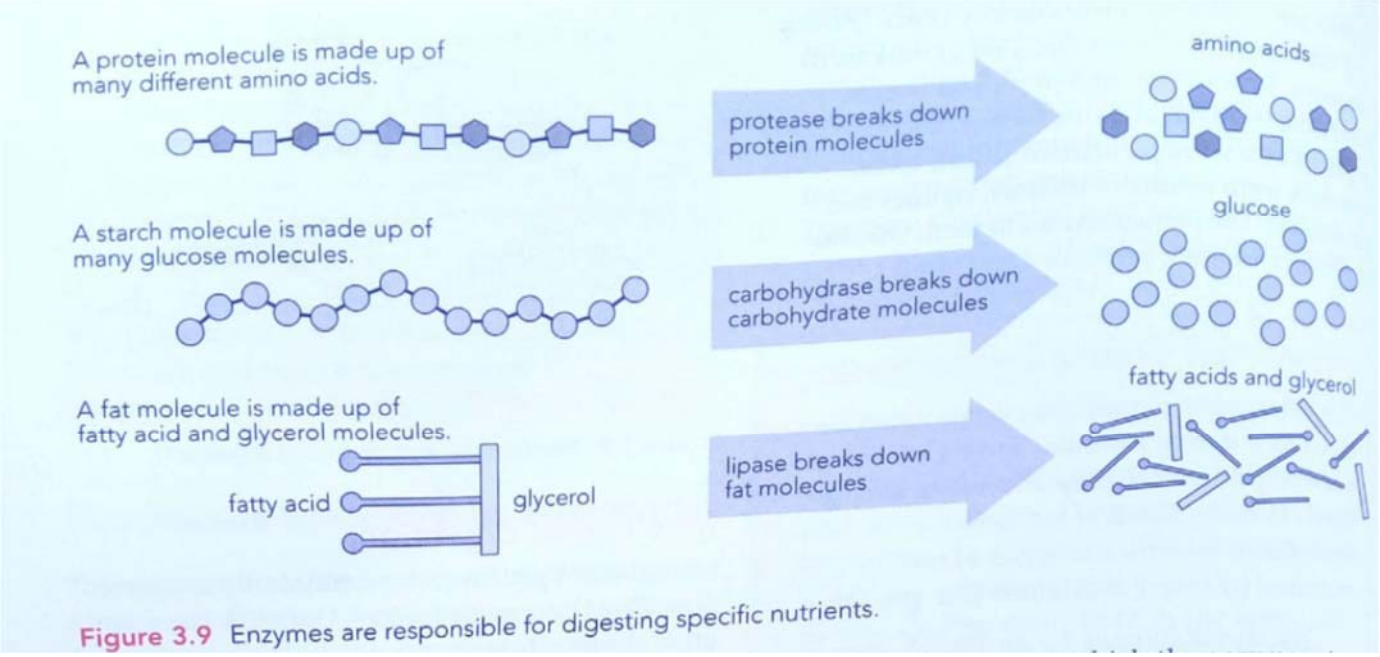
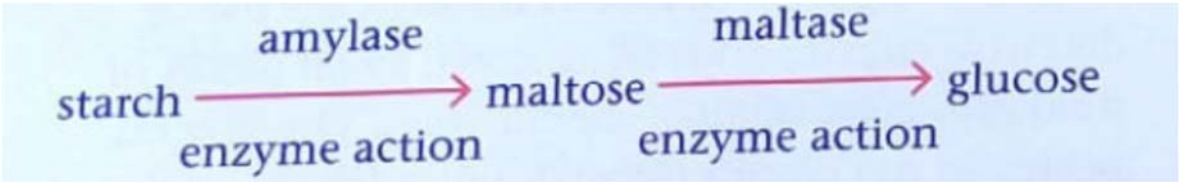


Figure 3.9 Enzymes are responsible for digesting specific nutrients.

- Each of these major groups of enzymes includes specific enzymes acting on specific substances for example amylase is a carbohydrase that acts on starch breaking it down into maltose, maltose is then broken down by the enzyme maltase to form glucose.



- The substance being acted on by the enzyme is called the substrate and the substance resulting from the reaction is called the product.
- Usually enzymes are named by replacing the name of the substrate on which it acts on with (-ase). For example, maltose becomes maltase

EXPERIMENT: INVESTIGATING THE ACTION OF THE ENZYME AMYLASE ON FOOD

Materials: 1% amylase enzyme, 2% starch solution, egg membrane or visking tubing and reagents for the starch and sugar tests.

1. Prepare two bags using the visking tubing or the egg membrane.
2. In each bag add 2% starch solution, label the bags A and B.
3. In bag A add 1% amylase enzyme.
4. Place the bags in two separate containers half-filled with distilled water.
5. Leave them set up like that for a few hours.
6. Test the contents of each bag for starch and simple sugars and also test the water from each container for both starch and simple sugars.

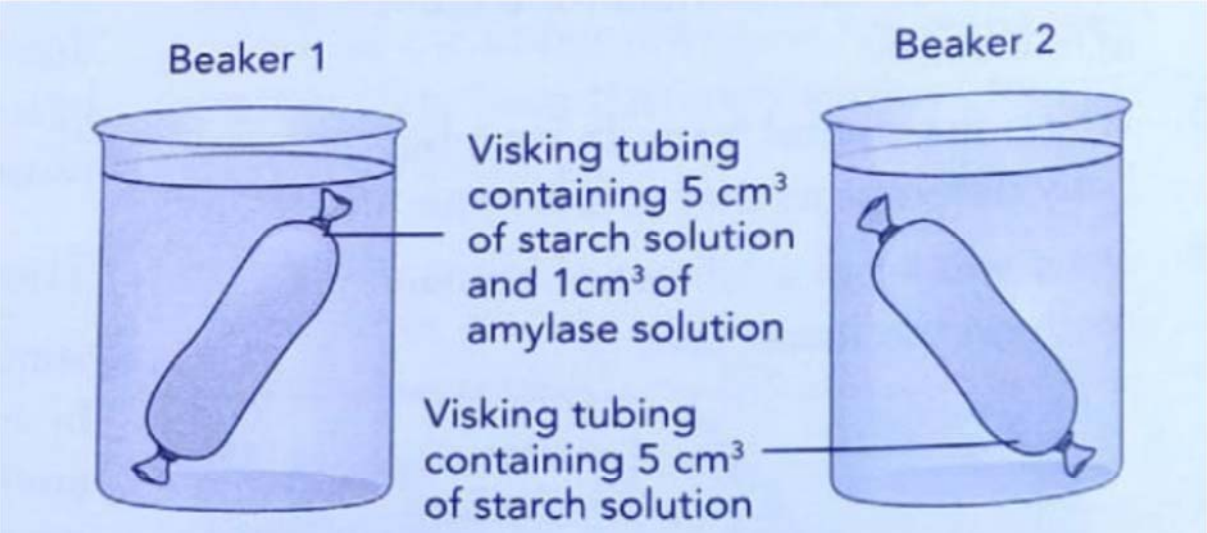


Figure 3.10 Investigating the action of amylase on starch

Results and explanation of the experiment

- This is a controlled experiment, so we begin by identifying the control experiment and the actual experiment. In this case bag B, the one without amylase is the control experiment and bag A is the actual experiment.
- At the end of the experiment the contents of bag A tested negative for starch, this is because amylase is an enzyme that digests starch, by the time the experiment ended all the starch in bag A had been digested.
- Contents of bag A tested positive for simple sugars (glucose) the end product of starch digestion by enzymes.
- The water in container A also tested positive for simple sugars and negative for starch.
- Contents of bag B tested positive for starch and negative for simple sugars.
- The water in container B tested negative for both starch and simple sugars.

END PRODUCTS OF DIGESTION

Food group	End products
Carbohydrate	Glucose
Protein	Amino acids
Fats	Fatty acids and glycerol

- Carbohydrates are digested by enzymes into simple sugars like glucose, fructose and galactose. These are mainly used during the process of respiration.
- All proteins are broken down into amino acids for use when it comes to growth, repair and replacement of cells also making enzymes and hormones.
- Fats are broken down into fatty acids and glycerol which is used to form cell membranes, fuel for cell reactions and also as a protective cover around organs in the body.

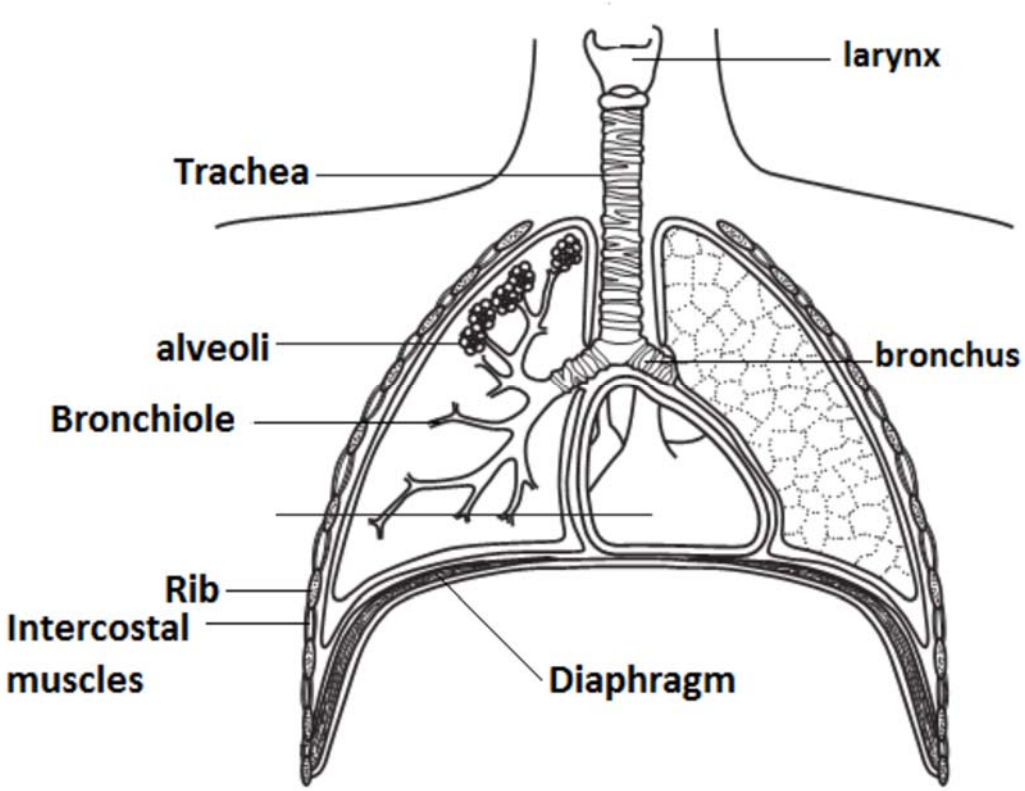
IMPORTANCE OF DIGESTION

- This is the way in which humans receive nourishment to keep our bodies healthy.
- Eating a balanced diet means that nutrients are efficiently digested by the digestive system.
- Nutrients are absorbed in the small intestines, passing into the blood stream.
- All the blood carrying these absorbed nutrients goes to the liver via the hepatic portal vein.
- In the liver any excess food is stored in the form of glycogen.
- From the liver the nutrient rich blood goes to the heart where it is pumped to the rest of the body.
- When you do not eat properly you get problems like bloating, gas, constipation, diarrhoea or a cramping tummy.

TOPIC 5: RESPIRATORY SYSTEMS

INTRODUCTION

- Mammals require oxygen like all living organisms in order for them to live.
- Oxygen is taken in and transported to all cells within the body for the process of respiration.
- Carbon dioxide is released during the process of respiration and it needs to be expelled from the body.
- The respiratory system ensures that oxygen is taken in and carbon dioxide is breathed out of the body.
- The respiratory system is made up of a pair of lungs and other organs which are found within the chest cavity, this is the system that allows us to breathe in oxygen and breathe out carbon dioxide.



The path taken by an air particle:

Nostrils → nasal passage → larynx → bronchus → bronchiole → alveolus

INHALING AND EXHALING

- To inhale is to breathe in.
- To exhale is to breathe out.
- When we inhale/breathe in, the intercostal muscles contract, this lifts up the rib cage increasing the volume of the chest cavity.
- As volume inside the chest cavity increases, pressure decreases inside the chest cavity, outside pressure or atmospheric pressure then forces air into the lungs.
- When we exhale those same intercostal muscles relax decreasing the volume in the chest cavity at the same time increasing the pressure inside the chest cavity this results in air being forced out of the lungs.
- This is what happens when human beings breathe in and out.

INHALED AIR VS EXHALED AIR

- When it comes to the human respiratory system, breathing in allows us to take in oxygen and expel or push out carbon dioxide.
- It is important to understand that the air that we breathe in is made up of a number of different gases.
- The composition of the air changes once it reaches the alveolus and gaseous exchange takes place.
- What happens is simple, air passes into the nose or the mouth when we breathe in, this air then travels via the trachea, enters the bronchi and then it enters the lungs through the bronchioles.
- We know that at the end of each bronchiole we find an air sac or alveolus. Once in the alveolus carbon dioxide which has been produced by cellular respiration diffuses out of the blood stream and

oxygen is taken into the blood stream, this is the process that we refer to as gaseous exchange and it changes the composition of air inside the lungs.

- In comparison the air we inhale contains more oxygen than the air we exhale, the table below shows the composition of inhaled and exhaled air.

Gas	Inhaled air (%)	Exhaled air (%)
Oxygen	21	16
Carbon dioxide	0.03	4.1
Nitrogen	78	78
Water **vapour**	a small percentage (although variable)	a larger percentage

EXPERIMENT: TO COMPARE THE COMPOSITION OF INHALED AND EXHALED AIR.

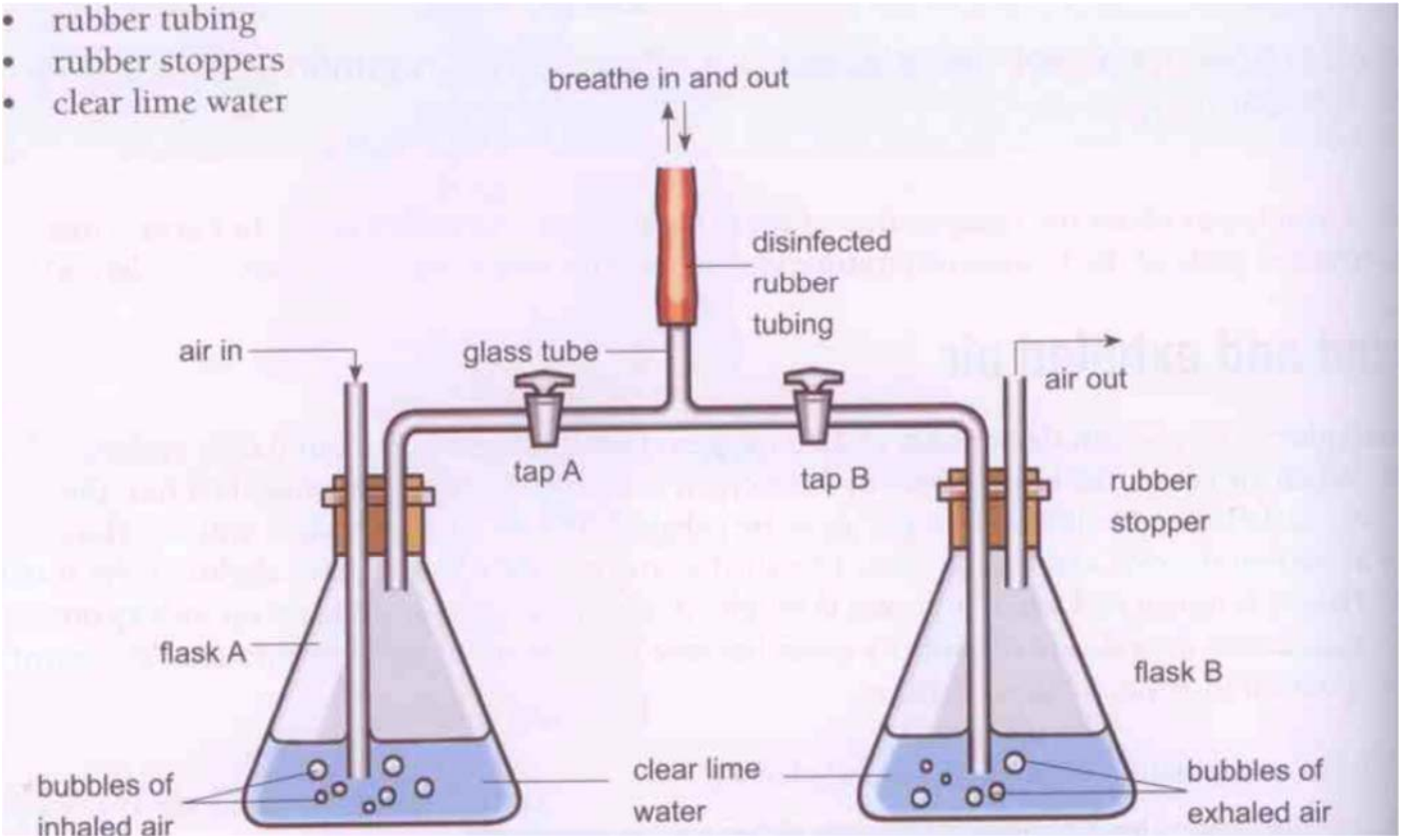
MATERIALS: carbon dioxide indicator either lime water or bicarbonate indicator, glassware and apparatus as shown below.

