BIOLOGY NOTES (4025)
NEW CURRICULUM 2017 – 2022

FORM 3 TERM 1

TOPIC 1

SAFETY, CAREERS AND BRANCHES IN BIOLOGY

Safety in the Laboratory

- When working in the laboratory, you need to know safe procedures in practicals and investigations so as to avoid accidents.

Causes of accidents in the laboratory

- Handling of microorganisms and small animals. Schools must not keep snakes in the lab.
- Improper handling of apparatus.
- Fire – There should never be open flames in the lab. Make it a working rule that water is the only nonflammable liquid you are likely to encounter.
- Explosion – Never heat a closed system or conduct a reaction in a closed system (unless specifically directed to perform the latter process and then only with frequent venting).
- Chemical and Thermal Burns – Many inorganic chemicals such as the mineral acids and alkalis are corrosive to the skin and eyes.
- Sharp objects / Cuts – All broken glassware should be discarded into the 'broken glass container'
- Absorption of Chemicals – Keep chemicals away from the skin. Many organic substances are not corrosive, do not burn the skin, or seem to have any serious e_ects. They are, however, absorbed through the skin, sometimes with direct consequences. Always wear gloves.
- Inhalation of Chemicals – Keep your nose away from chemicals.
- Ingestion of Chemicals – The common ways of accidentally ingesting harmful chemicals are: (1) by pipette, (2) from dirty hands, (3) contaminated food or drink and (4) food use of chemicals taken from the laboratory. Pipettes must be fitted with suction bulbs to transfer chemicals. DO NOT USE MOUTH.

Laboratory rules

The teacher and learners are tasked with planning, organising, motivating and leading all activities going on in laboratory. Good laboratory practice results in minimised or reduced accidents but with maximised learning.

Laboratory rules

1. Do not run and scream in the laboratory.
2. Do not eat and drink in the laboratory,
3. Do not bring bags and extra books into the laboratory.
4. Follow given instructions from your teacher.
5. Do not taste any substance in the lab unless told to do so, do not place your mouth on any chemical equipment, avoid inhalation of fumes of any kind, to test an odor, fill your lungs with air and cautiously sniff the vapors as you wash (fan) them from the source.

6. All odorous and/or fuming chemicals must be kept in the dispensing hood. Any reaction that emits a fume must be carefully set-up to trap the fumes, or to direct them into the bench-top hoods.
7. All accidents should be quickly reported.
8. Through wastes into bins and liquid wastes into a sink.
9. Do not touch chemicals with your hands.
10. Report any spillages or breakages immediately, never leave excess or spilled chemicals on equipment (in particular, the handling surface of glassware); wipe clean with a damp towel immediately and dry immediately with another towel.
11. Closed shoes must be worn during the entire time that you are in the laboratory to protect you from splashes of chemicals, broken glass, and other hazards that may occur in the lab. The shoes must cover your feet without gaps such as open toes.
12. Keep a list of safety phone numbers for fire department and ambulance on the wall.

Emergency Procedures in the Lab

- Immediately alert your instructor in case of ANY accident or fire.

A: Fire

- In the event that your hair or clothing catches fire — DO NOT RUN. This will fuel the fire. STOP – DROP – ROLL to smother the fire.
- Help to smother any fire on a co-worker with your apron or lab coat, or with your own body. If a fire begins and is confined in an open container such as a beaker, it can usually be extinguished simply by covering the top of the beaker to remove the source of oxygen.

B: Evacuation

- Whenever a Fire Alarm sounds, turn on water and electrical devices at your lab station, collect your bag and/or calculator and exit the building by the stairwell closest to your lab.
- Caution: AVOID PANIC. DO NOT RUN.
- Avoid inhaling smoke from a chemical fire. Assemble in front of the assembly point. Your teaching assistant will check the student roster to be sure everyone is safe. Do not leave the area until your TA has checked your name on the roster. Return to the building ONLY after a security officer gives clearance.

C: Injury

- Be familiar with the location and operation of the eye wash fountains and safety showers. Any chemical splash into the eye should be flushed for a full 15 minutes using the nearest eye wash.
- First aid supplies are available in the Stockroom. Slight wounds or burns may be treated there. Report all burns, cuts, or other injuries to your instructor.

Lab management techniques

- Chemical handling
  1. Acids and chemicals are stored in a lockable room.
  2. Treat all chemicals in the lab as toxic substances.
  3. Keep them away from your skin and clothes.
  4. There is need to wear protective clothing like goggles, laboratory coat and gloves.

5. Do not mix chemicals for fun, dispose any chemicals if instructed, when diluting acids do not pour water into acids but pour acid into water.
6. Wash hands after using chemicals. When acids or bases get onto your skin, wash it with water and inform your teacher.
7. School laboratory manuals should always be consulted for such activities.

- Technical Skills – Teachers should be able to service, repair and maintain using the basic laboratory microscope and should demonstrate to learners how they work however learners should not repair electric faults. Fire drills should be done several times so that learners know what to do if there is a fire in a building. First Aid kit and how to use it should be known such that one may assist others when an accident occurs in the laboratory.
- Small animals in cages should not be left to pupils because they go for holidays. The animals also require food water and clean cages. There is also need to avoid keeping live snakes because of the danger.
- The science laboratory should have a first aid kit for treatment of minor accidents like application of bandages ointments and washing of eyes and such others. Serious accidents should be reported to the administration.
- Experiments that produce poisonous fumes must be done in a fume cupboard and keep all windows open or conduct the activity outside.
- The teacher and learners should maintain basic plants for use in experiments and decoration in the laboratory.
- Safe use of electricity- Do not use cords with naked wires and do not pull cords when disconnecting. Do not overload circuits. Keep electrical wires away from water or damp conditions.
- Sand buckets, fire extinguishers and a fire guard are also needed.
- Handling of apparatus – Proper handling by learners and teachers since glass is fragile. Never heat glassware when not completely dry. Put safety goggles. Learn how to use burners.

How to light a Bunsen burner

1. Put your safety goggles.
2. Place the burner on a heat-proof mat in the centre of the work place.
3. Check that the gas tube is attached to the gas tap.
4. Close air hole of the burner.
5. Strike a match.
6. Open the gas tap and wave the match above the burner.
7. Turn off the gas if the flame leaps out too high.

Branches of Biology

- The division and different branches of science are constantly spreading with the increase of knowledge in science.
- The two main branches of science are Physical science and Biological science.
- Physical Science is also called the science of non-living things.
- In Physical Science characteristics, chemical reactions and many similar other properties of non-living objects are examined and discussed.
- Observation, examination and study of livings things are included in Biology.
- The term Biology comes from two Greek words

- **bios** which means **life** and
- **logos** means **knowledge**
- Aristotle is regarded as the father of Biology.
- Therefore Biology is defined as the study of living things.
- There are two types of life in nature.
- One is plant life while the other is animal life.
- Biology is the study of all life or the study of structure, functions, growth, origin, event and distribution of living organisms.

Major Branches

- Zoology – the study of animals including animal behaviour.
- Botany – the study of plants including agriculture.
- Cytology / Cellular biology – the study of cells.
- Anatomy – the study of different parts of any organised body to discover their situation, structure and dissections.
- Physiology – is the study of the functions of organisms and their parts.
- Ecology – the study of how organisms interact with others and their environment.
- Genetics – the study of heredity.
- Biotechnology – is the study that deals with application of principles and practices of engineering and technology in life sciences.
- Microbiology – deals with the study of very small organisms, their effects on other living organisms and man.
- Histology - this is the study on structure, location and function of different tissues.
- Taxonomy- in this branch discussion is made on identification, nomenclature, and classification of plants
- and animals into groups and subgroups.

Other Branches

- Evolutionary biology – the study of the origins, changes of species over time.
- Molecular – the study of biological molecules.

Careers

A Career is a profession or occupation or work. Biology is an important subject as it opens doors to many careers hence learners (males or females) should take it up to high levels. Biology links with other subjects to include arts subjects hence makes it useful in many different careers which can offer opportunity for men and women.