RESULTS

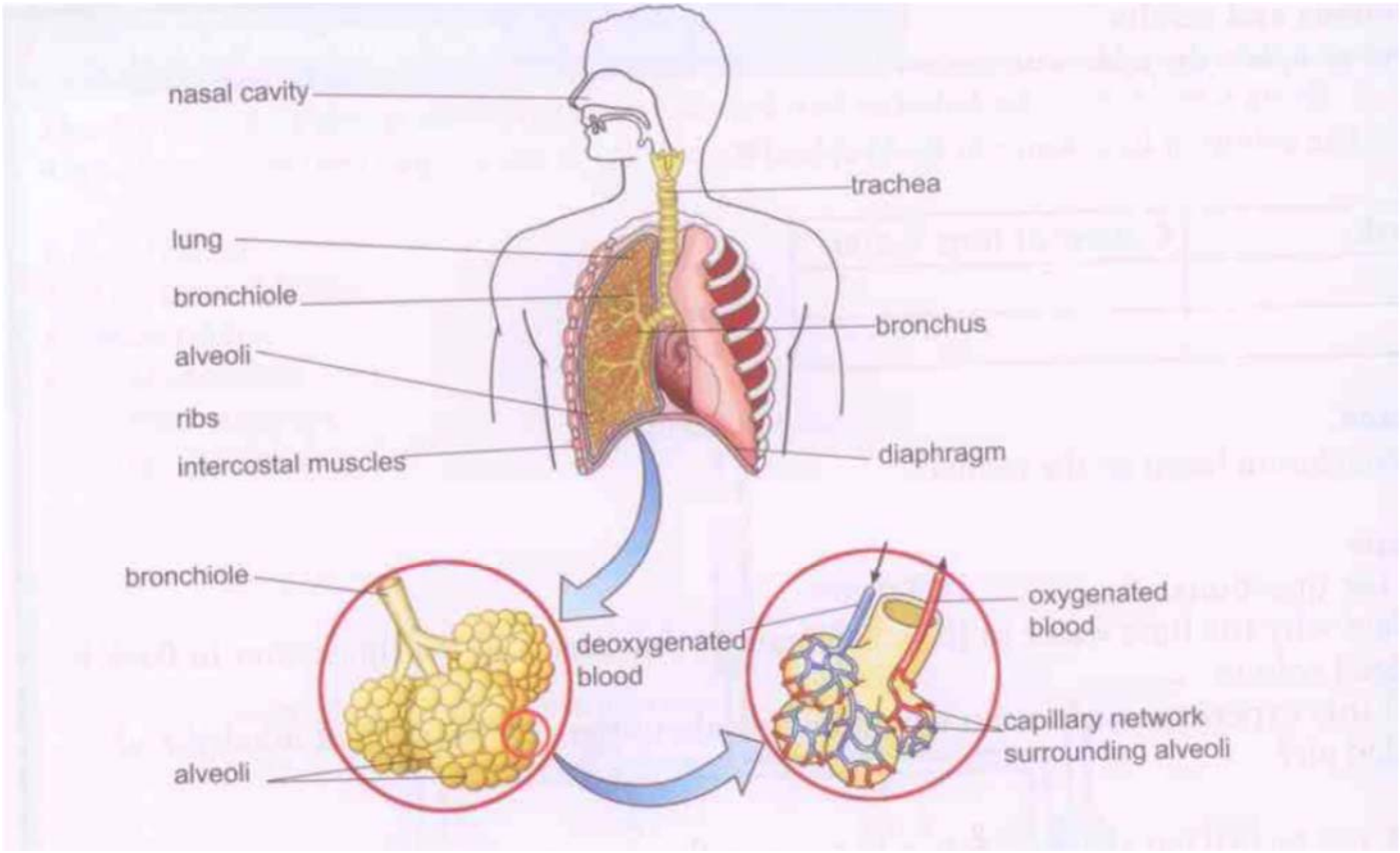
- Lime water in flask B turns milky.
- Lime water in flask A does not turn milky white

CONCLUSION/EXPLANATION

- the lime water in flask A did not turn milky because it is basically inhaled air, therefore it contains less carbon dioxide.
- The lime water in flask B turned milky because it was exposed to a higher concentration of carbon dioxide.
- Therefore, we can conclude that inhaled air contains less carbon dioxide than exhaled air.



THE ROLE OF THE ALVEOLI IN GASEOUS EXCHANGE



- So far we know that air from the atmosphere enters via the nose and/or the mouth, it then moves through the trachea and enters the lungs.
- The trachea divides into two main branches called bronchi (bronchus).

- The bronchi further subdivide into smaller bronchioles (bronchiole) at the end of each bronchiole that is where we find the air sac also called the alveoli (alveolus).
- The structure of the alveoli is adapted to the process of gaseous exchange, each lung has, millions of tiny microscopic alveoli these help increase the surface area for gaseous exchange in the lungs.
- The large surface area allows oxygen to move into the blood and carbon dioxide to be removed from the blood.
- The walls of the alveoli are one cell thick, this means that gases can diffuse in and out of the alveoli easily.
- The inside of the alveolus is kept moist so that it remains open allowing oxygen to dissolve allowing faster diffusion.
- Around each alveolus there is a network of blood capillaries these allow for the effective transport of respiratory gases to and from the lungs.

GASEOUS EXCHANGE IN THE ALVEOLUS

- Gaseous exchange is a term used to refer to the exchange of gases through a membrane.
- Air entering the alveolus has a higher concentration of oxygen than the air in the blood capillaries, so oxygen diffuses from the alveolus into the blood (high concentration to low concentration).
- From there the oxygen is then transported by the blood to all cells around the body to be used during the process of respiration.
- Carbon dioxide produced during the process of respiration is transported to the lungs, the blood surrounding the alveolus has a higher concentration of carbon dioxide than the alveolus itself, so carbon dioxide diffuses from the blood into the alveolus.
- After that it is exhaled.

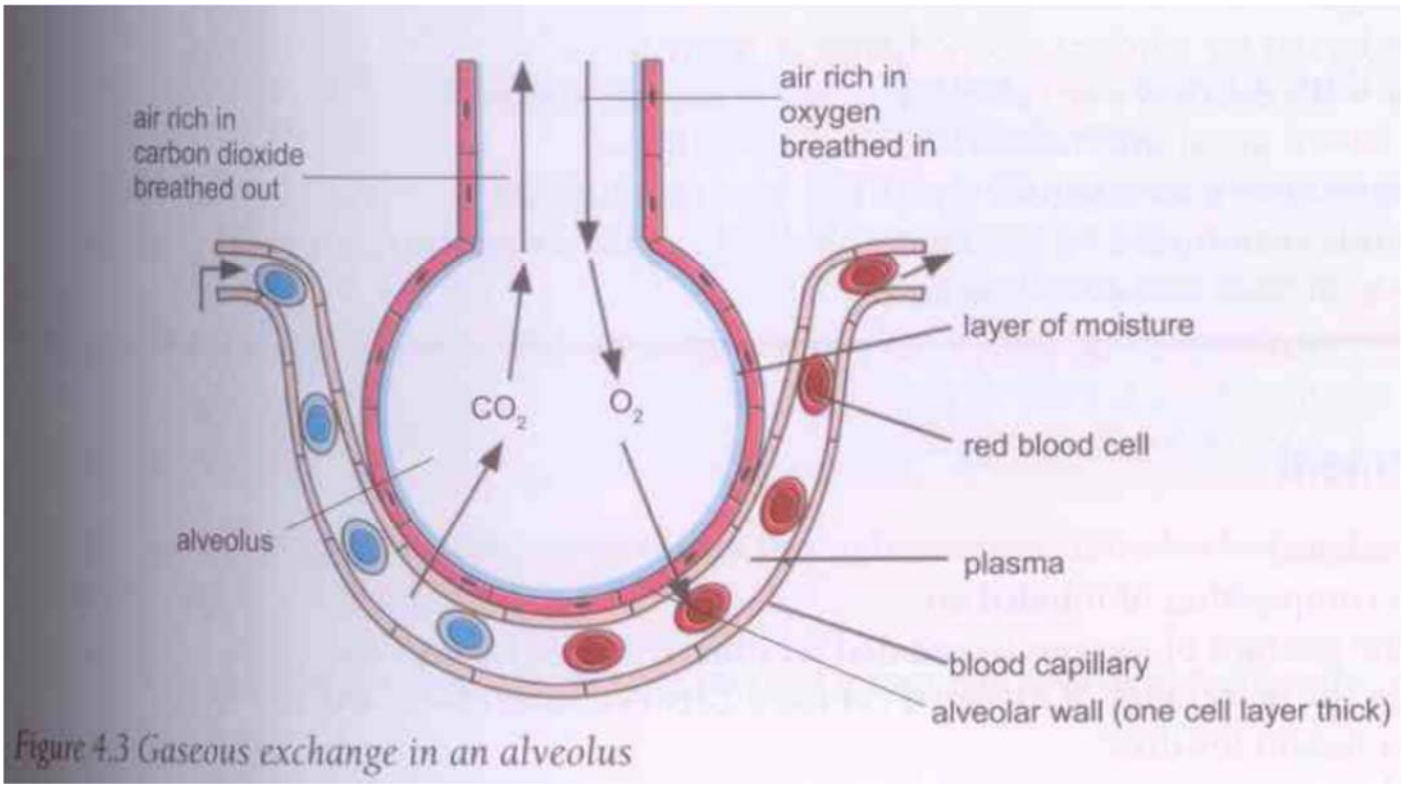
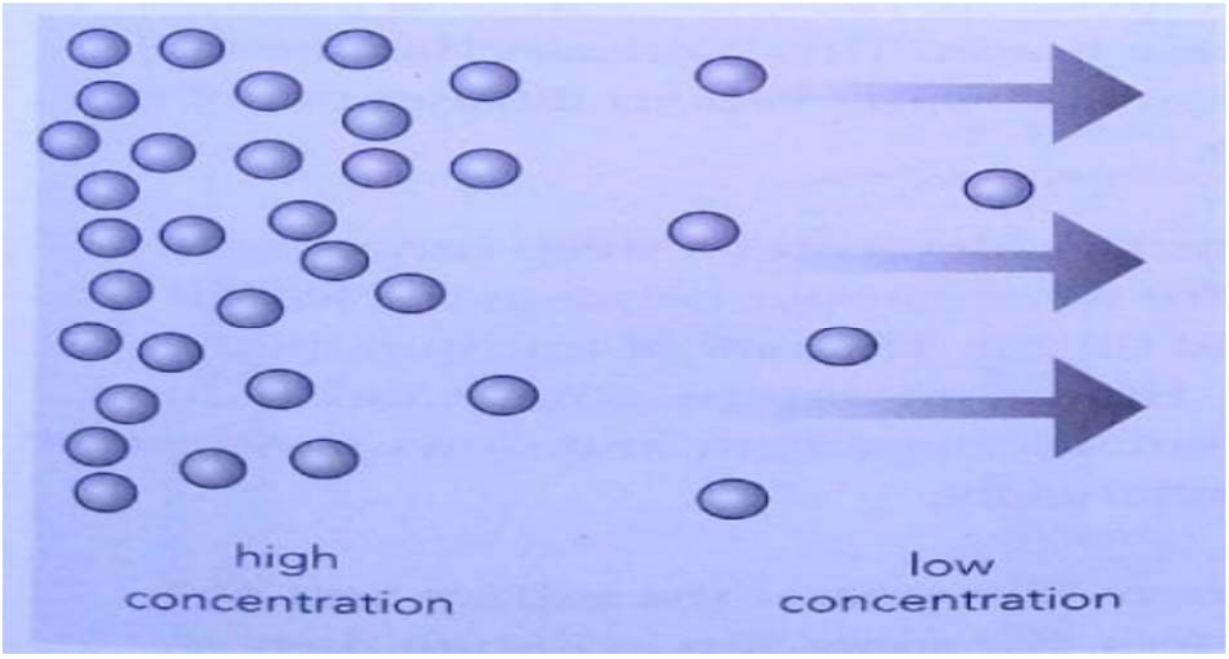


Figure 4.3 Gaseous exchange in an alveolus

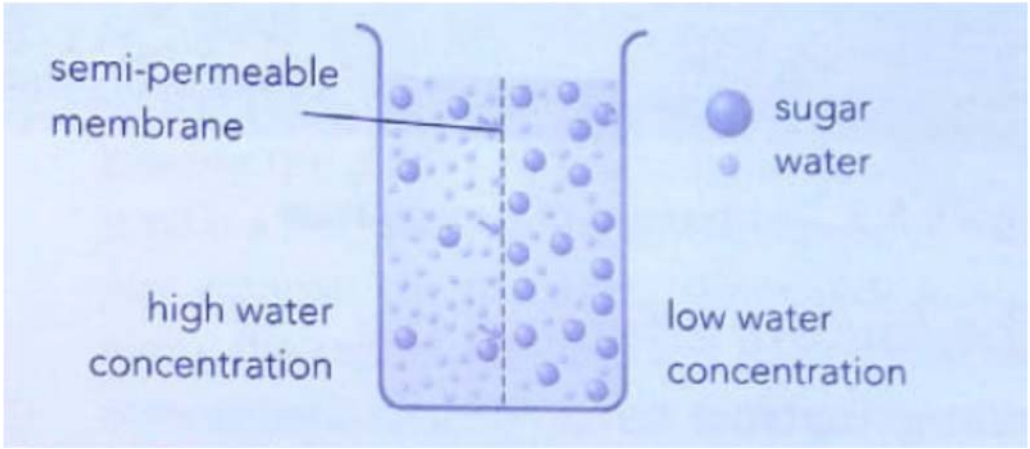
TOPIC 6: TRANSPORT SYSTEMS IN PLANTS

INTRODUCTION

- When it comes to plants, substances like food and mineral salts, move in solution. What this means is that for them to move from one part of the plant to another they have to be dissolved in water.
- The movement of water and these other substances in plants happens in two ways:
  - ❖ Diffusion
  - ❖ Osmosis
- Diffusion is the movement of molecules from a region of high concentration to a region of low concentration as shown by the diagram below.



- Osmosis occurs when water molecules move from a region of high concentration to a region of low concentration across a semi-permeable membrane.
- Please note that osmosis refers to the movement of water molecules only and not dissolved substances.

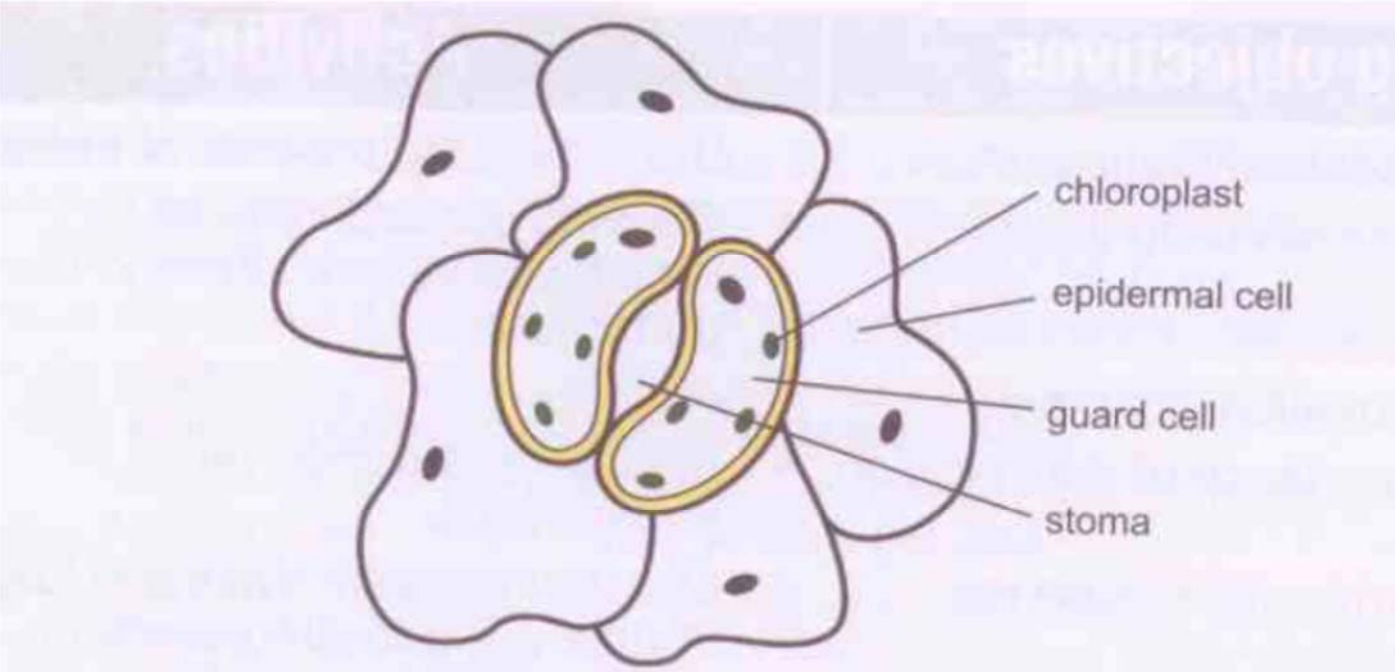


- The differences in the concentration of a substance over distance is called the concentration gradient of that substance.
- For example, there is a concentration gradient for water between the soil and the leaves of a plant.

- This concentration gradient creates a situation for water to move from the roots to the leaves.

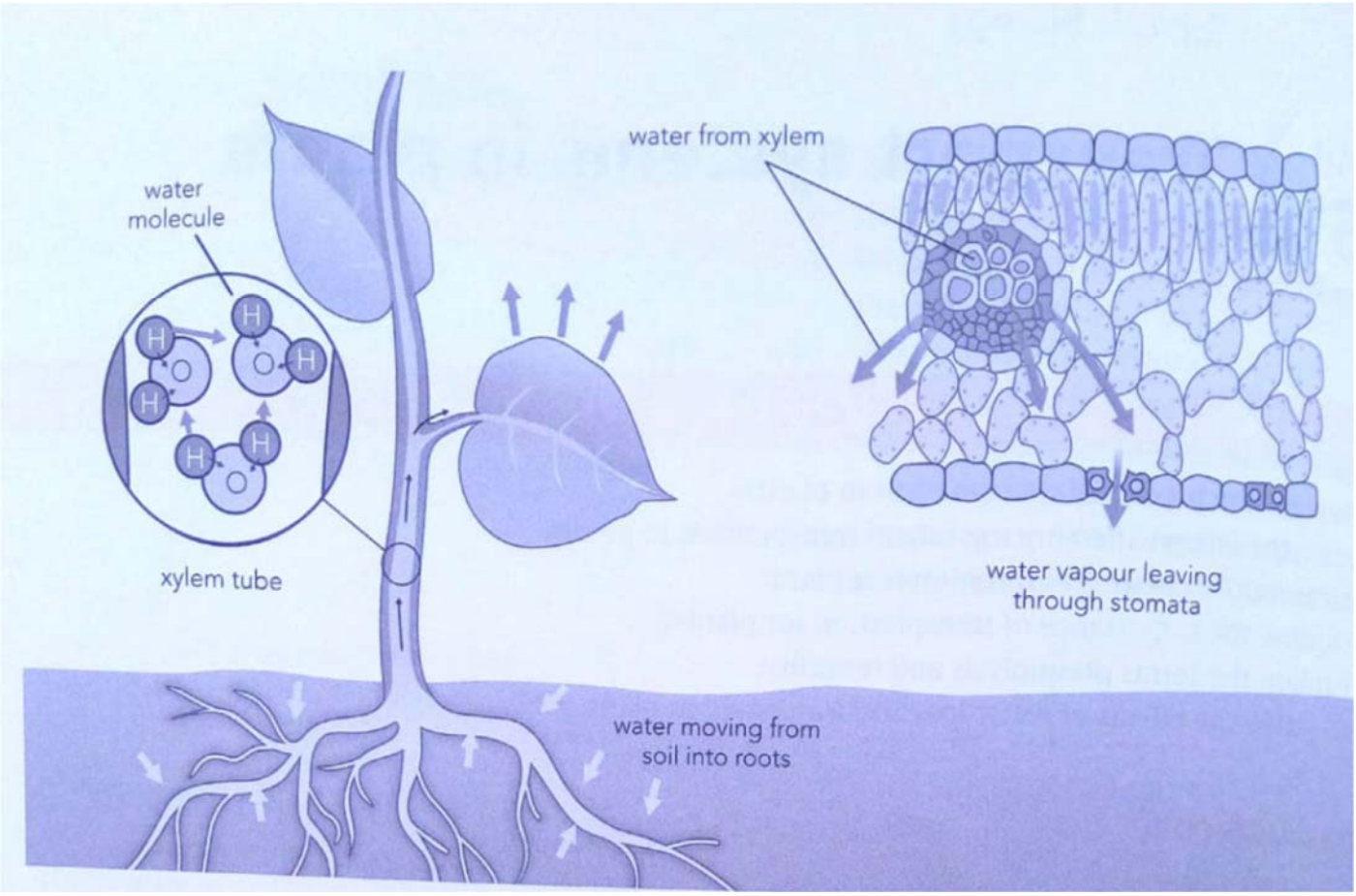
TRANSPIRATION

- This is the loss of water vapour from the surface of the leaf by evaporation.
- The more transpiration occurs the more water is taken up by the roots.
- Water vapour leaves the leaf via the stomata, these are openings on the bottom surface of the leaf.
- Stomata are surrounded by guard cells, these open and close the stomata.

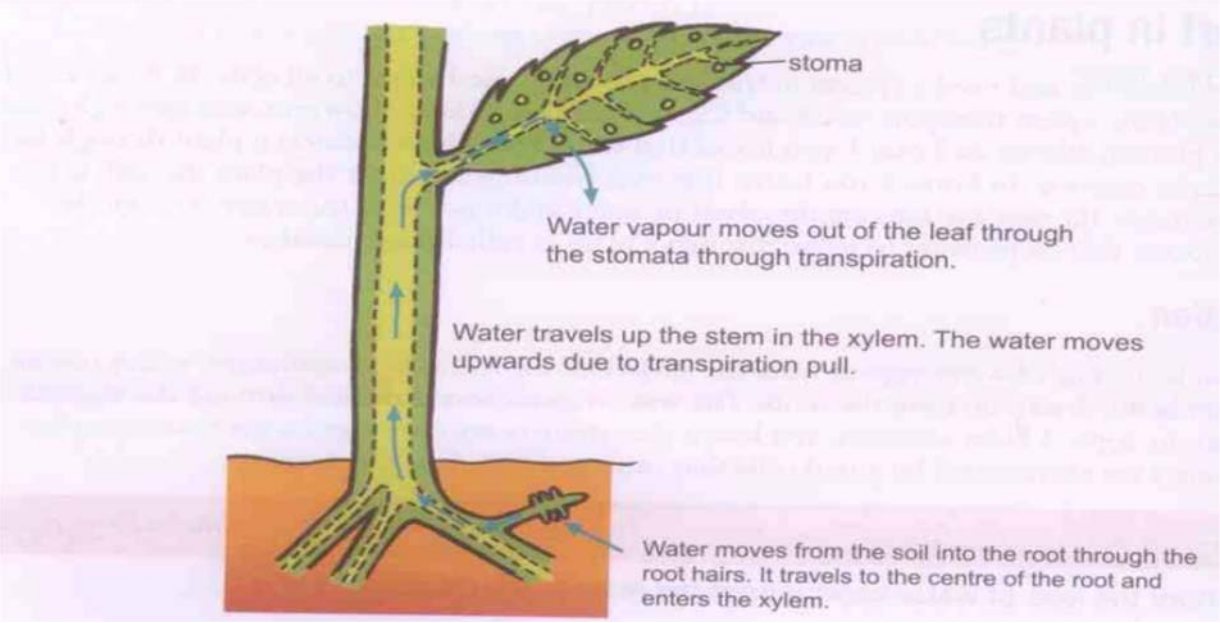


A stoma in the lower epidermis of a leaf

HOW DOES TRANSPIRATION OCCUR?



- Water enters the roots from the ground, it is then transported via a tube known as the xylem, to all leaves.
- The water moves from the xylem (located in the veins) into the cells of the leaf via osmosis.
- When the water reaches the air spaces of the spongy mesophyll layer in the leaf it evaporates from the cells into the air spaces as water vapour.
- The water vapour diffuses out of the leaf through the stomata.
- We say it diffuses because there is a high concentration of water vapour molecules inside the leaf than outside in the atmosphere.
- As water exits because of transpiration, it has a pulling effect on the water left in the xylem and the cells of the leaf, this effect is called transpiration pull and it plays an important role in the movement of water in a plant from the roots to the leaves.



- Transpiration pull is not the only factor responsible for the upward movement of water in plants, there is also root pressure.
- Water enters the roots through osmosis, the xylem vessels fill up and this puts more pressure on the rigid outer cells of the root, water is forced up as a result of this pressure.

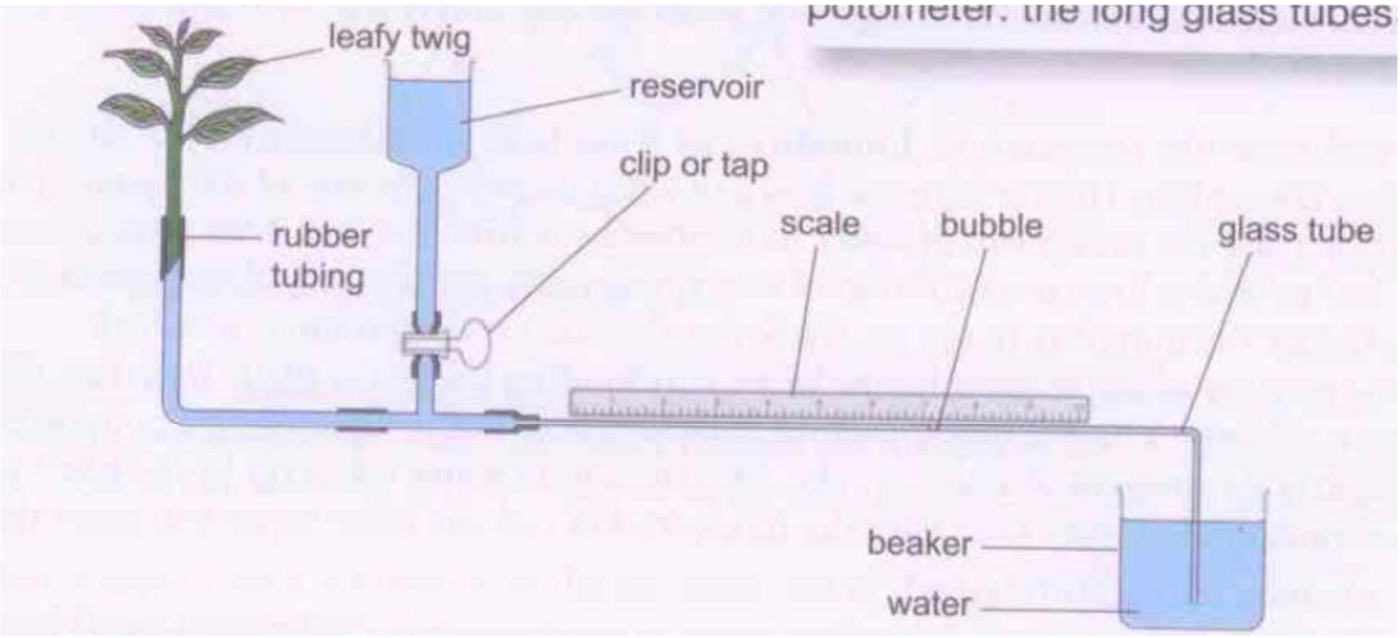
FACTORS AFFECTING THE RATE OF TRANSPIRATION

- We understand that transpiration pulls water up into the plant, sometimes this pulling force is stronger meaning the plant will end up losing more water by transpiration than it is taking in through the roots.
- The speed at which the plant loses water by transpiration is called the rate of transpiration.
- Rate of transpiration varies depending on the structure of the plant and the environment in which it resides.
- Understand this, any factor that influences evaporation and the movement of water vapour can also influence the rate of transpiration.
- Here are some internal and external factors that can affect the speed at which plants lose water by evaporation from the surface of the leaf (transpiration):
    - ❖ Wind: the leaf is surrounded by a thin layer of still air, the water vapour that exits the stomata diffuses through this layer of unmoving air and then it is carried away by the wind/moving air. The wind can change the rate of transpiration by removing this layer of unmoving water vapour, this increases the concentration gradient between the leaf spaces and the air causing transpiration rate to increase.
    - ❖ Temperature: when temperature rises the leaves of plants become hotter this increases the rate of evaporation causing water vapour to diffuse out of the leaf much faster.
    - ❖ Humidity: dry air causes a steep concentration gradient between the cells of the leaf and the outside air because of this steep concentration gradient, rate of transpiration increases. Humid air decreases this concentration gradient and also reduces the rate of transpiration.
    - ❖ Surface Area: the greater the surface area of the leaves the more exposure to sunlight they get, if leaves are exposed to more sunlight more water moves within the leaves leading to more water being lost by transpiration. The smaller the leaf surface the less water the plant loses by transpiration.
    - ❖ Light Intensity: in bright light the stomata open and allow more transpiration to take place. This means that more transpiration takes place during the day than at night when the stomata are almost closed.

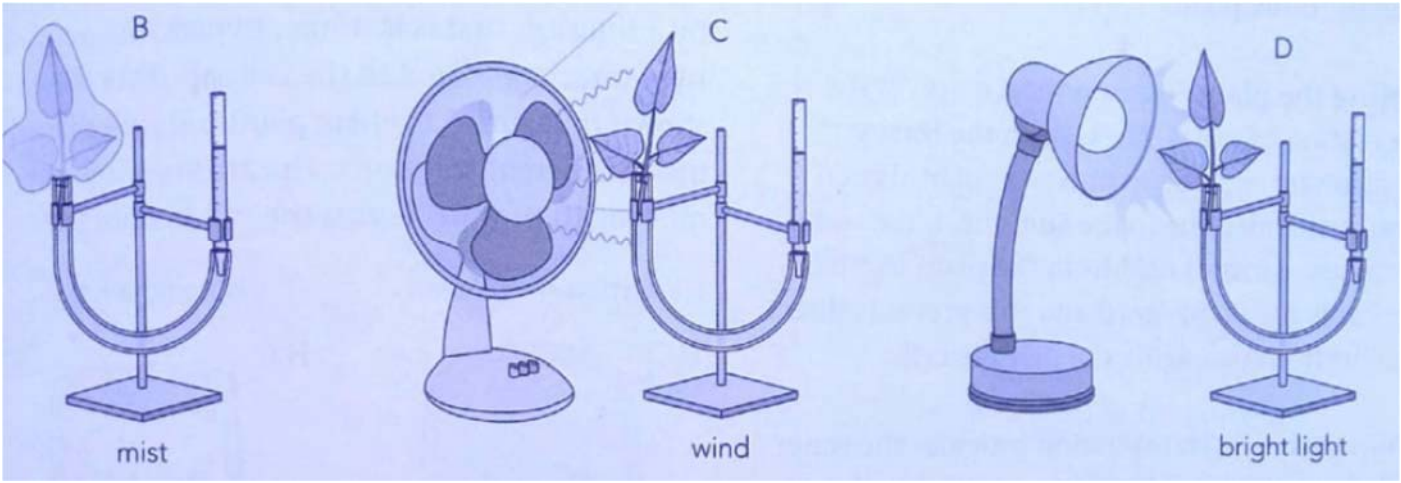
- ❖ Stomata distribution: some plants have more stomata than others, the more the stomata the more the plant loses water by transpiration. More stomata are found on the underside of the leaf away from the sunlight and the wind, these will lose less water through transpiration.

- All these factors combine to influence how much water is lost through transpiration, excessive transpiration leads to a shortage of water in a plant, this in turn leads to wilting and then the death of the plant itself will eventually take place if it continues to lose water through transpiration.

MEASURING THE RATE OF TRANSPIRATION



- A potometer is a device used to measure the rate at which a leafy shoot draws in water.
- Since the shoot draws in water as it loses it through transpiration, the device also allows us to measure the rate of transpiration.
- There are different types of photometers but they all have more or less the same features
  1. A capillary tube- a bubble is introduced into the capillary tube at the start of the experiment, as water is taken up by the plant, the bubble moves along the capillary tube. The distance the bubble travels over time is determined by the rate of transpiration.
  2. A reservoir- by turning the tap on the reservoir we can set the position of the bubble at the beginning of the experiment, some designs use a syringe instead of a funnel with a tap.
  3. A tube for holding the leafy shoot- in the above diagram the leafy twig is held in place by placing a rubber stopper in the tube, the rubber stopper has a hole in it and that is where we place the leafy twig. The hole in the stopper through which the leafy twig passes must be kept airtight by covering it with petroleum jelly.
- As the leaves transpire, the plant will be using water from the potometer this causes the air bubble inside the capillary tube to move showing the amount of water the plant uses.
- As a result, the water level in the beaker drops.
- For us to investigate the factors affecting the rate of transpiration we set up the potometer under different atmospheric conditions for example placing the plant in bright light, placing it near a fan or placing it in humid conditions.
- The speed at which the bubble moves along the capillary tube will indicate the rate of transpiration.

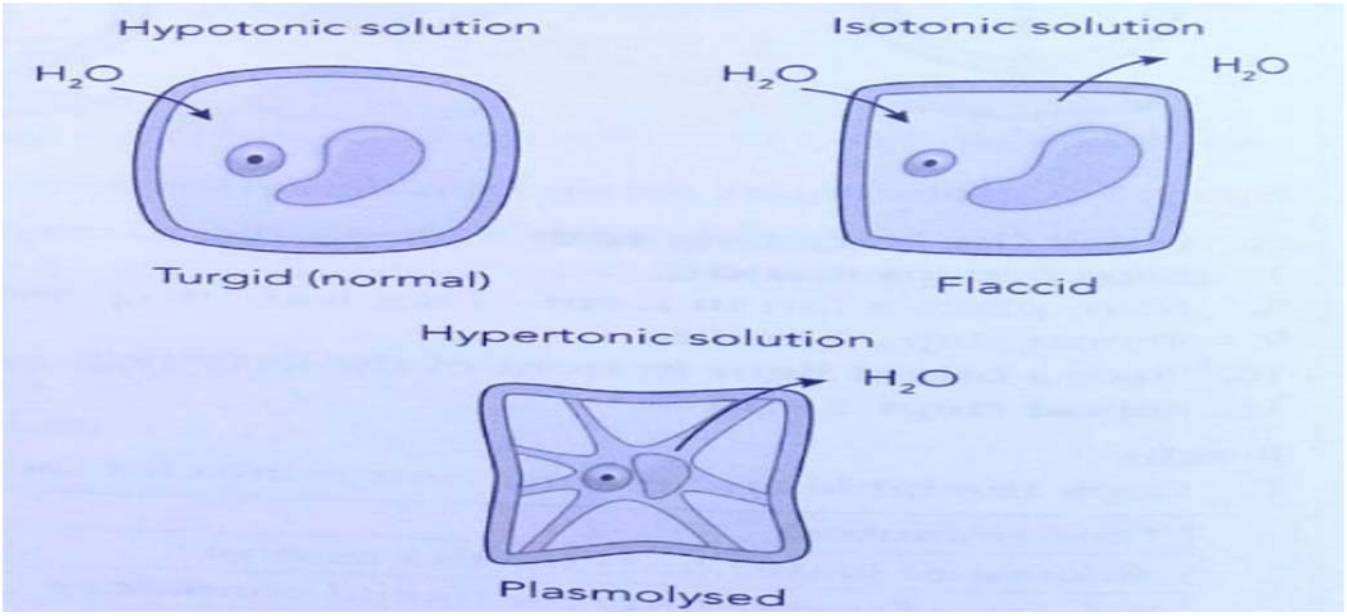


IMPORTANCE OF TRANSPIRATION

- Transpiration is an important process in plants, it is important because it helps with the following:
  1. Movement of water and minerals: transpiration allows an upward flow of water from the roots to the leaves via the xylem. It creates a situation whereby the plant is forced to take in more water from the soil, as it takes in water through the roots the plant also takes in mineral salts in solution. The water then travels throughout the entire plant as a result of transpiration pull.
  2. Cooling the plant: transpiration involves the evaporation of water, when water is lost from the surface of the leaf it also carries with it excess heat from the plant. Therefore, transpiration cools the plant down and ensures that the cells do not get damaged by direct sunlight.
  3. Photosynthesis: transpiration provides the water needed for the process of photosynthesis.

PLASMOLYSIS AND TURGIDITY

- In plants the movement of water from cell to cell occurs as a result of the process osmosis.
- Water moves from a region of high concentration across a semi-permeable membrane to a region of low concentration.
- The solutions in plants re made up water and dissolved substances, these solutions can either be isotonic, hypertonic or hypotonic.
- We compare these solutions according to the amount of dissolved substances in the water.
- A hypotonic solution contains a lower concentration of dissolved substances than another solution.
- An isotonic solution the concentration of dissolved substances is equal to that of the other solution.
- A hypertonic solution contains a higher concentration of dissolved substances than the solution to which it is being compared to.
- In plants the movement of water through osmosis is determined by whether the plant cells are surrounded by a solution that is isotonic, hypotonic or hypertonic compared to the cell sap.
- The diagram below shows plant cells placed in different solutions, the arrows show the movement of water in and out of the cells depending on the type of the solution.