Biology Related Careers

- Nurse
- Dermatologist
- Biological Technician
- Medical and Health Services Manager
- Biologist
- Biochemist
- Medical microbiologist
- Virologist

- Haematology
- Biotechnology research scientist
- Genetic Counselor
- Biology Teacher or Higher education Lecturer
- Nature conservation officer (Conservationists)
- Ecologists
- Dieticians
- Research scientists.
- Botanical instructors, etc.

Watch a video on Careers in Biology: https://www.youtube.com

Home work: Explain the above biology related careers.(10)

TOPIC 2

CELLS AND CELLULAR ACTIVITIES

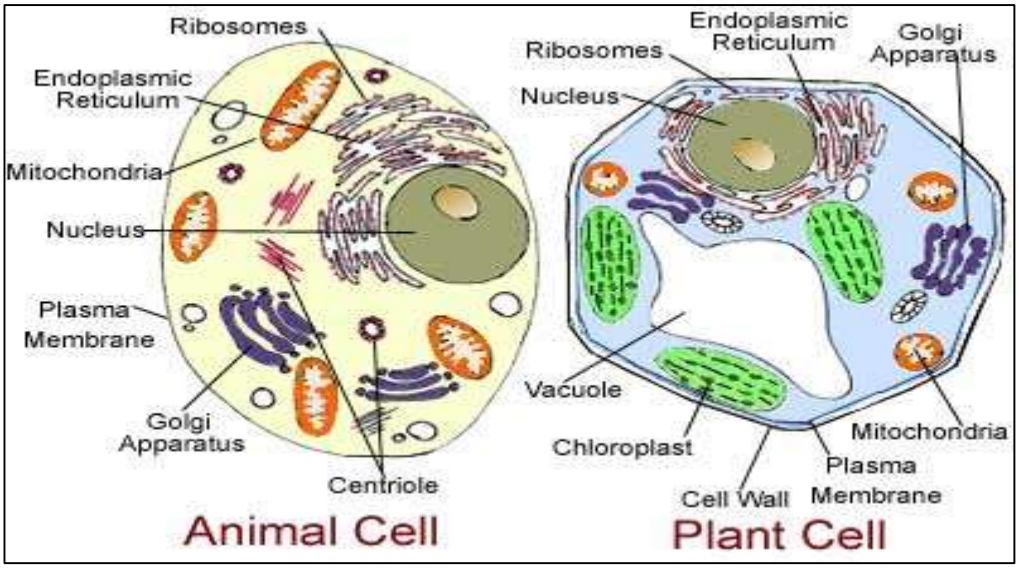
Plant and Animal Cells

A cell is the smallest unit that can carry on all the processes of life.

Cells are very tiny they could be seen only through a microscope. We have two types of cells: plant and animal cell.

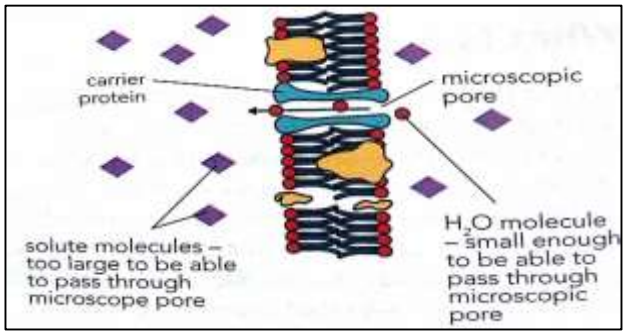
Cell structures:

The structure of an animal and plant cell



Cell membrane:

- Present in all cells
- Also called as plasma membrane or cell surface membrane
- Made up of thin layer of protein and fats
- Partially permeable and controls movement of substances in and out of the cell. Water and small particles can pass through.
- It maintains a constant interior cell environment which is different from the outside.
- Inside cell membrane lies cytoplasm and other cell organelles.



Cell wall:

- Present in plant and prokaryote cells
- In plants, made up of cellulose
- Cellulose forms fibres in criss-cross patterns over one other
- Cell wall forms very strong covering to cell and provides support and its shape.
- Prevents cell from bursting
- Permits certain molecules to pass through.

Cytoplasm:

- Jelly like substance
- Contains 70% water
- Metabolic reactions of the cell take place over here.
- Harmful and useful substances diffuse in and out of cells through the cytoplasm (Inclusions).

Nucleus:

- Contains genetic information present in chromosomes.
- Chromosomes are made up of Deoxyribonucleic acid or DNA.
- Controls the functions of the cells and gives instructions carry them out.
- Determines size, shape of cells and play a role in cell division.
- Present in both plant and animal cells and absent in a prokaryotic cell.

Vacuole:

- Vacuoles are spaces in cells containing a solution called cell sap.
- Large vacuoles are present in plant cells to store the useful products formed in photosynthesis.
- In animal cells, small vacuoles or no vacuoles at all can be present as animal cells are heterotrophic.
- Small vacuoles in animal cells often store food and water.

Chloroplast:

- Is the organelle that distinguishes between an animal and a plant cell
- Contains a green coloured pigment known as chlorophyll
- They are important for plant cells in the process of photosynthesis

Mitochondria:

- Are powerhouses of cells
- Are found in all cells except those of a prokaryote
- In aerobic respiration, oxygen is used to release oxygen from the contents of the mitochondrion (starch in plants and glycogen in animals)

Cells containing mitochondria are-

1. Muscle cell- to work
2. Sperm cell- to swim in the semen

3. Neurons- to carry electrical nerve impulses

Ribosomes:

- Ribosomes are cell organelles that are the places where a protein is made by the synthesis of amino acids.
- They are arranged in a network known as rough endoplasmic reticulum
- They are found in all kinds of cells ranging from prokaryotic to eukaryotic.

Starch grains

- Found in plant cells representing a form of storage of carbohydrates.
- In animal cells, carbohydrates are stored in form of hydrogen.

A Comparison between a plant and animal cells:

Plant cells	Animal cells
Have a cellulose wall covering the cell membrane	Don't have cell wall
Have a cell membrane	Have a cell membrane
Have cytoplasm	Have cytoplasm
Have a nucleus	Have a nucleus
Often have chloroplasts with chlorophyll in them	Chloroplasts absent in animal cells
Often possess large vacuoles containing cell sap	Have no vacuoles
Often have starch grains	Only have glycogen granules present sometimes
Often have a regular shape	Often irregular in shape

Calculating Magnification:

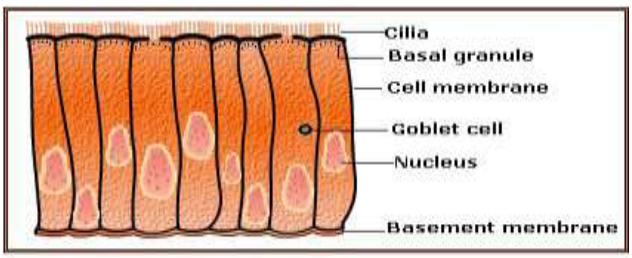
Magnification = Size of Image/Actual Size

Cell Specialisation

Specialised cells

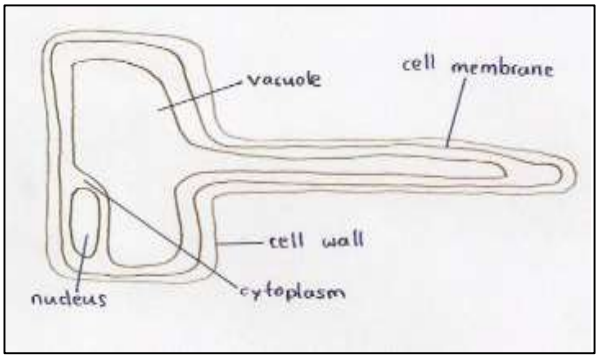
A specialised cell is designed to do a particular job. There specialised plant and animal cells. They develop a distinct shape, special kinds of chemical change take place in their cytoplasm. The changes in shape and the chemical reactions enable the cell to carry out its special function.

Ciliated cell: found in the trachea and bronchi, moves the mucus towards the throat. They are adapted by the tiny hair like projections called cilia which sweeps the contaminated mucus upwards. The mucus is secreted by goblet cells which are next to ciliated cells.