HYPOTONIC SOLUTION

- This is a solution that contains a lower concentration of dissolved substances than the cell sap.
- Water enters the cell and the vacuole through osmosis, there it mixes with the cell sap.
- The water entering the cell causes it to swell stretching the cell wall slightly.
- Stretched wall exerts an inward pressure on the contents of the cell, this inward pressure is known as wall pressure.
- When the walls of the cell cannot stretch anymore it results in a build up of inner pressure within the cell, this is called turgor pressure.
- The cell is said to be turgid.
- Turgid cells are firm, they help to maintain the shape of the plant, turgidity is important in that it helps the plant cells to keep standing upright.
- Plant cells that lose a lot of water by osmosis have less turgor pressure, we say they are flaccid. After flaccidity any further water loss will lead to wilting of the plant.
- When a plant cell is turgid it becomes swollen because of the high fluid content, this high fluid content increases the mass of the cell.

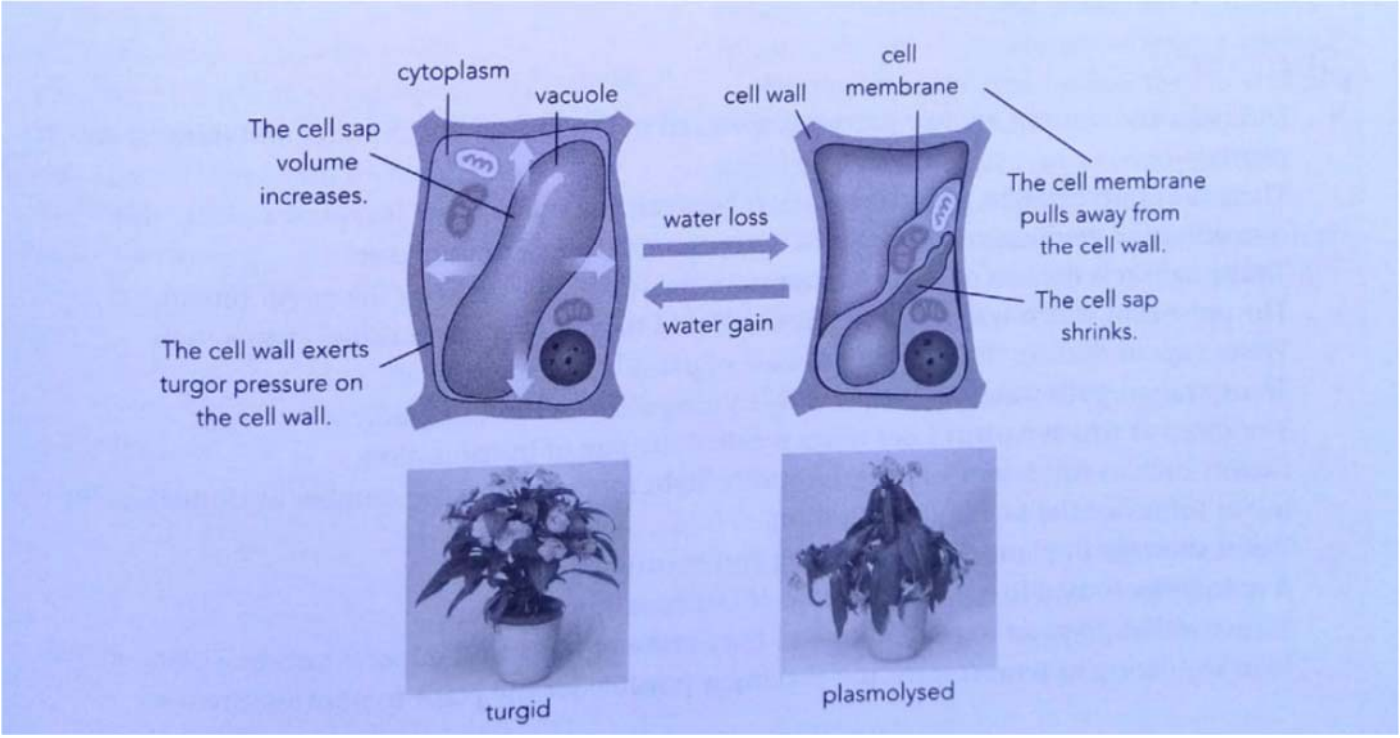
ISOTONIC SOLUTION

- When a solution is isotonic compared to the cell sap inside a cell it means that the concentration of dissolved substances in the solution is the same as the cell sap in the vacuole.
- In such a situation there is an equilibrium, the amount of water molecules leaving the cell is equal to the amount of water molecules entering the cell.

HYPERTONIC SOLUTION

- When a cell is placed in a hypertonic solution the solution is more concentrated than the cell sap in the vacuole.
- As a result, the cell loses water by osmosis.
- As the water flows out of the cell, the cytoplasm and the vacuole contract.
- If cells in a plant lose too much water, they shrink and become flaccid.
- The plant will have less support, the stem no longer remains upright and the leaves wilt.
- If the outward flow of water continues the cell membrane pulls away from the cell wall, this is known as plasmolysis.
- As water is lost through osmosis the vacuole also collapses.

- The contents of the cell shrink reducing the cell size and mass, we say the cell is now plasmolysed.



TOPIC 7: TRANSPORT SYSTEMS IN HUMANS

INTRODUCTION

- The human body is made up of millions and millions of cells, these cells require nourishment and oxygen in order to survive.
- Waste substances that are produced by the body need to be taken to the kidneys and the skin to be removed from the body.
- In order to transport all these substances, the human body has a complex transport system, the system is made up of the heart, which acts as the pump or engine that runs the system, it also has blood, which is the transport medium for all the substances, the blood is found in blood vessels.
- The heart ensures that the blood moves quickly and under high pressure to all parts of the body.

FUNCTIONS OF THE BLOOD

1. **TRANSPORT OF VARIOUS SUBSTANCES**-
   - ❖ blood transports important nutrients and substances to and from cells.
   - ❖ It transports nutrients and oxygen to the cells.
   - ❖ It transports waste substances like carbon dioxide to the lungs and urea to the kidneys and the skin for excretion.
   - ❖ Blood transports white blood cells and antibodies to sites of infecton.
   - ❖ It also transports hormones to their target organs.
2. **DEFENCE**
   - ❖ White blood cells prevent the spread of diseases and infections in the body.
   - ❖ They attack foreign particles and pathogens (germs), they engulf bacteria and waste materials and they digest them.
   - ❖ White blood cells have the ability to release antibodies and antitoxins which destroy harmful pathogens.

- ❖ Platelets are another component of blood; they help prevent blood loss by helping the blood to clot quickly.

3. **HOMEOSTASIS**
   - ❖ The body is exposed to many different internal and external changes in the environment.
   - ❖ For the human body to function efficiently it has to operate within a set of acceptable conditions, this means that if the external environment changes the body has to make certain adjustments to keep its internal environment stable.
   - ❖ It needs to maintain the equilibrium; this means it needs to maintain homeostasis.
   - ❖ Enzymes that can be found in the blood are sensitive to temperature, they can only work well at 37 degrees, blood plasma maintains this temperature to ensure that processes in the body continue efficiently.
   - ❖ Enzymes are also sensitive to pH- blood has a pH value of 7.4, levels below or above this figure will affect the activities of enzymes and overall cellular metabolism. So the blood controls the level of hydrogen ions in the body to maintain a favourable pH value.
   - ❖ The blood also regulates the levels of water and salts in the body as well.

COMPONENTS OF BLOOD

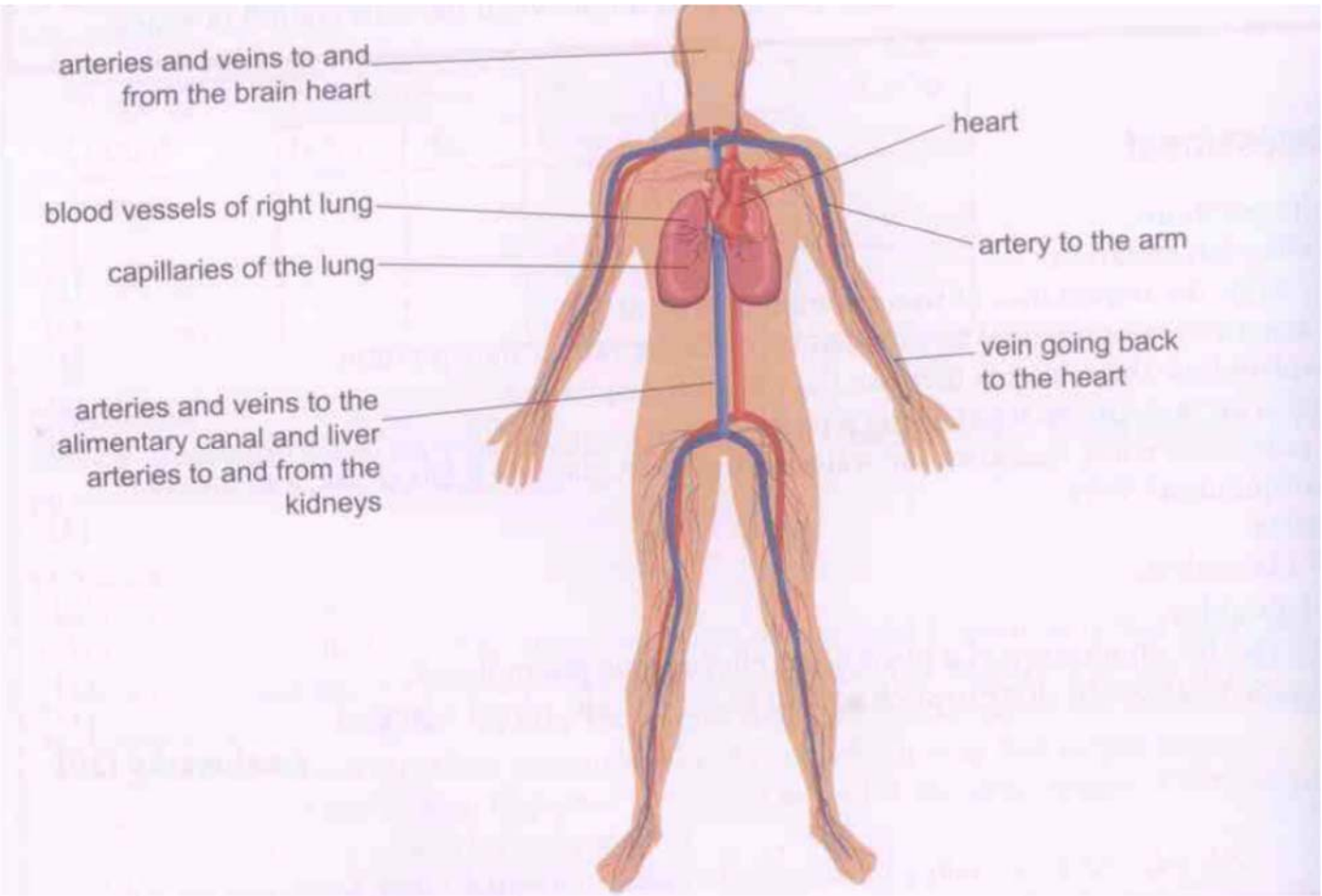
- Blood is made up of the following components:

1. **Plasma-**
   - ❖ this is a pale yellow liquid, red blood cells, platelets and white blood cells float in this liquid.
   - ❖ The function of plasma is to transport nutrients, waste products, blood proteins, dissolved gases and antibodies.
   - ❖ Plasma also distributes body heat it assists in regulating body temperature.
2. **Red Blood Cells-**
   - ❖ these are produced by the red bone marrow found in the ribs, the sternum, vertebrae and the skull.
   - ❖ Red blood cells are small biconcave disks that have no nucleus in them.
   - ❖ Their biconcave shape provides a large surface area for the absorption of oxygen, they are flexible and they can squeeze and bend when they travel in small capillaries.
   - ❖ Red blood cells contain a pigment known as haemoglobin, it combines with oxygen to form oxyheamoglobin, this substance is taken to all cells of the body.
   - ❖ Red blood cells have a lifespan of about 120 days, they are broken down in the spleen and the liver.
   - ❖ There are about 5 million red blood cells per cubic mm of blood, they also help to transport carbon dioxide from the cells to the lungs.
3. **White Blood Cells-**
   - ❖ These are much larger in terms of size than the red blood cells.
   - ❖ White blood cells vary in size, they have an irregular shape and a large nucleus.
   - ❖ They are also colourless.
   - ❖ White blood cells have the ability to leave blood vessels so that they can invade infected tissue.
   - ❖ White blood cells are formed in the spleen, tonsils, lymph glands and also in red bone marrow.
   - ❖ There are two types of white blood cells, there are granular and agranular white blood cells.
   - ❖ Granular white blood cells have a nucleus suspended in granular cytoplasm and they display amoeboid movement.
   - ❖ Granular white blood cells protect the body against harmful organisms.

- ❖ Agranular white blood cells have a round or kidney shaped nucleus and a cytoplasm without granules.
- ❖ There are two types of agranular white blood cells, there are lymphocytes and monocytes.
- ❖ Lymphocytes produce antibodies against pathogen toxins whilst monocytes engulf pathogens.

4. **Platelets-**
   - ❖ They are not complete cells; platelets are cytoplasmic fragments that have no nuclei.
   - ❖ They stick together to prevent small leaks in the blood vessel walls and when they come into contact with air they cause the blood to clot.
   - ❖ Platelets produce a substance called histamine which causes blood vessels to narrow thereby reducing the loss of blood.

THE CIRCULATORY SYSTEM

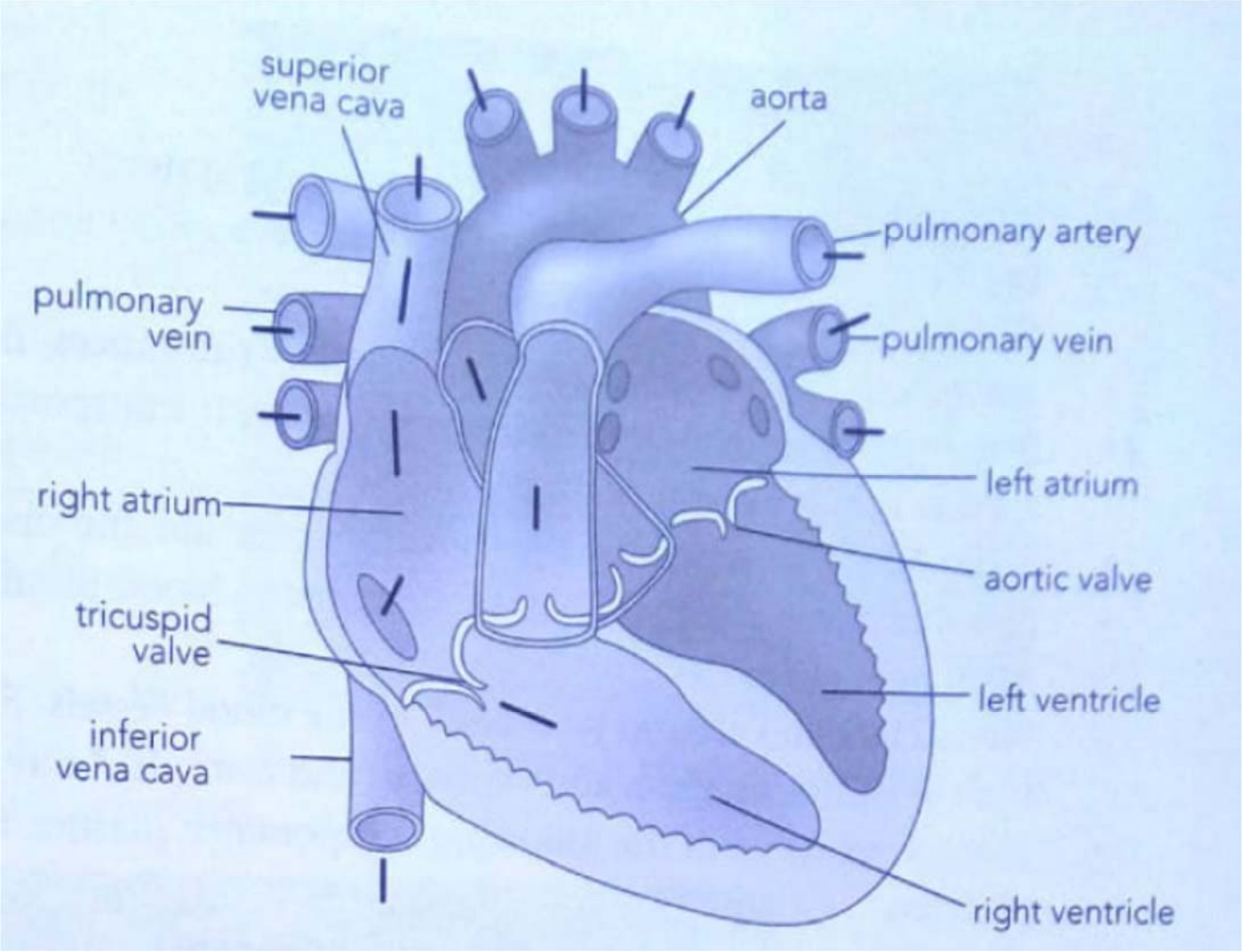


- The main structures of the human circulatory system are the heart, arteries, veins, capillaries and blood.
- The heart pumps blood through all the blood vessels in the human body.
- Basically the circulatory system is responsible for carrying substances to and from the different parts of the body for example the body needs a constant supply of oxygen and food in order to survive and waste products must be removed – blood carries oxygen and food to the cells and also removes waste products like carbon dioxide.

THE HEART

- The heart is a muscular organ which is located inside the chest cavity of a human being slightly tilted to the left.

- It is roughly the size of a human fist and it is protected by the breast bone.
- The muscles of the heart are called cardiac muscles.
- The heart beats continuously in order to pump blood throughout all the blood vessels in the human body.



ARTERIES

- Carry oxygen rich blood away from the heart to all parts of the body.
- Blood is carried under high pressure because of the hearts strong contractions.
- They have thick muscular walls surrounding a small cavity- these can withstand the pressure.
- They do not have valves- this is because blood is under a lot of pressure within the arteries so there is no risk of backflow.

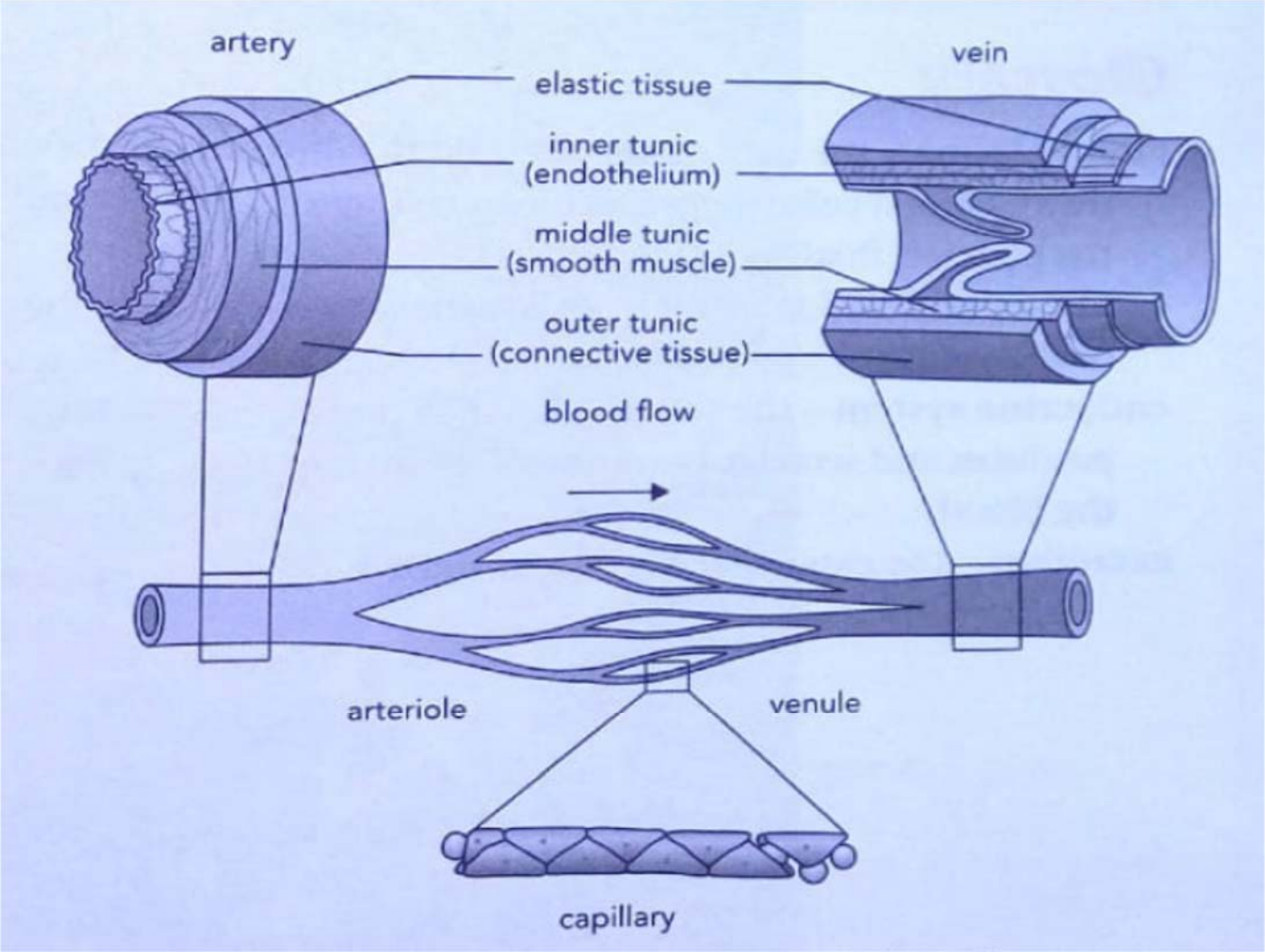
VEINS

- They carry mainly de-oxygenated blood i.e. blood that has a high concentration of carbon dioxide.
- Veins can be found closer to the surface of the body than arteries.
- Veins carry blood under low pressure to the heart, they have thin elastic walls surrounding a large cavity that collapses when they are empty.

- There are valves on the inside of veins to prevent backflow of blood, they force the flow in one direction.

CAPILLARIES

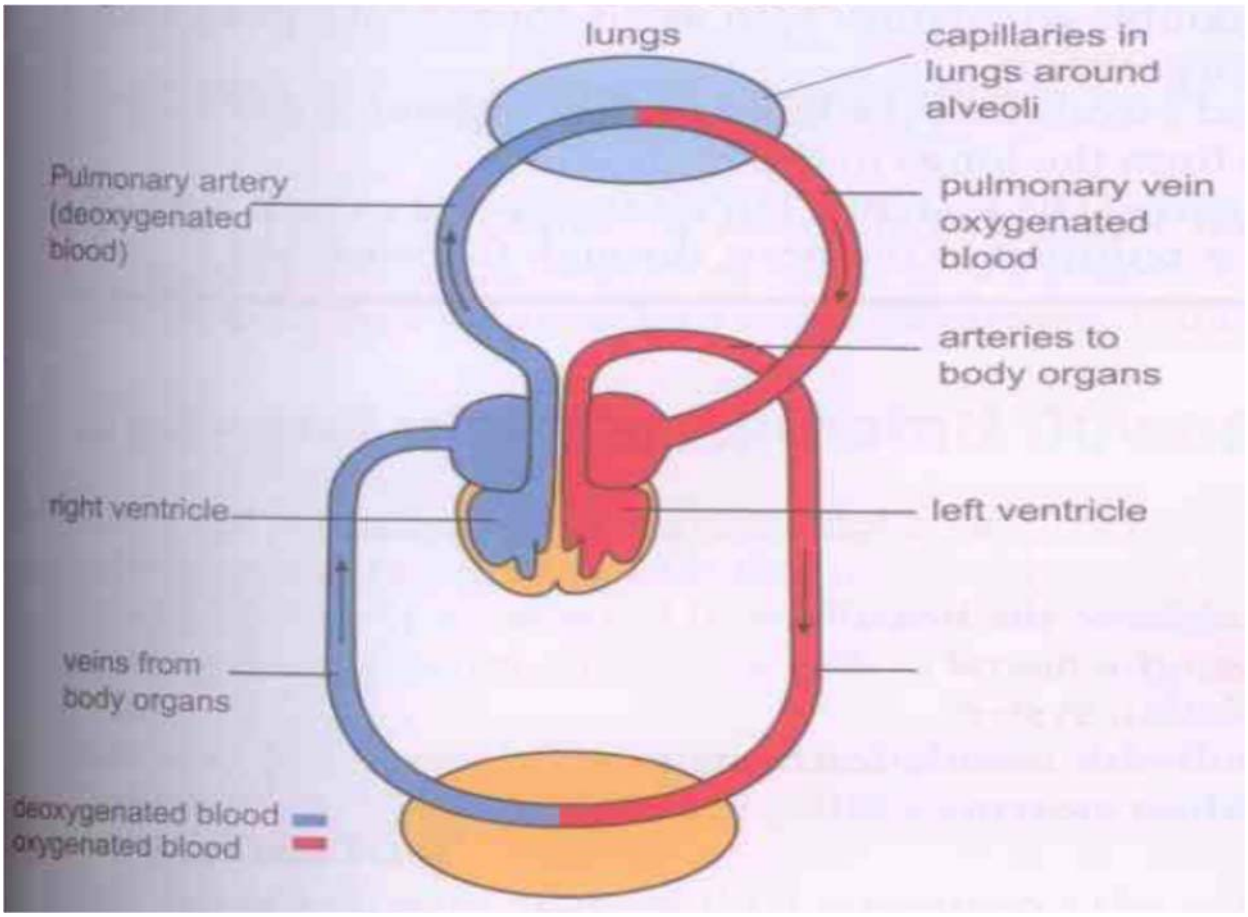
- These are tiny blood vessels that connect arteries to veins, they reach every part of the human body.
- Walls of the capillaries are one cell thick and they allow gases to pass through as well as digested food molecules and also waste substances for transport.



THE DOUBLE CIRCULATORY SYSTEM

- The human circulatory system has many blood vessels, we now understand that arteries carry blood from the heart to the rest of the body and veins carry blood to the heart.
- Humans have what is known as a closed circulatory system- this means that all the blood is contained within the blood vessels.
- For every complete journey around the human body the blood flows through the heart twice, therefore the human circulatory system is referred to as a double circulatory system.
- The circulatory system is made up of a pulmonary circulatory system and a systemic circulatory system.
- The pulmonary circulatory system transports blood from the heart to the lungs and then back to the heart again.

- The systemic circulatory system transports blood from the heart to the rest of the body and then back again to the heart.
- The following diagram illustrates the double circulatory system.



- The pulmonary artery carries blood from the heart to the lungs- this blood is basically de-oxygenated blood it has high concentration of carbon dioxide.
- Once in the lungs the blood releases carbon dioxide and takes in oxygen- the blood is now oxygenated blood.
- The pulmonary vein carries oxygenated blood from the lungs back to the heart, this is the pulmonary circuit.
- Oxygenated blood is then pumped through the systemic circuit to the rest of the body. Blood leaves the heart through the aorta.
- The systemic circuit pumps blood to all cells transporting oxygen for respiration.
- Deoxygenated blood is brought back to the heart via the vena cava.

TOPIC 8: PLANT REPRODUCTION

INTRODUCTION

- Flowers are the reproductive organs when it comes to plants.
- Basically the structure of a flower is made up in such a way that it ensures the processes of pollination and fertilisation occur.

STRUCTURE OF A FLOWER

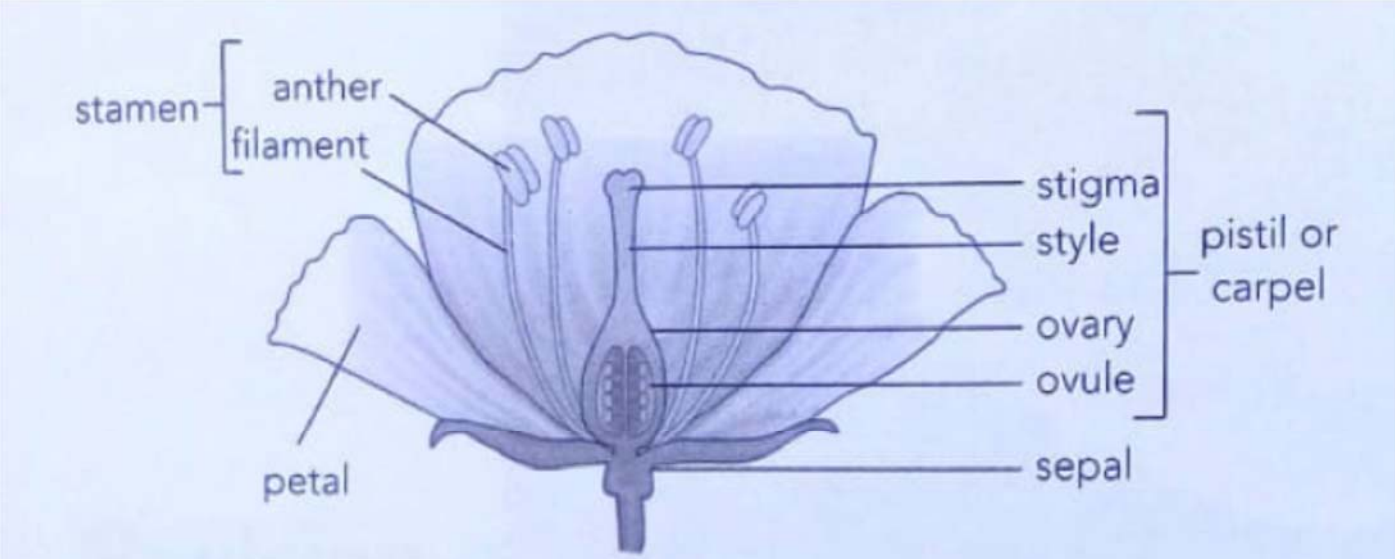


Figure 7.1 The parts of a flower

- Flowers are arranged in 4 whorls which are attached to a wide base known as the receptacle.
- The receptacle can be found at the end of the flower stalk.
- The outer whorl is made up of sepals, these protect the flower bud.
- The petals of a flower are usually colourful in order to attract insect pollinators.
- The 2 inside whorls contain the male and female reproductive organs, these produce the sex cells.
- The male organ is known as the stamen, it is made up of the anther and the filament.
- The function of the anther is to produce sex cells in the form of pollen grains.
- The female sex organ is known as the pistil or carpel, it is made up of the stigma, style and the ovary.
- The ovary produces ovules; each ovule carries one female sex cell.

POLLINATION

- Flowers can only form seeds and fruit after they have been pollinated.
- Pollination can be defined as the transfer of pollen grains from the anther to the receptive stigma of the same species.
- The purpose of pollination is to allow fertilisation to occur.
- Fertilisation is basically the fusion of male and female gametes or sex cells.
- Basically the male gamete is produced by the anther (pollen) and the female gamete is produced in the ovary (ovule).
- Pollen can be transferred from one flower to the next in a number of different ways for example it can be carried by insects or it can be carried by the wind.
- There are two types of pollination, i.e. self-pollination and cross pollination.
- Self-pollination is when pollen grains are transferred to the stigma of the same flower.
- Cross pollination is when the pollen grains are transferred to the stigma of another flower.

- A pollinator is the medium that carries pollen grains from the anther to the stigma, therefore insects can be called pollinators as they do exactly that.

WIND AND INSECT POLLINATED FLOWERS

- Flowering plants make use of different pollinating agents or pollinators.
- For example, birds, insects, the wind and even mammals.
- As a result of this different flowers have adapted their structure so as to be suited to a specific pollinating agent.

WIND POLINATED FLOWERS

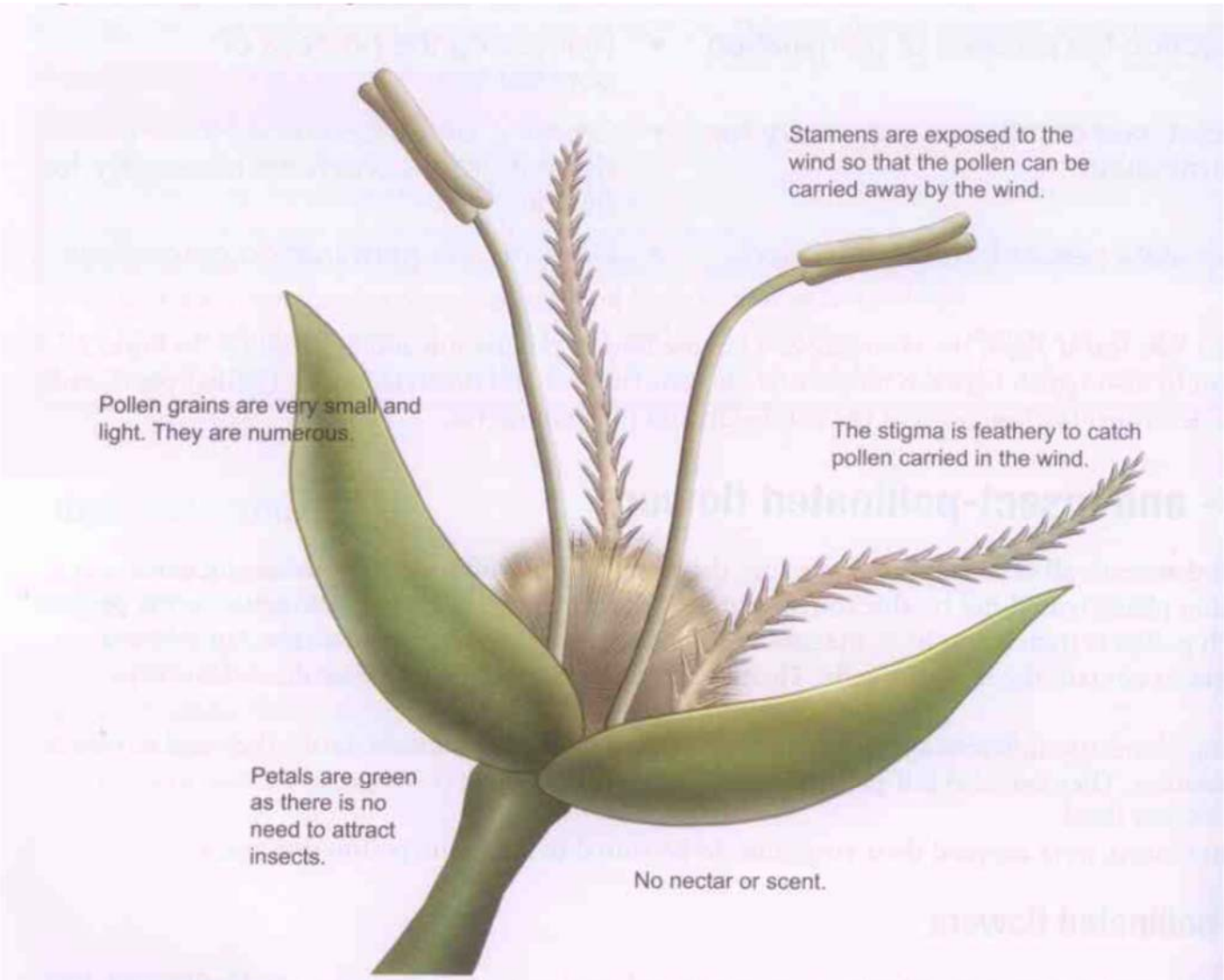


Figure 7.1 Wind-pollinated flower structure

- These have adapted to be pollinated by the wind, for example most grasses are wind pollinated.
- These flowers produce a lot of pollen grains which are very light so that they can easily be carried by the wind.
- Both the anther and the stigma are long in such a way that they remain exposed to the wind and not protected inside the petals.
- Small petals.
- They have a feathery stigma which can catch as much pollen from the wind as possible.

- Wind pollinated flowers do not need to attract insects so their petals are usually green and not brightly coloured.
- They do not produce nectar and they do not have a scent.