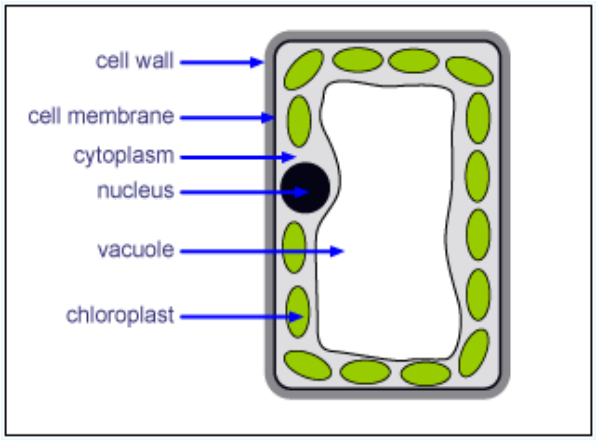


Memory cell : found in the blood, keep antibodies ready to kill pathogens that have affected you more than once.

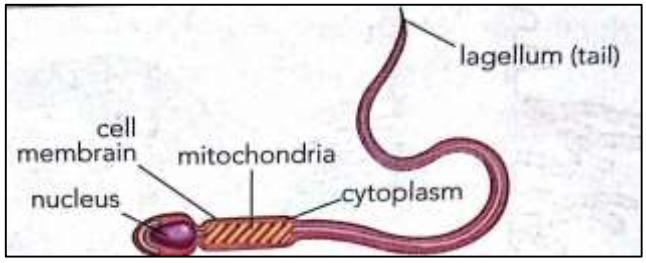
Root hair cell : found at the end of the plant roots are responsible for the absorption of minerals and water. They are adapted by 3 ways. One, they have an extension that increases the surface area for more water intake. Two, they have a large number of mitochondria for respiration to become more active. Three a concentrated vacuole to help absorbing water by osmosis.



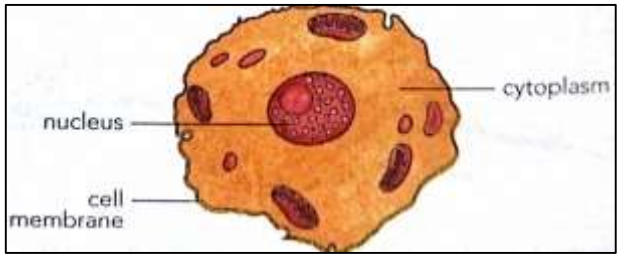
Palisade mesophyll cell : found beneath the epidermis of a leaf are specialised at photosynthesis. How are they adapted to suit function? (3)



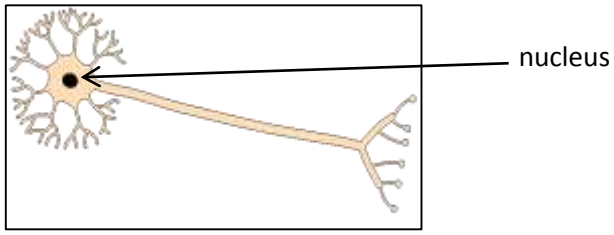
Sperm cells: are male sex cells. The front of the cell is oval shaped and contains a nucleus which carries genetic information. There is a tip, called an acrosome, which secretes enzymes to digest the cells around an egg and the egg membrane. Behind this is a mid-piece which is packed with mitochondria to provide energy for movement. The tail moves with a whip-like action enabling the sperm to swim. Their function is reproduction, achieved by fertilising an egg cell.



Egg cells (ova, singular: ovum): are larger than sperm cells and are spherical. They have a large amount of cytoplasm, containing yolk droplets made up of protein and fat. The nucleus carries genetic information. The function of the egg cell is reproduction.

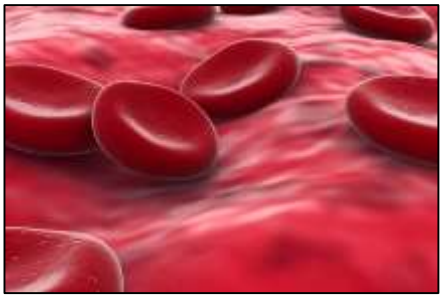


Nerve cell : found throughout the bodies of all organisms are responsible for the transmission of electrical nerve impulses

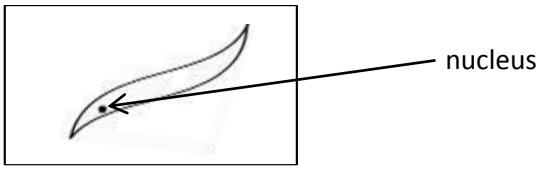


Red Blood Cell : found throughout in the blood of mammals and specialis e at the transport of oxygen using the red pigment haemoglobin. Do not have a nucleus. They are adapted by four ways: They have a biconcave disc shape that gives it a large surface area to carry more oxygen. They contain a chemical called haemoglobin that combines with oxygen and carbon dioxide. They have no nuclease to carry more oxygen and carbon

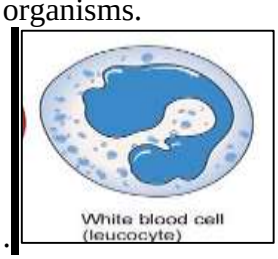
dioxide. They are tiny enough to squeeze through capillaries.



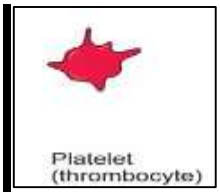
Muscle cells: They are cells found in muscles in animals, they contract and relax together to move the organisms.
Their function is to contract to support and move the body. They are adapted by two ways, First, Is that they are made of contractile filament to help in contraction. Second is it contains lots of mitochondria to supply the cell with energy.



White blood cells: attack bacteria. Have nuclei and mitochondria and are very active. Can engulf bacteria and break down foreign substances and some secrete antibodies to fight against foreign organisms.



Platelets: help clotting



Xylem Vessels: these are dead lignified cells that exist in the stem of a plant. Their function is to transport water and minerals from the roots to the leaves and the rest of the plant through the stem. And to support the plant. They are adapted by 2 ways. Firstly, they are hollow to allow water and minerals to pass through them with no resistance. Secondly they are strong and lignified to support the plant.

What things are made up of:

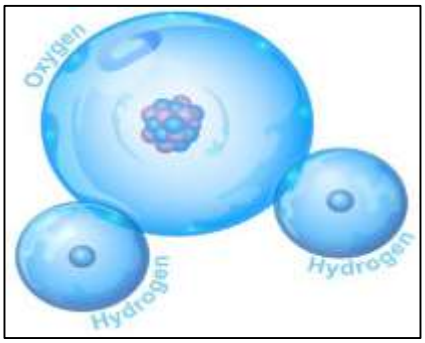
- Cells : eg: ciliated cells, root hair cells etc.
- Tissues : are group of cells with the same function and of the same type. eg: epidermis tissue, palisade tissue, muscle tissue etc.
- Organelles: are permanent structures within a cell (e.g. nucleus, vacuole, cytoplasm and chloroplast are all organelles of a plant cell).
- Organs: are groups of tissues. eg: heart, lungs, trachea, leaf, fruit, flower, root etc.
- Organ systems: are made from groups of organs. eg: digestive system, respiratory system, circulatory system, reproductive system, nervous system etc.
- Organism: is what the end result is with several organ systems that make them up! Eg: you, tiger, snake, scorpion etc

TOPIC 3

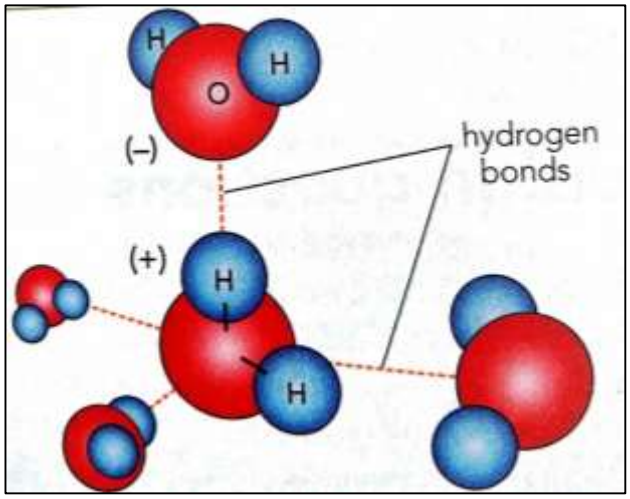
THE CHEMICALS OF LIFE

Constituents and identification

Water



- Water consists of 2 hydrogen atoms and 1 oxygen atom. It can stick together because of the hydrogen bonds. It is also neutral because of an uneven distribution of charges. The uneven distribution of charges is called **polar molecule.**
- There is an attraction between the hydrogen atom and oxygen atom. Weak hydrogen bonds form. Lots of hydrogen bonds can form so that one water molecule can form four hydrogen bonds at one time. The water molecules form a network in which the molecules can move around and break hydrogen bonds as they move.