INSECT POLLINATED FLOWERS

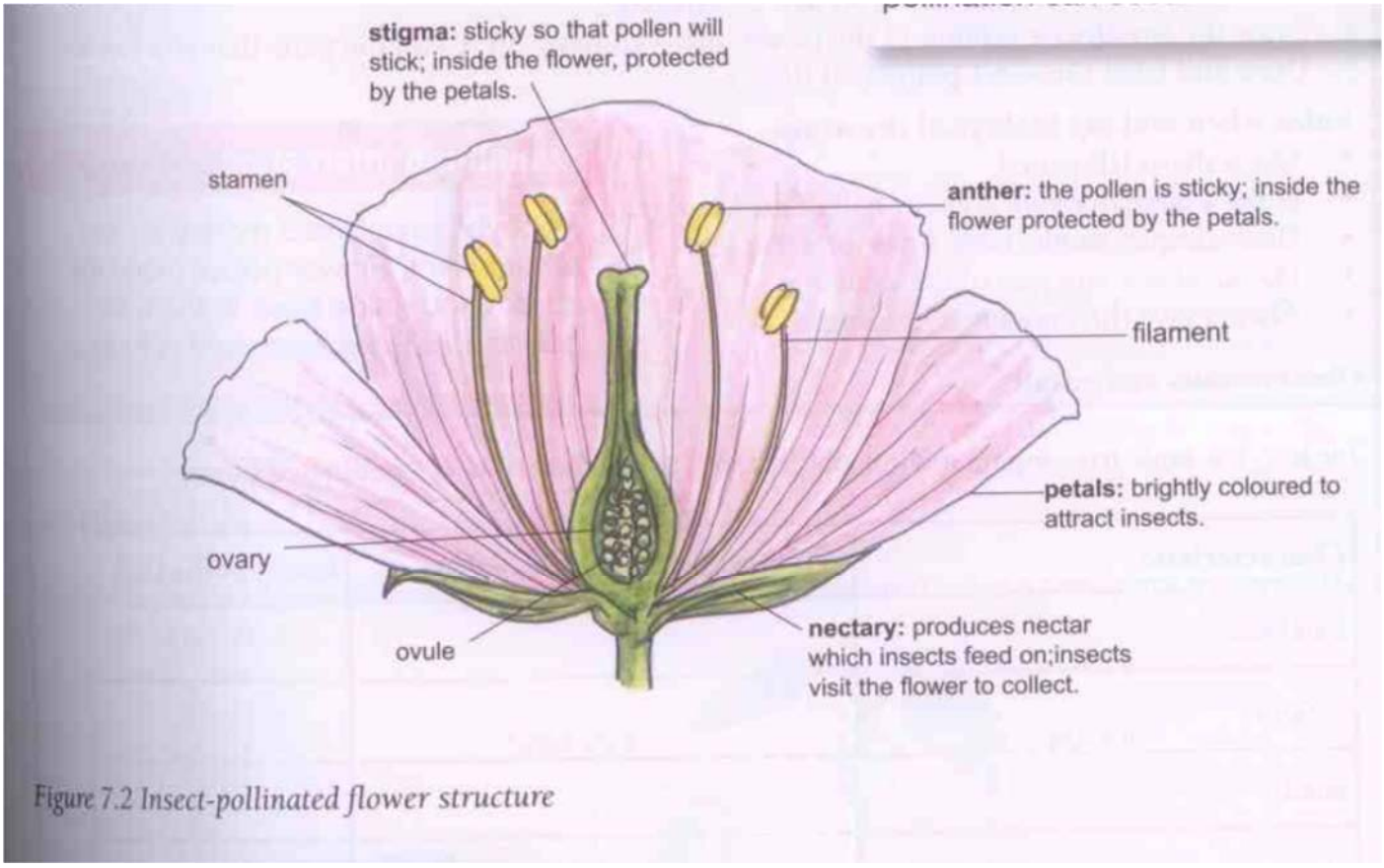
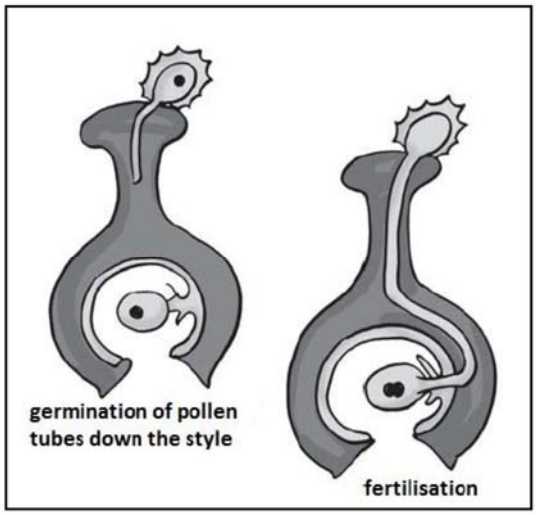


Figure 7.2 Insect-pollinated flower structure

- These flowers are adapted to attract as many insects as possible.
- They have large colourful petals.
- A sweet scent and even sweet nectar to attract insects and birds.
- Nectar is a sugary fluid made by flowers to attract insects and ensure the process of pollination occurs.
- The anthers of insect pollinated flowers produce sticky pollen grains; these stick to the body of the insect.
- The stigma itself is also sticky so that when an insect land on it the pollen grains on the insect's body stick to the stigma.
- Both the stigma and the anther are located inside a protective covering of petals.

WHAT HAPPENS AFTER POLLINATION TAKES PLACE?

- During pollination mature pollen grains land on the stigma of the same species.
- A mature pollen grain contains 2 sex cells.
- The pollen grain bursts open, it then grows a pollen tube down the neck of the style into an ovule.
- The two sex cells travel down this pollen tube until they reach the ovule, once there only one male sex cell fuses with the ovule and fertilisation takes place.
- The other male sex cell fuses with 2 cells in the embryo sac of the ovule creating the endosperm.
- This process is called double fertilisation.
- The endosperm is filled with starch that provides nourishment for the developing seed.
- After fertilisation has taken place the ovary swells or enlarge and becomes a fruit.
- The seeds are contained inside the fruit.
- The other parts of the flower, like the petals are no longer needed so they dry up and fall off.
- The sepals and the stamens also dry up and fall off.



Pollination occurs first and then the pollen grains germinate and grow tubes down the style into the ovary.

Fertilization then takes place.

GERMINATION

- After pollination and fertilisation have occurred seeds begin to form in the ovary.
- For these seeds to develop into new plants they first have to germinate.
- Seeds can remain dormant for months or even years until certain specific conditions conducive for germination and the growth of new plants are just right.
- The seed of a dicotyledonous plant has 3 main parts i.e.
  1. Seed coat
  2. Embryo
  3. Cotyledons.
- The seed coat is a tough protective outer covering.
- The embryo is made up of the young root and also the young shoot that will grow to be an adult plant later on.
- The germinating seed gets food from the cotyledons, the seed uses the food stored in the cotyledons until it is able to make its own food (photosynthesise)
- The process of germination begins when a seed absorbs water, this causes the seed to swell.
- The food supply in the cotyledons is just enough to last until the small germinating plant develops some roots and a stem above ground with its first leaves.

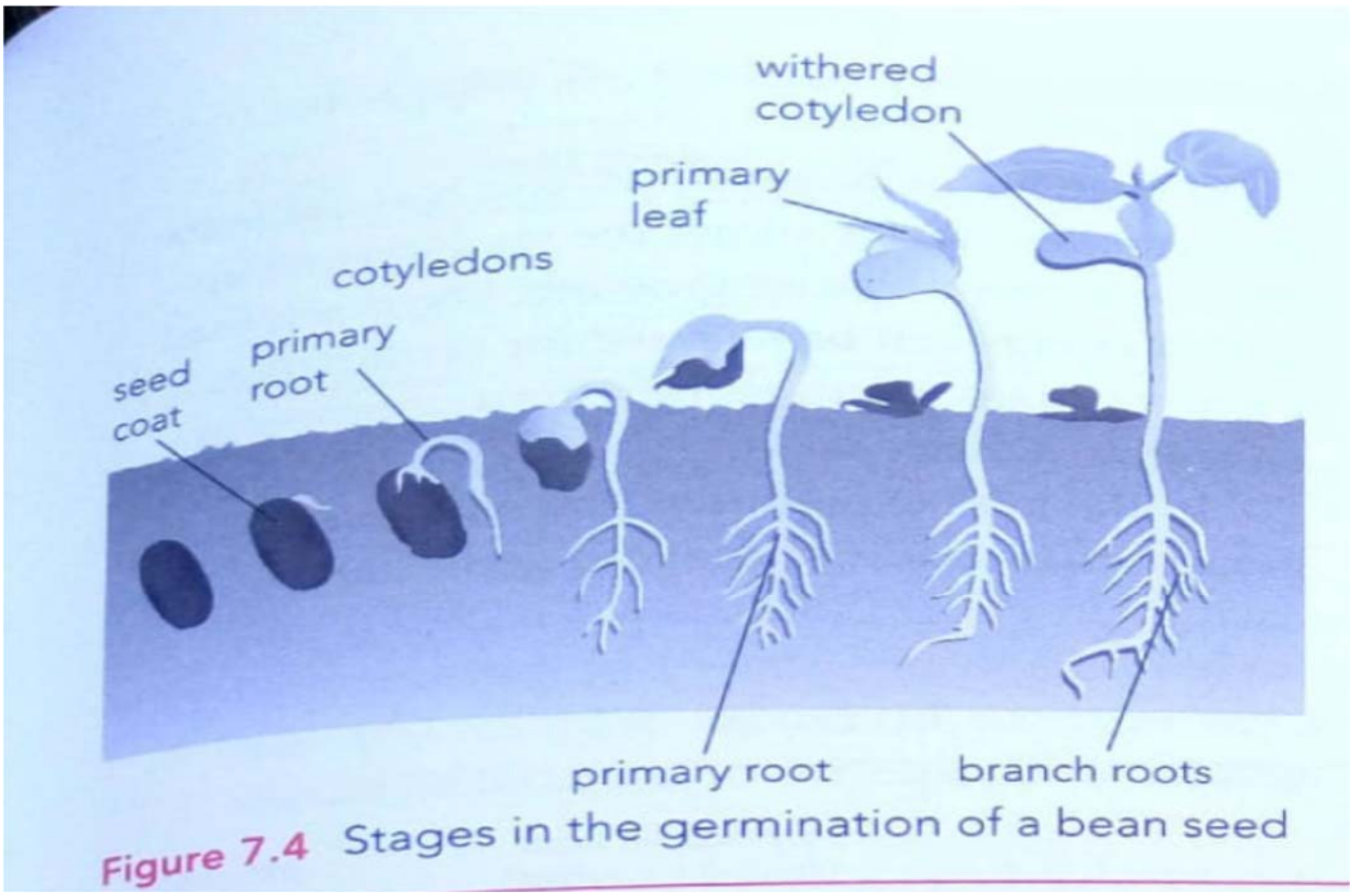
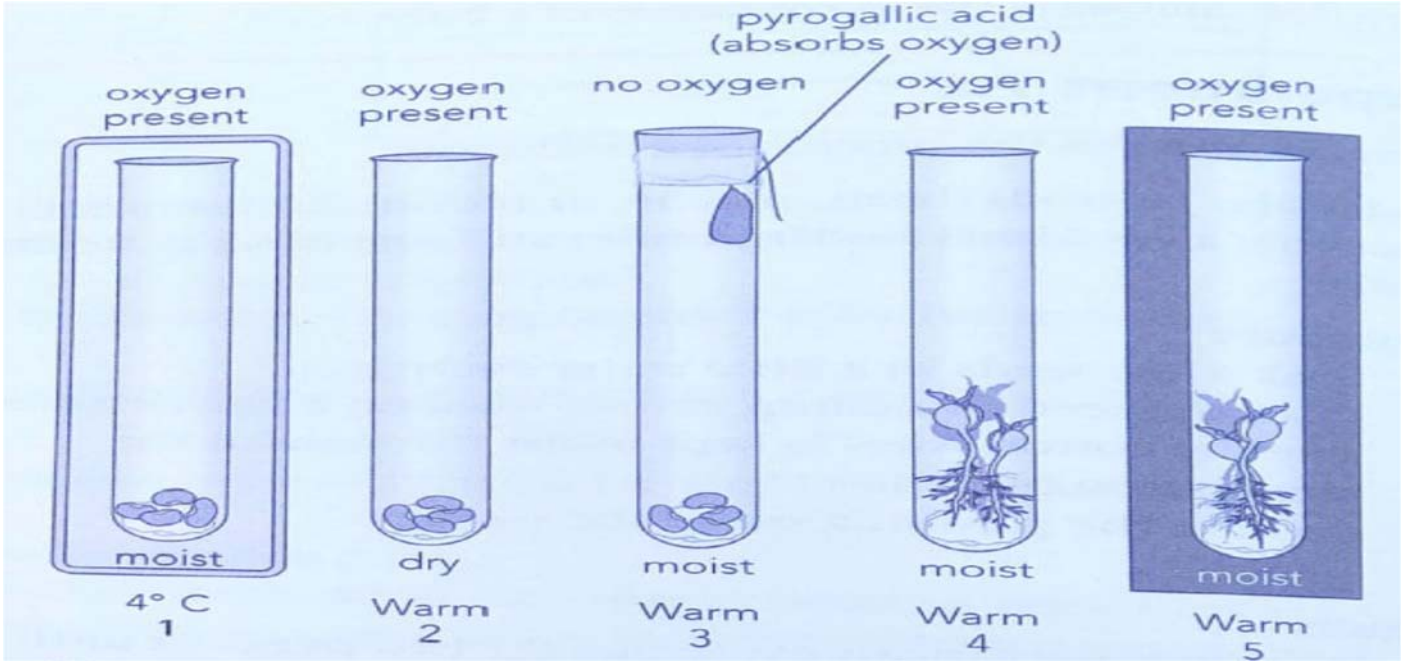


Figure 7.4 Stages in the germination of a bean seed

CONDITIONS NECESSARY FOR GERMINATION

- For seeds to germinate they need the following conditions:
  1. Water- allows the seed to swell up and the embryo to begin growing.
  2. Oxygen- used for the process of respiration which releases energy for growth.
  3. Warmth- germination improves as temperature rises; however, this is only up to a certain point. If it gets to hot enzymes die out and germination does not occur, if it's too cold the enzymes become inactive and germination does not occur.

EXPERIMENT: TO INVESTIGATE THE CONDITIONSNECESSARY FOR GERMINATION



- Explain what happens in each of the above test tubes>

GERMINATION RATE

- Some seeds remain dormant until conditions are conducive for germination.
- As a result of various factors some seeds will germinate whilst others will not.
- We calculate germination rate to determine the germination potential of the seeds that we have sown.
- Germination rate is expressed as a percentage and it is calculated using the following formula:

$$= \frac{\text{number of seeds sprouted}}{\text{total number of seeds on board}} \times \frac{100}{1}\%$$

TOPIC 9: HUMAN REPRODUCTION

INTRODUCTION

- The main function of reproduction is the continuation of a species by producing offspring.
- For human's reproduction is done sexually.
- The female ovaries produce eggs whilst the male testes produce sperms, these are the sex cells in humans.
- Conception (fertilisation) occurs when the male sex cell fuses with the female sex cell.

MALE REPRODUCTIVE SYSTEM

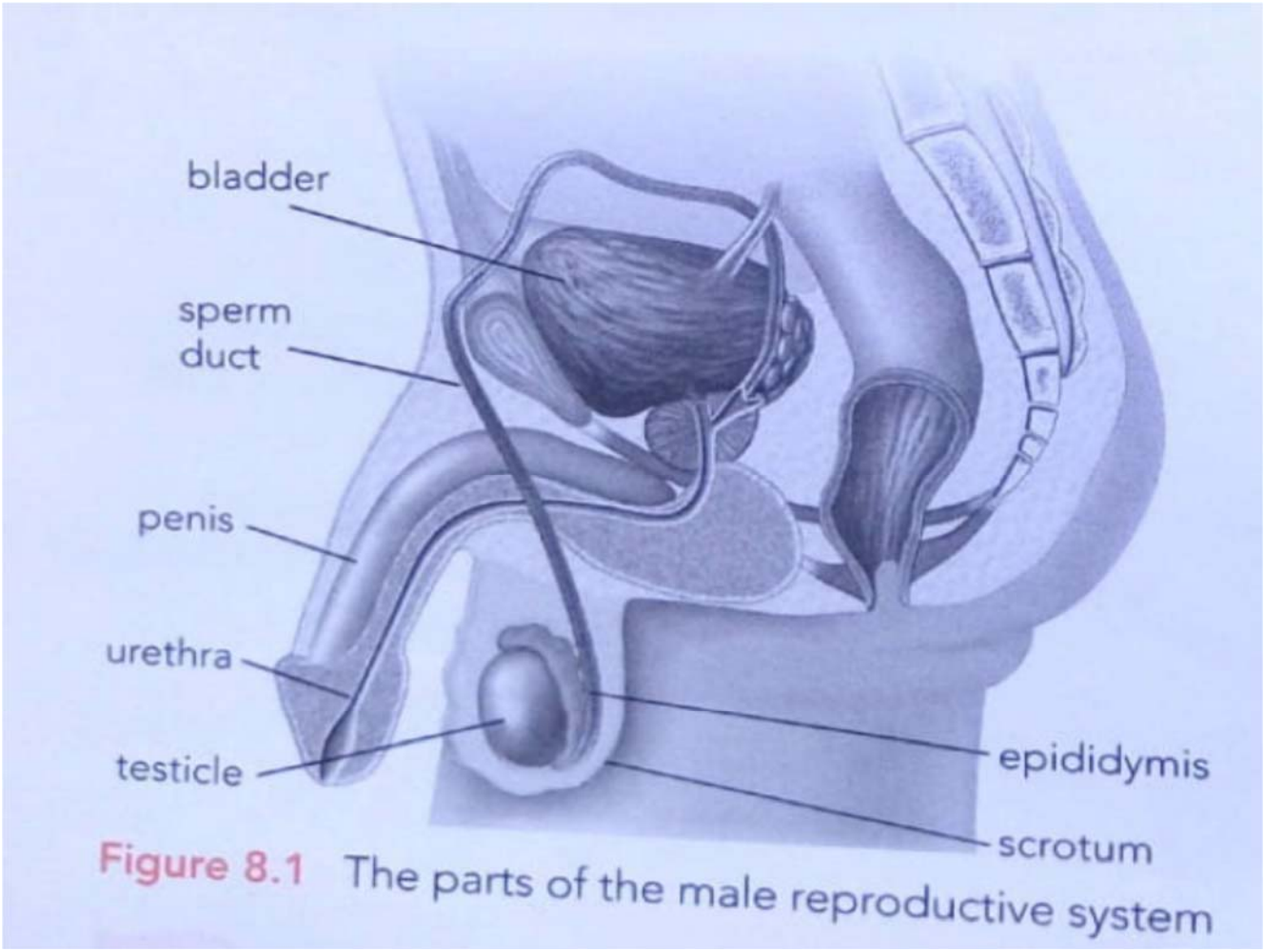


Figure 8.1 The parts of the male reproductive system

- It is made up of 2 testes, the sperm duct, the scrotum and the penis.
- The male organ is specialised to produce sperms (sex cells) and deliver them to the female.
- The testes produce millions of sperms on a daily basis, these are then stored in the epididymis where they can mature.
- The testes also produce hormone called testosterone.
- The function of testosterone is to determine the secondary sexual characteristics of a male during puberty.
- Testes hang outside of the body protected by a bag known as the scrotum.
- For them to develop sperm cells need a lower temperature than normal body temperature, this is why the scrotum and the testes hang outside the body. What this means is that temperature in the scrotum is much lower than normal body temperature.
- In order to transfer sperms into the female the penis needs to be erect, there is special tissue within the penis that is filled with blood, this makes the penis stiff or erect allowing it to transfer sperms into the females' vagina during intercourse.
- The tip of the penis is enlarged and covered by a piece of skin known as the foreskin, the function of the foreskin to cover and protect the head of the penis.
- Sperms travel from the teste into the sperm duct, during this process special glands release fluid know as semen into the sperm duct.
- Semen contains food that provides energy to help the sperm swim.
- The sperm duct then joins the urethra, this is a tube that comes from the bladder and opens outside at the tip of the penis.
- The urethra channels the sperm to exit the body through the penis during a process calculation.

FEMALE REPRODUCTIVE ORGANS

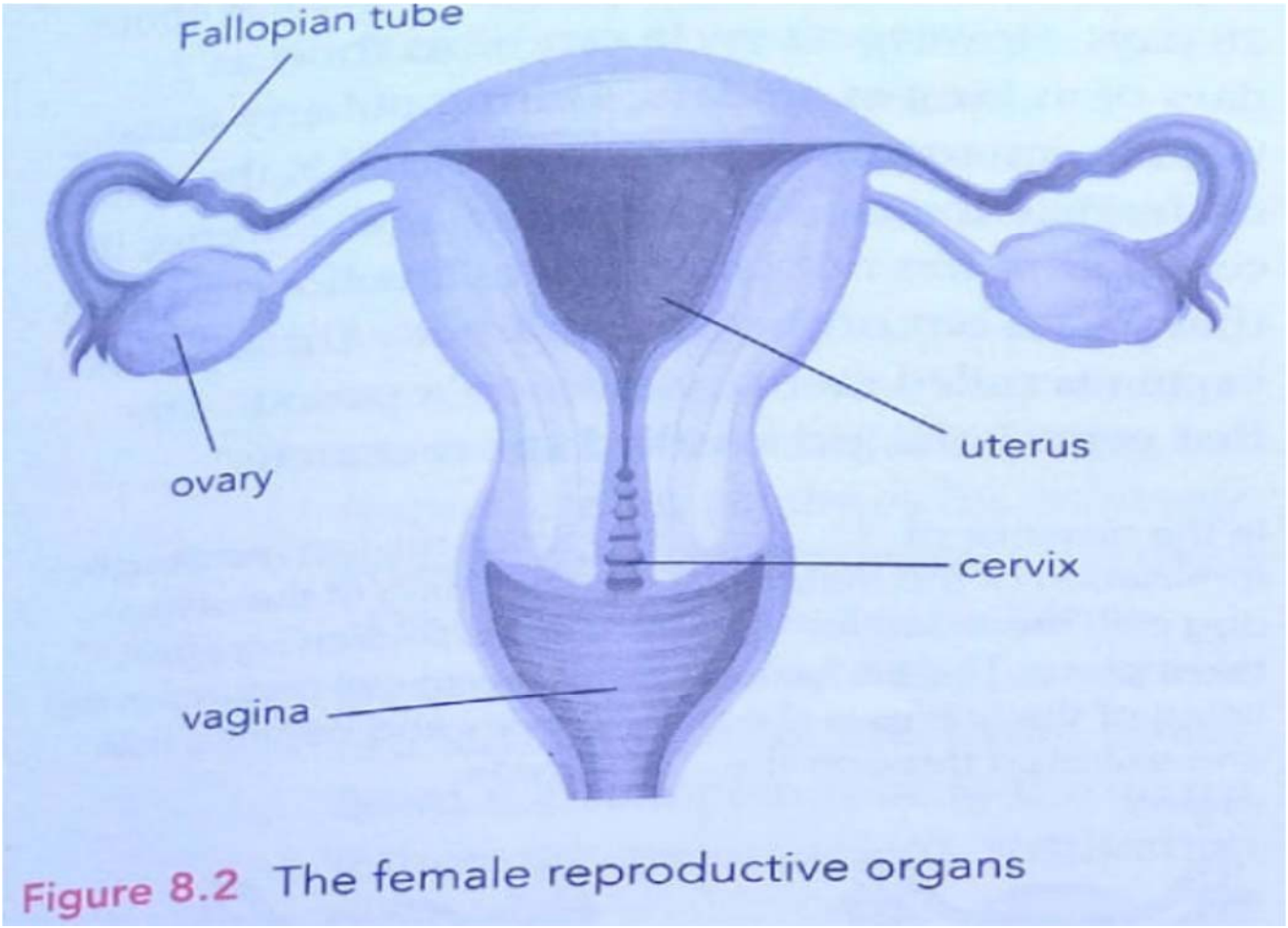


Figure 8.2 The female reproductive organs

- Made up of 2 ovaries, 2 fallopian tubes, a uterus and a vagina.
- The female reproductive system is designed to produce female sex cells and also hold and protect the growing embryo that will later develop into a foetus during pregnancy.
- The ovaries produce hormones that control the menstrual cycle.
- The ovary also contains many egg cells or ova (singular ovum).
- The ovum is released from the ovary; it travels along the fallopian tube towards the uterus.
- Fertilisation takes place inside the fallopian tube.
- The uterus can be described as a pear-shaped structure, this is where the fertilised egg is implanted, also this where the embryo develops during pregnancy.
- The uterus has strong muscular walls, it also has a soft spongy layer lining its walls, this layer is called the endometrium.
- If and when fertilisation occurs the fertilised ovum will implant itself into the endometrium.
- At the base of the uterus there is a ring of muscle called the cervix, this leads to the vagina and it also produces a fluid which it passes into the vagina.
- The muscular walls of the vagina stretch during child birth.

STRUCTURE OF THE SEX CELLS

MALE SEX CELLS

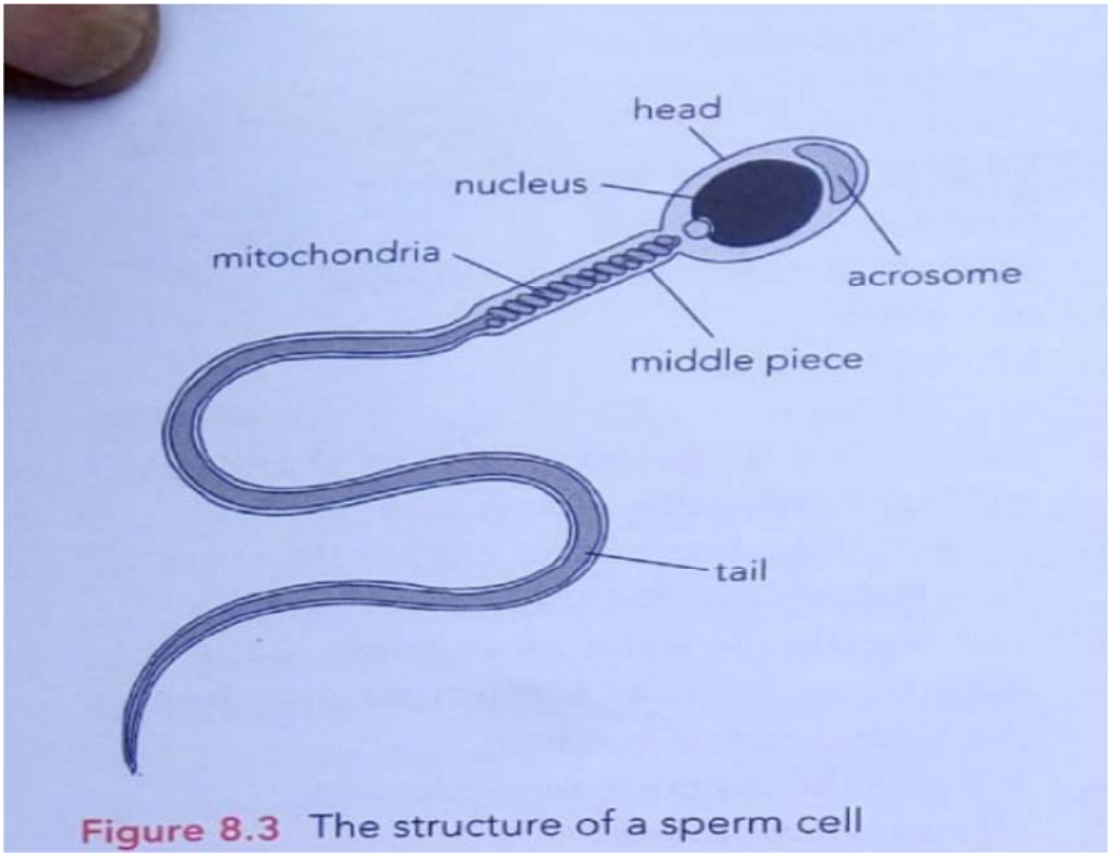


Figure 8.3 The structure of a sperm cell

- Sperm cells are smaller than the ova.
- It is divided into 3 parts
  1. Head
  2. Middle section
  3. Tail.
- The head of the sperm cell contains a nucleus which carries the heritable traits of the father

- At the tip of the head there is a structure containing enzymes which is known as the acrosome. The enzymes carried in this structure are used to break down the membrane of an ovum so that fertilisation can take place.
- Inside the middle section there are many mitochondria (mitochondrion, singular) these provide energy so that the sperm can swim towards the ovum.

FEMALE SEX CELLS

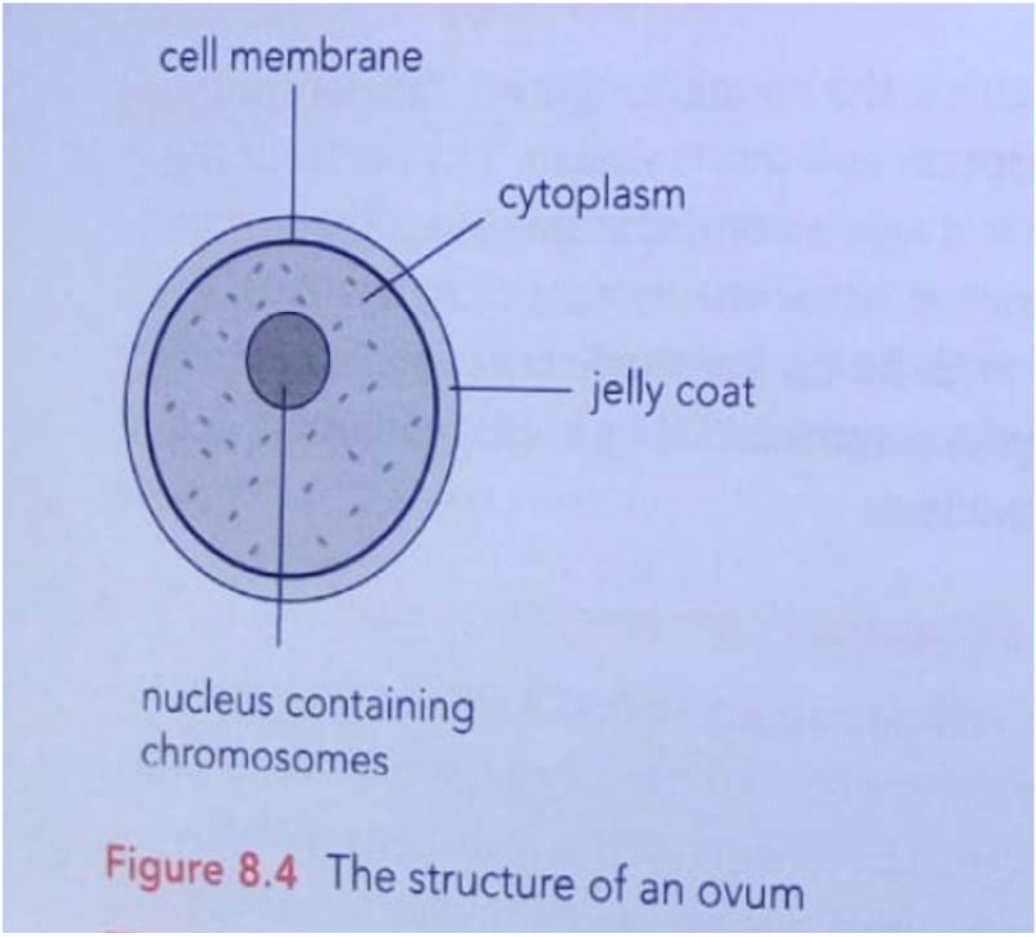


Figure 8.4 The structure of an ovum

- The ovum is made up of a nucleus, cytoplasm and cell membrane.
- The nucleus carries the heritable traits or characteristics of the mother.
- The function of the cytoplasm is to store food for the embryo to develop and grow.
- There's a thick jelly coat covering the cell membrane

THE MENSTRUAL CYCLE

- This is the process that prepares a woman's body for pregnancy.
- When girls are born, they have thousands of immature ova in their ovaries, these ova mature at puberty.
- Within the oa there is genetic information that will pass on characteristics of the mother to her child, if fertilisation takes place.
- The ovary releases one ovum about every 28 days, this means that the average menstrual cycle lasts for about 28 days.
- A cycle can be as short as 21 days and as long as 45 days.
- Menstruation begins at puberty.
- What happens is this, during the cycle the lining of the uterus i.e. the endometrium builds up in preparation for pregnancy, however if there is no fertilisation the endometrium deteriorates, what this means is this; menstrual blood is a result of the deterioration of the lining of the uterus.

- The flow of blood is known as menstruation or period.
- The first period of a girl is called the menarche.