- The body is majorly composed of water. Approximately 70% of living cells is water. It is vitally important that you drink enough water. Dehydration can seriously damage performance of body.

Properties of water

Property: High heat of fusion

- This is a measure of the heat energy required to melt a solid (ice).
- Liquid water must lose a large amount of heat energy to freeze.

Biological role

- Contents of cells and their environment are therefore less likely to freeze.
- This is an advantage for bodies of living organisms and organisms that live in water.

Property: Density and freezing

- The density of water decreases below 4°C and ice tends to form on top and floats.
- Since ice floats, it forms at the top first and at the bottom last.

Biological role

- Ice insulates the water below it, thus increasing the chances of survival of organisms in water.
- It also helps maintain circulation in large bodies of water (water expands and rises at 4°C).

Property: Polar solvent

- Water is an excellent solvent for ions and polar molecules because the water molecules attract to them, collect and separate them.
- This is what happens when a substance dissolves in water.
- Once a chemical is in solution, it is free to move about and react with other chemicals.
- Most processes in living organisms take place in solution.

- Non-polar molecules like lipids are insoluble in water.
- If surrounded by water they tend to repel/ push away forming micelles.

Biological role of this property

- This is important in hydrophobic interactions in protein structure and membrane structure by increasing the stability of these structures.

Property: High surface tension and cohesion (adhesion and cohesion)

- Cohesion is the force whereby individual molecules stick together.
- Adhesion is the force whereby water molecules stick to other surfaces.

Biological role

- Cohesion helps water to move as an unbroken column in the xylem tubes in plants.
- Adhesion helps the water to stick to the inside of the vascular bundle.
- High surface tension resulting from high cohesion forces enable small organisms such as insects to skate the surface of the water.

Property: Water as a reagent

- Water is biologically significant as an essential metabolite, that is, it participates in the chemical reactions of metabolism.
- For example water is used as a source of hydrogen in photosynthesis and in hydrolysis reactions, condensation and respiration.

Property: Transport medium

- Water is a neutral liquid medium because it has a pH of 7.

Biological role of this property

- Water's solvent properties also mean that it acts as a transport medium in the blood transporting cells, lymphatic and excretory system, the alimentary canal and in the xylem and phloem.

Property: High heat capacity

- Water has a high heat capacity of 4 200 J.
- This means that a large increase in heat energy results in a relatively small rise in temperature.
- This is because much of the energy is used in breaking the hydrogen bonds which restrict the mobility of the molecules.
- Therefore temperature changes of water are minimized as a result of its high heat capacity.

Biological role

- It makes it easier to achieve a stable body temperature.

Experiment 1

Aim: To investigate the behaviour of water when frozen.

Materials: Ice tray or small container, water, a freezer.

Procedure

1. Fill the container so that water is level with the top of the container.
2. Place the container in a freezer.
3. Examine the container after a few hours.

Questions:

1. Describe what you observe.
2. Explain the observation.
3. Explain why it is advantageous to organisms that the density of ice is lower than that of water.
4. Write a conclusion.

The 4 'Organic Compounds'

There are four important organic compounds made majorly from Carbon, Hydrogen, Oxygen. i.e. carbon atoms bonded to other elements.

Carbohydrates

They contain the elements Carbon, Hydrogen and Oxygen. Carbohydrates are the body's main source of energy. Stores energy, forms body structures.

They come in two kinds:

1. Simple sugars are the simplest forms of carbohydrates.
2. Complex sugars

Simple sugar (Monosaccharide):

Simple sugars can provide a lot of energy for immediate usage. However, they contain no other useful nutrients. Example : Glucose and fructose.

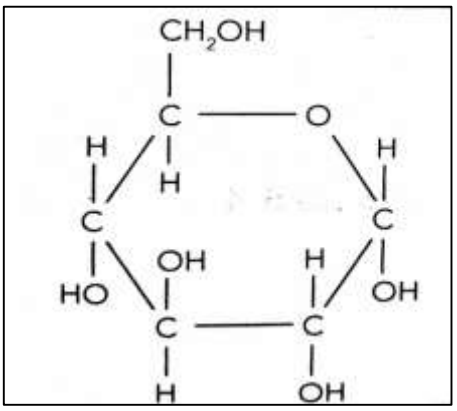
Complex sugar (Disaccharide and Polysaccharide):

They are good sources of energy. The body can easily store this form of energy for rapid use in future.

- Animal cells store complex sugars in the form of glycogen.
- Plant cells store complex sugars in the form of Starch.

Example :

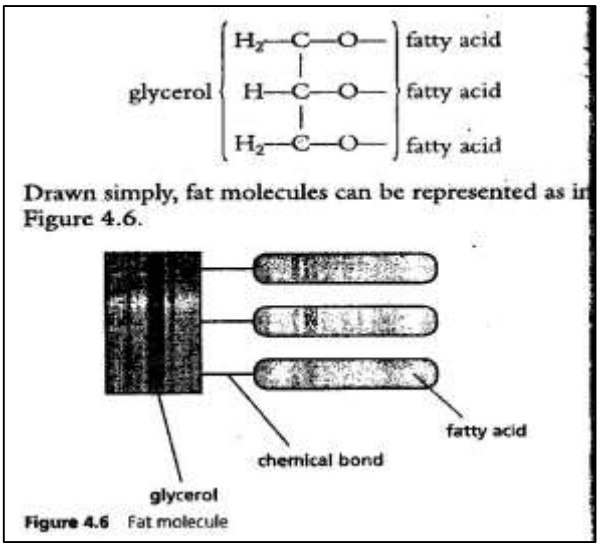
1. Disaccharide: Maltose, sucrose, maltose and lactose.
2. Polysaccharide: Starch, Glycogen and cellulose.



Foods containing carbohydrates: Bread, Root vegetables, potatoes, pasta, milk, cassava

- As mentioned above, energy from carbohydrates is converted into glycogen and is stored in the liver and in our muscles.
- When energy is needed, the body changes the glycogen into glucose which is used by the body during aerobic respiration.
- If a lot of carbohydrate is eaten, it will be stored as fat.

Fats



Fats are solid form of a group of molecules called **lipids**. When lipids are liquid they are known as oils. They contain the elements Carbon, Hydrogen and Oxygen only. They used for energy but only when

carbohydrate supplies run low and form cell membranes.

Their simplest forms are fatty acids and glycerol. A fat molecule consists of 3 organic acids and 1 glycerol.

There are two types of fat:

- Saturated Fat: These are usually found in foods such as milk, butter, cheese and meat.
- Unsaturated Fat: These usually found in foods such as fish oils, cooking oils and vegetable oils.

Saturated fats are converted to cholesterol by the liver.

There are two types of cholesterol:

1. HDL (High Density Lipids): Must be in greater amounts as it is beneficial and good
2. LDL (Low Density Lipids): Must be in controlled amounts or else the person may get infected with Coronary Heart Disease.

For this reason, no more than 10% of your energy should come from eating saturated fats.

If the percentage level of saturated fats in your diet increases, fat deposits begin to build up inside blood arteries, making them stiffer, less elastic, and narrower.

When this particularly happens in the coronary artery that supplies oxygen to the heart, very less oxygen is supplied to it, decreasing it's performance and increasing the risk of coronary heart disease. This usually results in a blood clot and a heart attack.

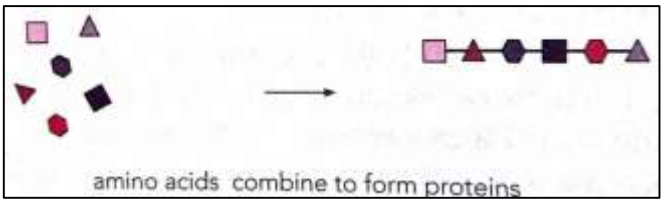
Eating too much of fat leads to obesity, coronary heart disease and diabetes.

Function of Fats:

- Needed to keep us warm
- Stored in the adipose tissue, which can break the fats if the body's carbohydrate stores get exhausted (food reserve).
- Animals need fats to make up cell structures such as cell membranes
- The Adipose tissue is needed to insulate our body

Proteins

- Proteins are used to generate energy only when the body has exhausted it's store of fat and carbohydrates.
- Proteins are very important for the body. Our muscles and other tissues, Haemoglobin, fibrin, keratin, collagen, DNA, enzymes etc. are all made up of proteins.
- The proteins you eat are broken down into amino acids, and are used by the body to build and repair cells and to make blood cells.
- Proteins are made by the synthesis of amino acids in the ribosomes of cells.
- Carbon, Hydrogen, Oxygen, Nitrogen and a bit of Sulphur is what amino acid molecules contain.
- Food containing proteins are: Eggs, Fish , Cow peas etc.
- Kwashiorkor is characterized by a protruding abdomen due to lack of proteins.
- Amino acids molecules link to form long chains called **polymers.**
- High temperatures and pH cause protein to break down. This is called protein has denatured**.**

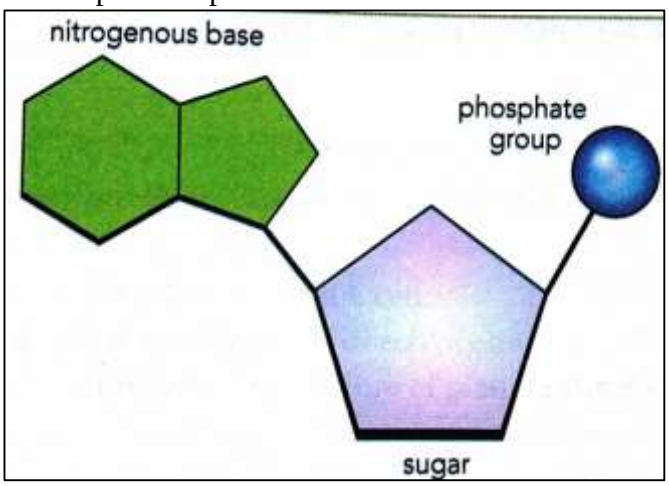


Nucleic Acids

- They are large molecules that contain carbon, hydrogen, oxygen, nitrogen and phosphorus
- Examples include: Deoxyribonucleic acid (DNA), Ribonucleic acid (RNA), Adenosine Triphosphate (ATP)
- The sub-units are **nucleotides**. A nucleotide consist of three parts: a sugar, a phosphate and a nitrogenous base group.

Functions

- Contains instructions for proteins, and store hereditary information.
- Helps make proteins.



Food Tests

Test for Starch:

- Put sample in a test tube.
- Add water to make it a solution.
- Add iodine solution.
- If starch is present the solution changes colour from yellowish brown to Blue Black.
- If starch is not present the solution remains yellowish brown.

Reducing sugars (carbohydrates) test:

Note: This test is only applicable on all sugars (monosaccharide and disaccharide) except for sucrose.

- Add 30 ml food sample into a test tube.
- Add Benedict's reagent.
- Put test tube in water bath for heating.
- If reducing sugars are present the solution turns from blue to yellow, orange, red (fire colours).
- If reducing sugars are not present the solution remains blue.

Proteins Test:

- Put sample (egg albumen) in a test tube.
- Add water to make a solution.
- Add Biuret reagent using a dropper.
- If proteins are present in the solution turns purple
- If proteins are not present the solution remains blue.

Note: Biuret reagent is blue in colour and made of copper sulphate and a small amount of sodium hydroxide.

Wear safety goggles as sodium hydroxide is corrosive. The mouth of test tube should not face people.

Fats Test:

- Add sample into 2 test tubes.
- Add $5cm^3$ethanol into each test tube and shake to dissolve fat.
- Add $5cm^3\ of$ water and shake well.
- Observe what happens.
- If fats are present the solution becomes unclear.
- If fats are not present the solution remains clear.

NB: Alcohol is highly flammable so do not bring flames near it.

Cellular Transport

Diffusion

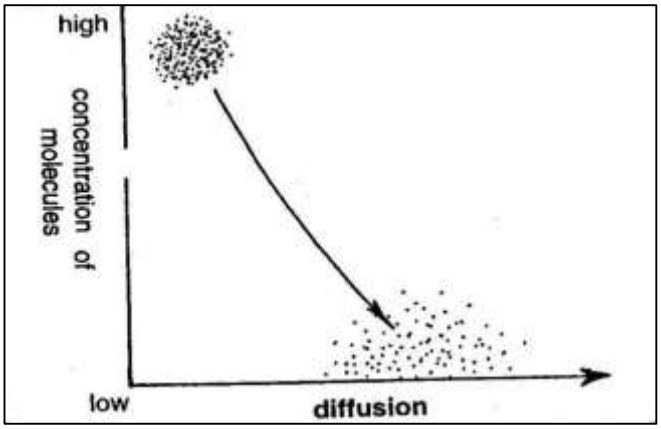
Is the movement of particles of substances from a region of high concentration to a region of low concentration through a concentration gradient.

Diffusion is needed by living organisms for:

1. Obtaining necessary requirements needed for metabolism
2. Getting rid of waste and toxic substances

Concentration gradient:

Is the difference between two regions/ points e.g. gas particles are more concentrated in the blood than lungs.



Examples of diffusion

a) Diffusion in liquids: dissolving crystals of copper sulphate or potassium permanganate in water. Substances break down into smaller particles and spread throughout the liquid by diffusion.

b) Diffusion in gases: open a container of ammonia the smell of ammonia spreads in the room by diffusion and spray perfume. Bottle is the region of higher concentration, and the room is a region of lower concentration. So the difference in the concentration gradients is what that causes diffusion.
c) Oxygen enters cells by diffusion and carbon dioxide leaves cells by diffusion provided there is a diffusion gradient.

Factors Which Affect Diffusion

- Particle size – diffusion is fast when particles are very small / fine and slow when particles are large / coarse.
- The steepness of the concentration gradient. The steeper the gradient the faster the particles diffuse.
- The surface area of the exchange membrane also affects the rate of diffusion. The larger the surface area of the exchange membrane the faster particles diffuse.
- Thickness of exchange membrane too determines the diffusion rate, the thinner it is, the easier it will be for particles to go through it, the faster the diffusion rate.
- Temperature is another factor affecting the diffusion rate, increasing the temperature will give particles more kinetic energy, making them move faster, thus increasing the rate of diffusion.

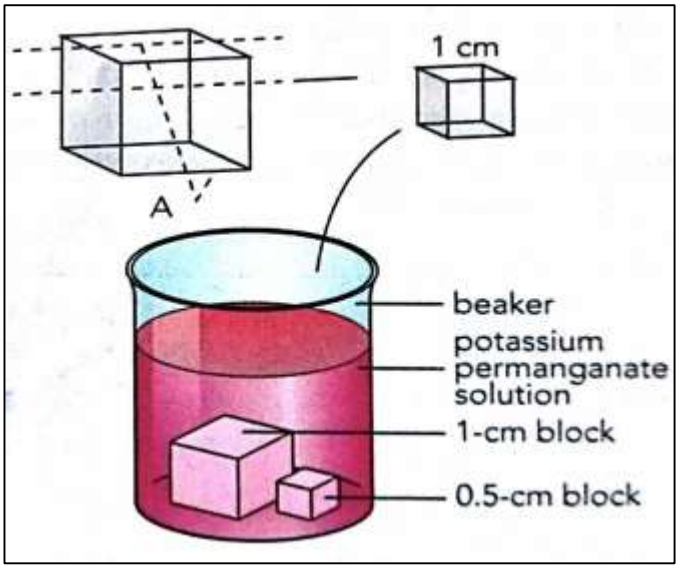
Experiments on diffusion

To determine the effect of surface area/ volume ratio on rate of diffusion

Procedure:

1. Use a block of starch agar or gelatine at least 3 cm thick.

2. Using a ruler and a sharp knife, measure and cut four cubes from the jelly with sides of 3.0 cm, 2.0 cm, 1.0 cm and 0.5 cm.
3. Place the cubes into a beaker of methylene blue dye or potassium permanganate solution.
4. After 15 minutes, remove the cubes with forceps and place them on to a white tile.
5. Cut each of the cubes in half and measure the depth to which the dye has diffused.
6. Calculate the surface area and volume of each cube and construct a table of your data. Remember to state the units in the heading for each column.