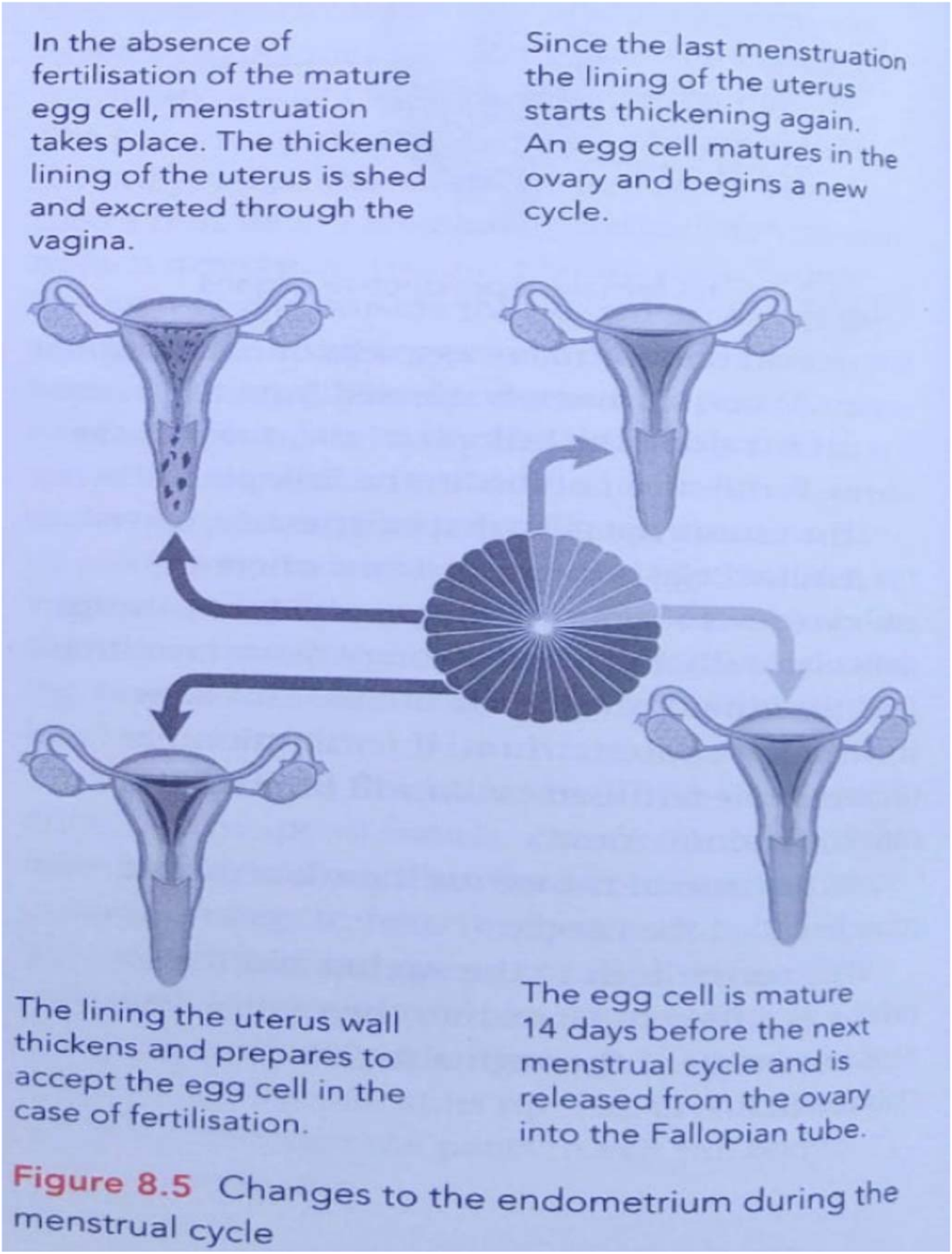


Figure 8.5 Changes to the endometrium during the menstrual cycle

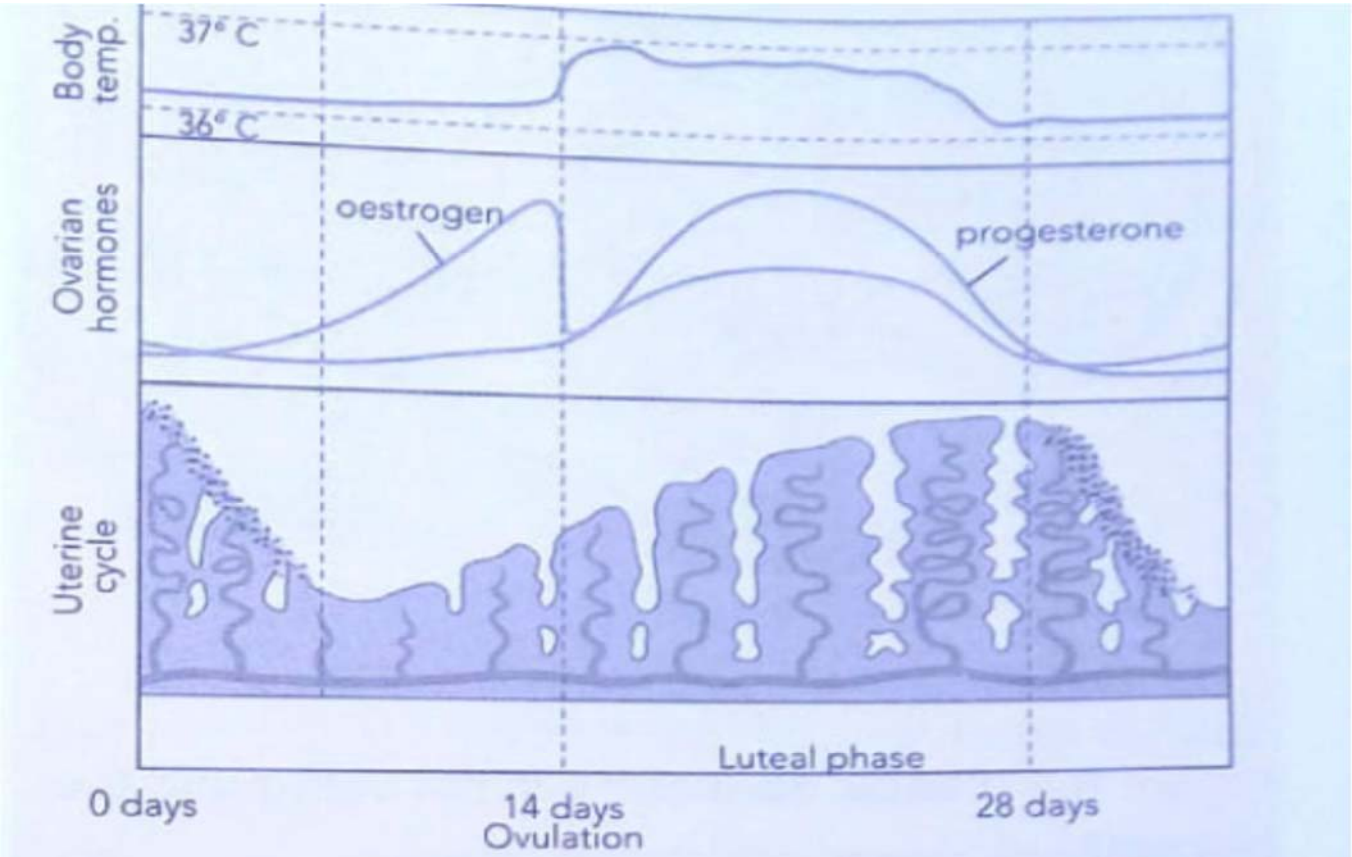


Figure 8.6 Hormone concentrations during the menstrual cycle

DAY 1-5

- The cycle begins on the first day of bleeding (menstruation)
- During this period the thickened lining of the uterus (endometrium) breaks down and passes out through the vagina.
- At this stage another ovum starts to mature inside the ovaries.

DAY 6-14

- The ovum maturing in the ovaries releases the hormone oestrogen, this hormone stimulates the endometrium and it starts to thicken again.
- The endometrium forms a new spongy layer in preparation for fertilisation.
- A mature ovum is released on day 14, this process is called ovulation.

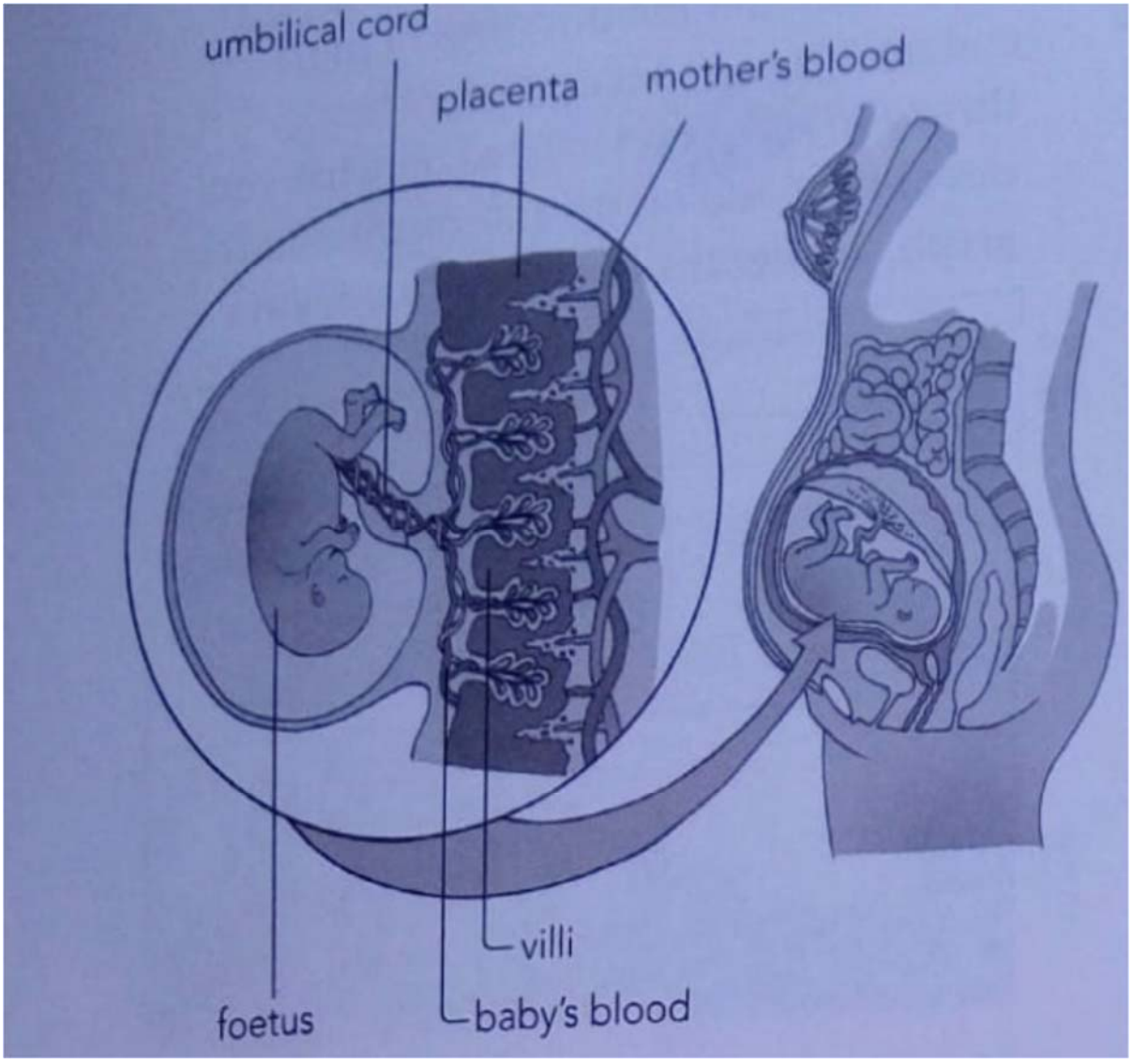
DAY 15-28

- The corpus luteum develops within the ovary which released the ovum.
- The corpus luteum is a yellowish body that produces the hormone progesterone.
- Progesterone stimulates the endometrium to thicken in preparation for the possible implantation of a fertilised ovum.
- The ovum passes down the fallopian tube as it goes to the uterus, if there are sperms present fertilisation can occur.
- However, if fertilisation does not occur, the ovum passes through the uterus and goes into the vagina and out of the body.

- The corpus luteum degenerates and stops producing progesterone, this affects the endometrium, without any progesterone present, the endometrium breaks down again restarting the cycle once more.

THE PLACENTA

- The placenta is formed during the third week of a pregnancy.
- It is shaped like a disk and it acts as a filter separating the mothers blood from the blood of the baby, in this way their blood never mixes.



- Substances such as nutrients and oxygen are allowed to pass into the blood of the baby whilst waste products are removed from the blood of the baby into that of the mother, these waste products are then excreted.
- Antibodies also have the ability to pass from the mother t child in the same way.
- Most harmful substances are prevented from entering the baby by the placenta.
- The placenta also produces progesterone to maintain the endometrium during pregnancy.
- The developing baby is attached to the placenta by the umbilical cord during the gestation period, this is the period from fertilisation to birth.
- In humans' gestation is 40 weeks (9 months)

TOPIC 10: HEALTH AND DISEASES

INTRODUCTION

- Pathogenic micro-organisms like bacteria, viruses, protozoa and fungi are responsible for causing infectious diseases.
- These infectious diseases can be transmitted from an infected person to a non-infected person through coming in contact with bodily fluids or even skin to skin contact or any other means like for example contaminated water or insect bites etc.
- Infectious diseases can also be called communicable diseases.
- It is important to understand that these diseases have different types of symptoms

SEUALLY TRANSMITTED INFECTIONS

- This is a group of diseases that are transmitted through sexual intercourse or other forms of sexual contact.
- These can be referred to as sexually transmitted diseases (S.T. Ds) or they can also be called venereal diseases.
- Diseases like this are contracted through sexual intercourse with an infected individual.
- The most common venereal diseases include; gonorrhoea, syphilis, chancroids, HIV/AIDS and genital herpes.

GONORRHOEA

- Caused by the bacteria know as Neisseria gonorrhoea also known as gonococci or gonococcus.
- It can be passed from one person to the other through direct sexual contact.
- Both males and females can be infected.
- Infection occurs in the urethra, cervix, anal canal and the conjunctiva or the mucous membrane of the eye.
- Gonorrhoea can lead to sterility, in males it infects the prostate gland and in females it infects the fallopian tubes.

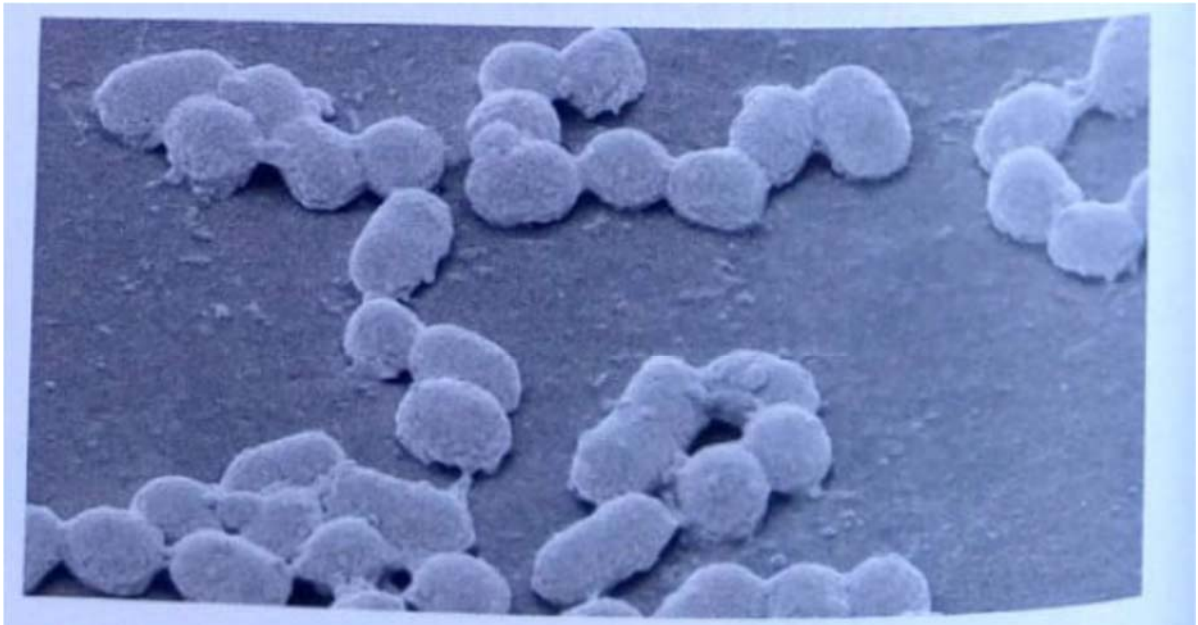


Figure 9.1 *Neisseria gonorrhoeae*

SIGNS AND SYMPTOMS

- Painful smelly urethral discharge in males, this discharge can be green, yellow or white in colour.
- Men experience a burning sensation during urination.
- In women it normally affects the cervix.
- Women suffer from swelling of the vulva, an abnormal vaginal discharge, and abnormal menstrual bleeding.
- In both males and females untreated gonorrhoea can spread to other parts of the body this includes the heart valves and also meninges surrounding the brain and the joints.
- When it reaches the joints it causes severe arthritis.

TREATMENT

- Gonorrhoea is treatable with antibiotics for example penicillin, tetracycline etc.
- Some strains of the bacteria have become resistant to treatment.
- Gonorrhoea can be contracted again, this means that if you had it and it was cured you can easily catch it again.

SYPHILIS

- Caused by the bacteria Treponema pallidum.
- It can be passed on during sexual intercourse or from mother to baby during childbirth.
- The bacteria can enter the body through cuts in the epithelium and by penetrating into mucous membranes.
- In pregnant women the bacteria can cross the placenta and infect the baby.
- Babies with congenital syphilis are usually very weak and ill, normally they live only a few hours after birth and then they die.

SIGNS AND SYMPTOMS

- Syphilis develops in 3 stages.
  1. Stage 1- a lump appears on the penis, vagina or cervix. This lump can turn into an ulcer that disappears after about 6 weeks, this stage may pass unnoticed.
  2. Stage 2- six to eight weeks later the infected person develops a mild fever and a rash or sores around the genitals, anus and mouth also eyes. During this stage the lymph glands in the neck may also swell up as well.
  3. Stage 3- can occur as many as 10 or more years after infection. By this time the bacteria will have invaded most parts of the body affecting many tissues and organs. This is the most destructive stage because the bacteria destroy nerves, causes heart disease, blindness, insanity and eventually death.

Figure 9.2 An example of a patient suffering from third stage syphilis

TREATMENT

- Can be treated with penicillin and other antibiotics.
- This is only possible during the early stages
- Once the disease reaches the third stage it is difficult to cure as the lesions may have caused permanent damage to organs.

CHANCROID (VENEREAL ULCERS)

- Caused by a bacteria known as haemophilus ducreyi.
- It attacks the tissue around the external areas of the reproductive organs for both males and females.
- An open sore or a chancroid (venereal ulcer) develops on the outside of the genitals.
- The ulcer bleeds and produces a contagious fluid that can spread bacteria during intercourse.
- Chancroid can be acquired by touching an open sore or during sexual intercourse.

SIGNS AND SYMPTOMS

- Small bumps appear on the penis or the labia 3-5 days after sexual intercourse (infection).
- In men these bumps develop into open sores on the penis and the scrotum.
- In females the bumps turn into ulcers, causing a painful burning sensation during urination or bowel movement.
- The sores usually heal quickly but they may persist if left untreated.

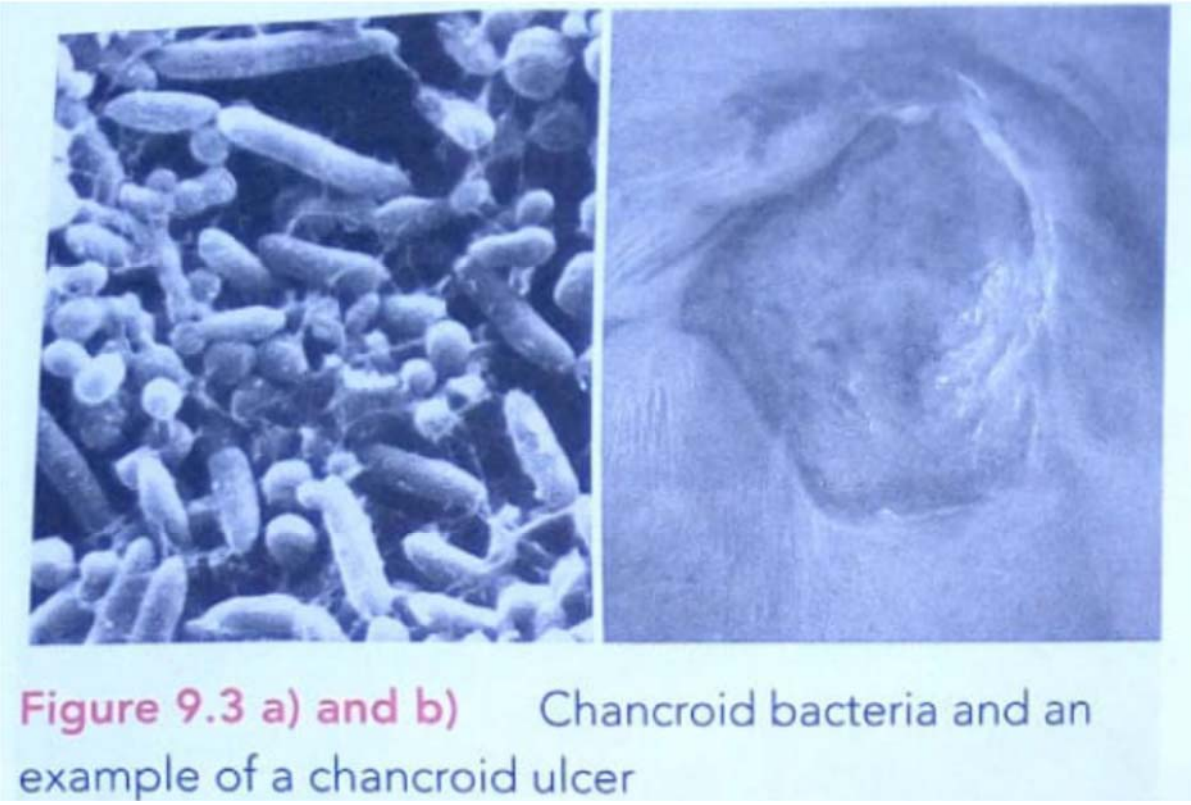


Figure 9.3 a) and b) Chancroid bacteria and an example of a chancroid ulcer

TREATMENT

- Treated using antibiotics such as tetracycline and sulphanilamide.
- These can decrease scarring after the healing of venereal ulcers.

GENITAL HERPES

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