Question

Imagine that these cubes were animals, with the jelly representing living cells and the dye representing oxygen.

Which of the 'animals' would be able to survive by relying on diffusion through their surface to provide them with oxygen?

Demonstrating the effect of temperature

Procedure:

1. Set up two beakers with equal volumes of hot water and iced water.
2. Add a few grains of potassium permanganate to each beaker and observe how rapidly the dissolved dye spreads through each column of water. An alternative is to use tea bags.

Question

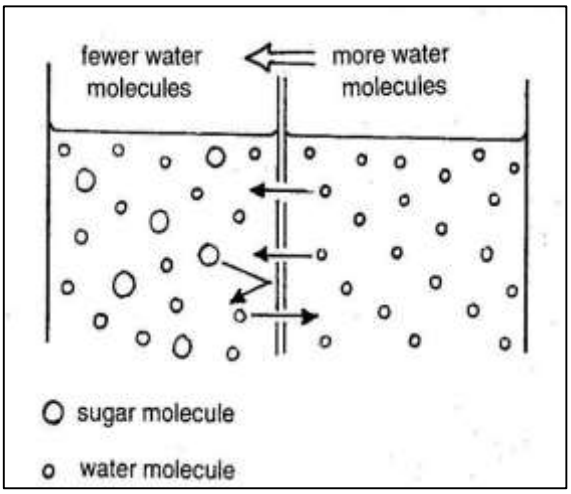
Give an explanation for the results you observed.

Osmosis

Osmosis is the movement of water molecules from a region of high concentration to a region of low concentration through a semi – permeable membrane.

Osmosis is a special type of diffusion which involves water particles only.

A semi permeable membrane



Demonstrating Osmosis

It can be demonstrated using

- Visking tubing
- Potato strip/ chip
- Egg shell membrane

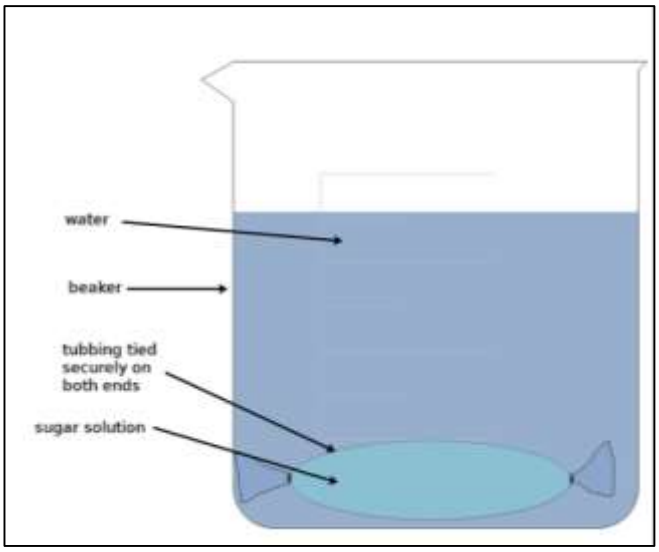
Visking tubing is an artificial membrane material made from cellulose and which acts as a partially permeable membrane.

Experiment 1

Demonstrating osmosis using visking tubings.

Materials: visking tubing, container, 20% sugar solution, balance, water.

Method



- Make a cylinder using the visking tubing by tying one end using a string.
- Add the sugar solution until half full.
- Tie the remaining end and make it secure.
- Wash the bag thoroughly and dry it well.
- Weigh the bag and place it in a beaker with water.
- After 20 mins remove the bag and weigh it.
- Record the weight.
- Repeat the by filling the tube with water not sugar solution.

Results

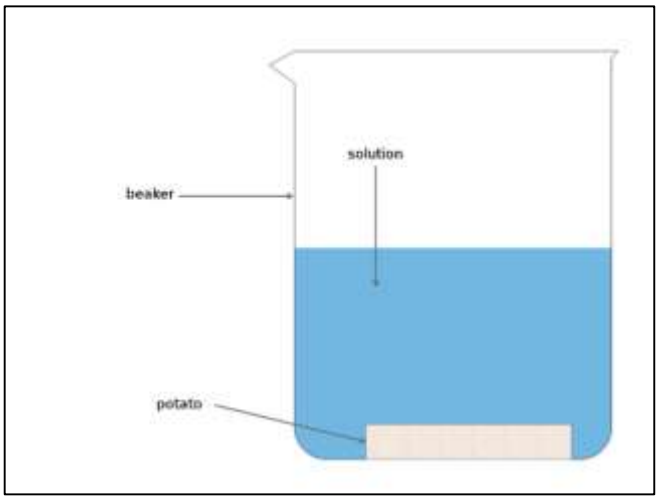
- There is an increase in weight of the sugar solution filled visking tubing because water diffuses into the visking tubing due to the differences in concentration inside and outside the tubing.
- With water, there is no change due to equal diffusion of water moving in and out since the concentration gradient is zero.

Experiment 2

Testing osmosis in living plant tissue / demonstrating osmosis using potato pieces.

Materials: potatoes, knife, distilled water, sugar / salt , three containers, balance, ruler.

Method



i. Prepare three small pieces of potatoes of 5cm x 1cm x1cm. Place them in distilled water until required.
ii. Prepare three solutions using either A – distilled water, B – 5% sugar or salt solution and C – 10% sugar or salt solution.
iii. Record length / mass of each potato piece.
iv. Leave the set up for a day
v. Record the final length / mass.

Results

- ✓ In A, there is a higher concentration of water in the beaker and lower concentration in the potato, waters moves by osmosis into the potato and cells become full of water and increase in size. The potato increases in size.
- ✓ In B there is no discernible change in size because of more or less equal water concentration without and within the potato piece hence negligible change in size.
- ✓ In C, there is a higher concentration of water in potato and low concentration in sugar / salt

solution. Water moves by osmosis from the potato into the sugar / salt solution. Cells shrink and the potato decrease in size.

Effect of Osmosis on plant and animal cells

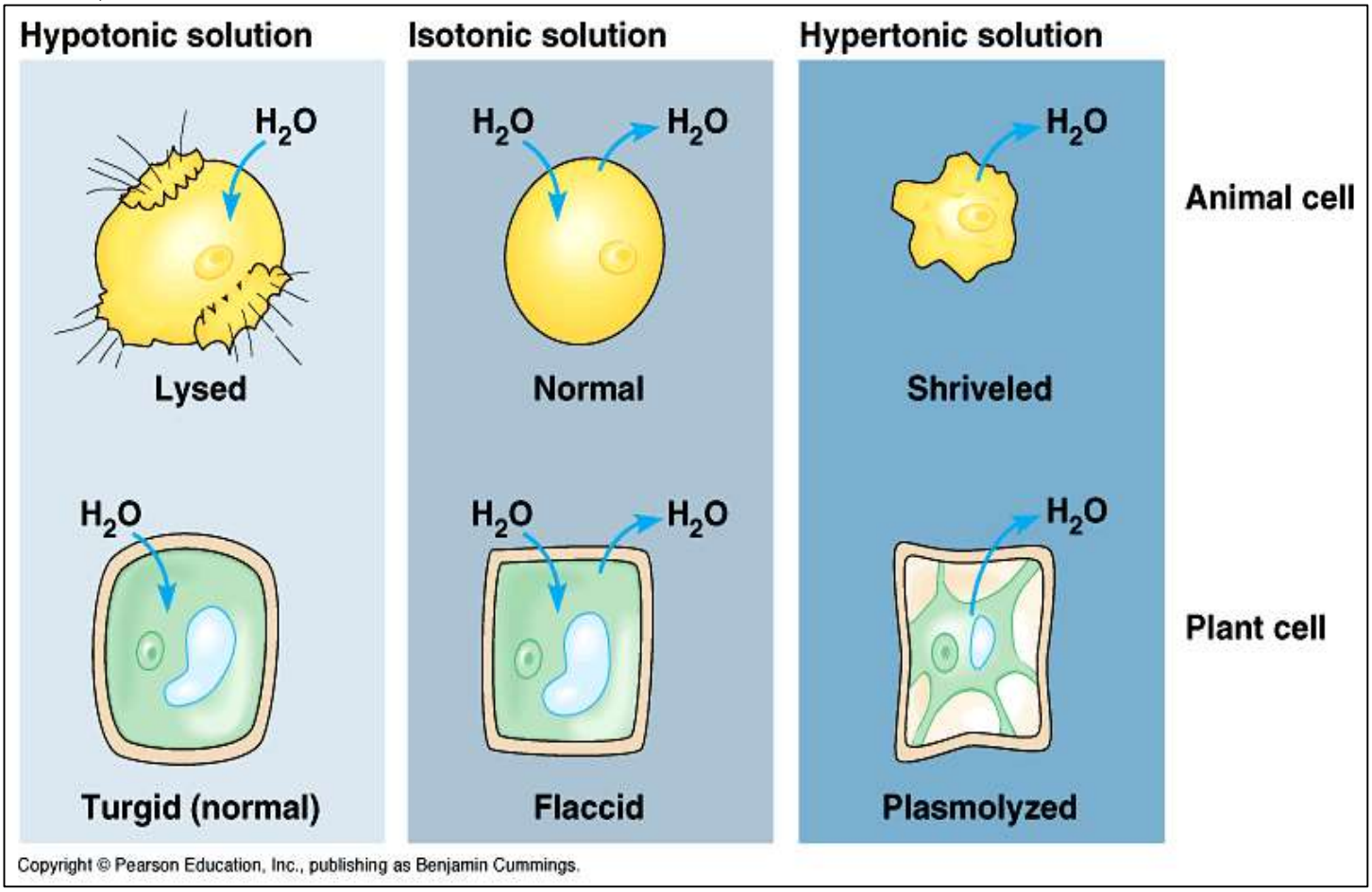
1. When placed **in H2O:** Concentration of H2O **outside** the cell is **higher** than inside it. Cells will **take in** H2O by osmosis:

- **Plant** cells become **turgid** (swollen) but do not burst (have tough **cell wall** which is fully permeable). **Animal** cells will burst (no cell wall).

2. When placed **in concentrated** sugar or salt **solutions**:

Concentration of H2O **inside** the cell is **higher** than outside it. H2O **get out** of the cells by osmosis:

- **Plant** cells become **flaccid** (soft and limp), cytoplasm is no longer pressed against the cell wall. The plant loses it firmness and begin to **wilt**. **Animal** cells shrink, become **crenated.**



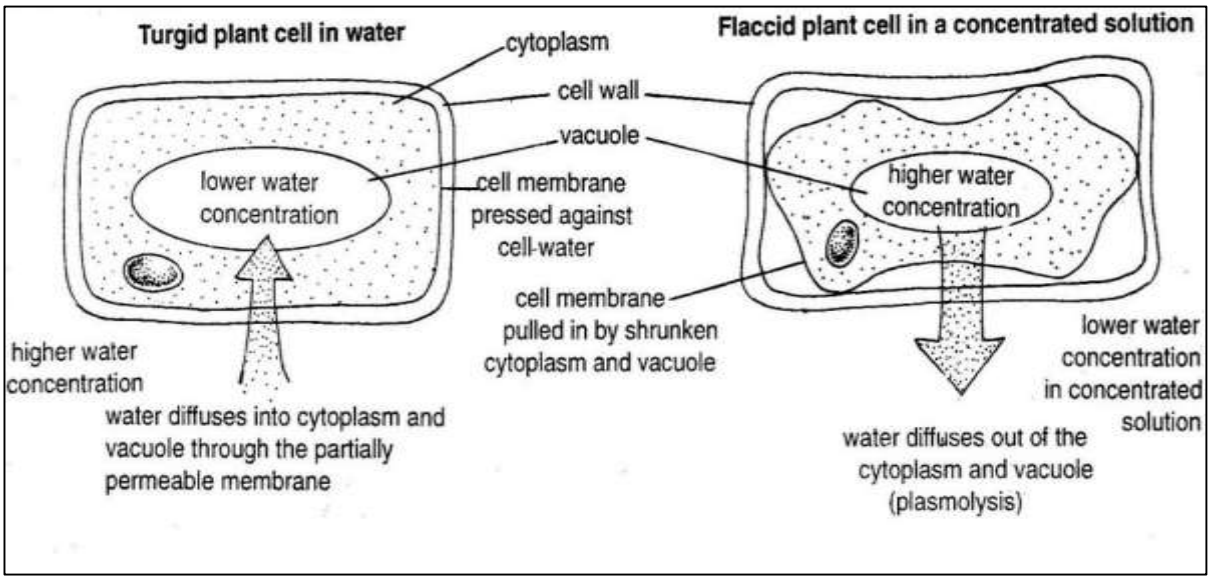
Turgor and Plasmolysis in Plant Cell

Turgor

They will be a low concentration of water inside the cell and a high concentration outside the cell. Water moves into the cell by osmosis through the cell which is semi permeable. The cell sap volume increases and the cell become full of water making the cell turgid. Water inside cell exerts a pressure on the walls called turgor pressure. The cell increases in size or volume. A cell full of water is said to be turgid. It cannot take in any more water. It becomes firm / hard.

Plasmolysis

They will be a high concentration inside the cell and a low concentration outside the cell. Water moves by osmosis from the cell to its surrounding. The cell remains with less water and the cell shrinks and decreases in size. Cytoplasm is pulled away from the cell wall and the cell becomes flaccid. It becomes soft.



Plants absorb water from the soil by osmosis until it enters the xylem vessels.

Mineral salts or ions are absorbed from the soil by active uptake, from lower to high concentration. The process uses energy.

Differences between diffusion and active transport:

- Direction of movement (down or up a gradient).
- Use of energy for movement.

TOPIC 4

PLANT SCIENCE

Nutrition

Photosynthesis

The process by which plants manufacture carbohydrates from raw materials using energy from light is called as photosynthesis. Photosynthesis is extremely important in the plant's nutrition.

Photo: Light

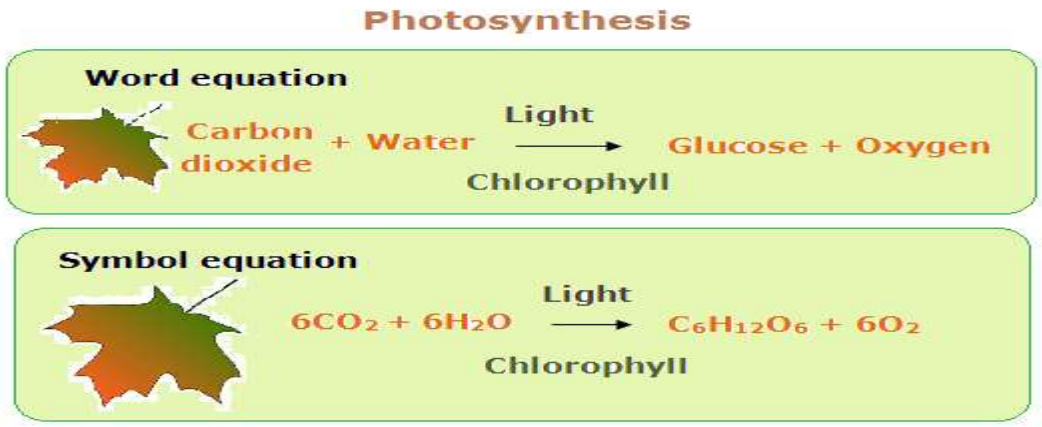
Synthesis: Manufacturing

How photosynthesis happen:

- Carbon dioxide and water enter the cell.
- The cell traps light energy using chloroplasts.
- The energy is used to split water (H_2O) into hydrogen and oxygen.
- The oxygen is excreted outside the leaf to the atmosphere as a waste product.
- The hydrogen reacts with carbon dioxide forming glucose.

The equation for photosynthesis

Word and Chemical equation:



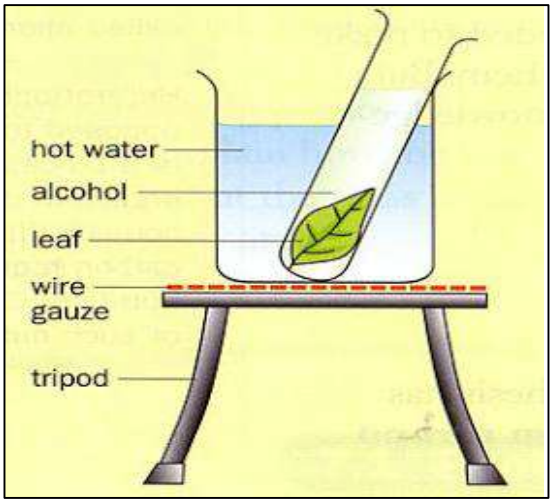
Photosynthesis investigations – Starch, chlorophyll, CO2, light and oxygen tests

Principles of investigations

1. Investigations need controls:
Control plant (or leave) has all substances it needs.
Test plant lacks one substance (light/chlorophyll/CO2).
2. Plants must be destarched.
It is very important that the leaves you are testing should not have any starch in them at the beginning of the experiment.

So, first of all, you must destarch the plants. Leave them in the dark for 48 hours. The plants use up all stores of starch in its leaves.

3. Starch test with Iodine solution



Method

- Place the leaves in boiling water for 30 seconds to stop chemical reactions.
- Boil the leaf in alcohol in water bath to remove chlorophyll.
- Place the brittle leaves in warm water for few seconds to soften the leaves.
- Spread the leaves on a white tile and flood the leaves with iodine solution.
- Record the colour change of iodine.

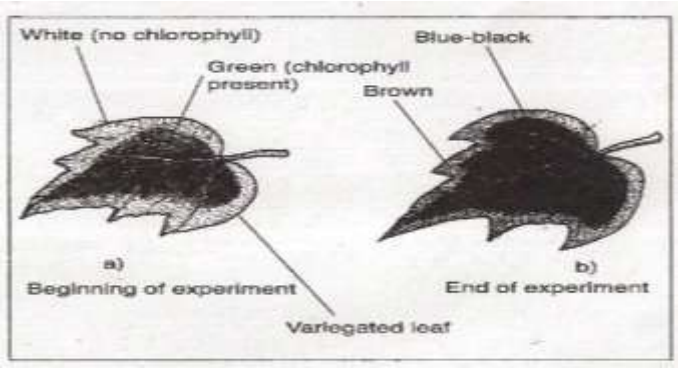
Results

The leaf turns to blue-black when starch is present. The leaf turns yellowish-brown when there is no starch.

Conclusion

Plants can make their own food.

Investigations to see if chlorophyll is needed for photosynthesis.



Method

- Take a potted plant with variegated (green and white) leaves.
- Destarch the plant by keeping it in complete darkness for about 48 hours.
- Expose the plant to the sunlight for a few days.
- Test one of the leaves for starch with iodine solution.

Observations

- Areas with previously green patches test positive (turn blue black).
- Areas with previously pale yellow patches test negative (remain brown).

Conclusion

- Photosynthesis takes place only in green patches because of the presence of chlorophyll.
- The pale yellow patches do not perform photosynthesis because of the absence of chlorophyll.

3. Is sunlight essential for photosynthesis?

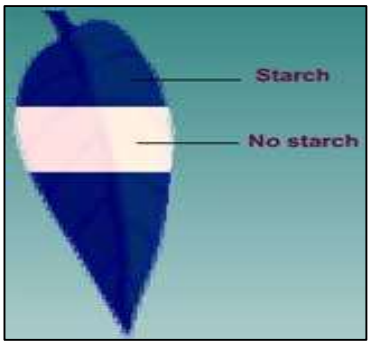
Method

- Take a potted plant.
- Destarch the plant by keeping it in complete darkness for about 48 hours.
- Test one of it leaves for starch, to check that is does not contain any.
- Fix a leaf of this plant in between two strips of a thick paper on leaf.
- Place the plant in light for a few days.

- Remove the cover from the leaf and test it for starch.

Observations

Positive starch test will be obtained only in the portion of the leaf exposed to light and negative test in parts with paper strip.



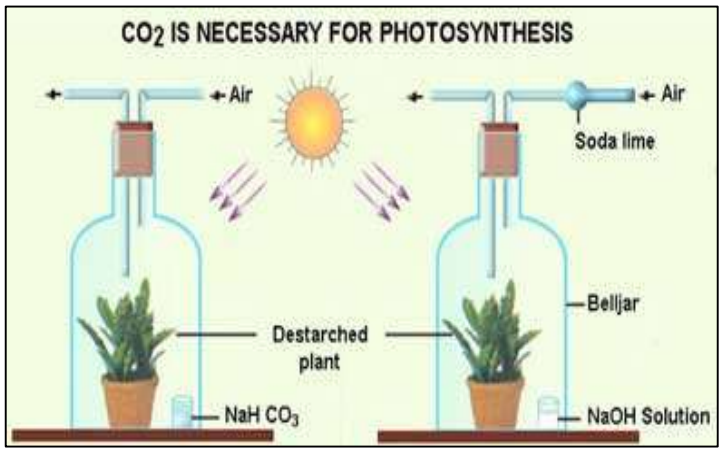
Conclusion

Light is necessary for photosynthesis.

4. Is carbon dioxide essential for photosynthesis?

Method

- Take two destarched potted plants.
- Cover both the plants with bell jars and label them as A and B.
- Inside Set-up A, keep $NaHCO_3$ (sodium bicarbonate). It produces CO_2.
- Inside Set-up B, keep NaOH (Sodium hydroxide). It absorbs CO_2.
- Keep both the set-ups in the sunlight at least for 6 hours.
- Perform the starch test on both of the plants.



Observations

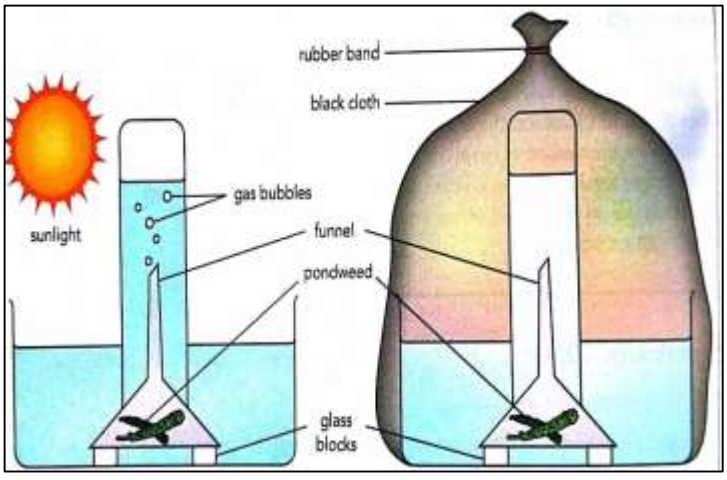
Leaf from the plant in which $NaHCO_3$ has been placed gives positive test.
Leaf from the plant in which NaOH has been kept give negative test.

Conclusion

Plant in Set up A gets CO_2 whereas plant in Set-up B does not get CO_2.
It means CO_2 is a must for photosynthesis.

5 Is oxygen produced during photosynthesis?

Materials: leaf (elodea), iodine solution, test tubes, beakers, funnels, water, glowing splint, stand



Method

i. Place a water weed in a beaker with water.
ii. Fill the test tube with water and invert it over the inverted funnel.
iii. Cover the other set up with a black cloth.
iv. Place the apparatus near a window so it receives sunlight.
v. Leave the apparatus until the test tube is full of gas.

Observations

Gas collects in the test tube A. Remove the test tube by lifting it upwards sob that the gas remains in it. Test the gas in the test tube with a glowing splint. Results; The splint burst into a flame.

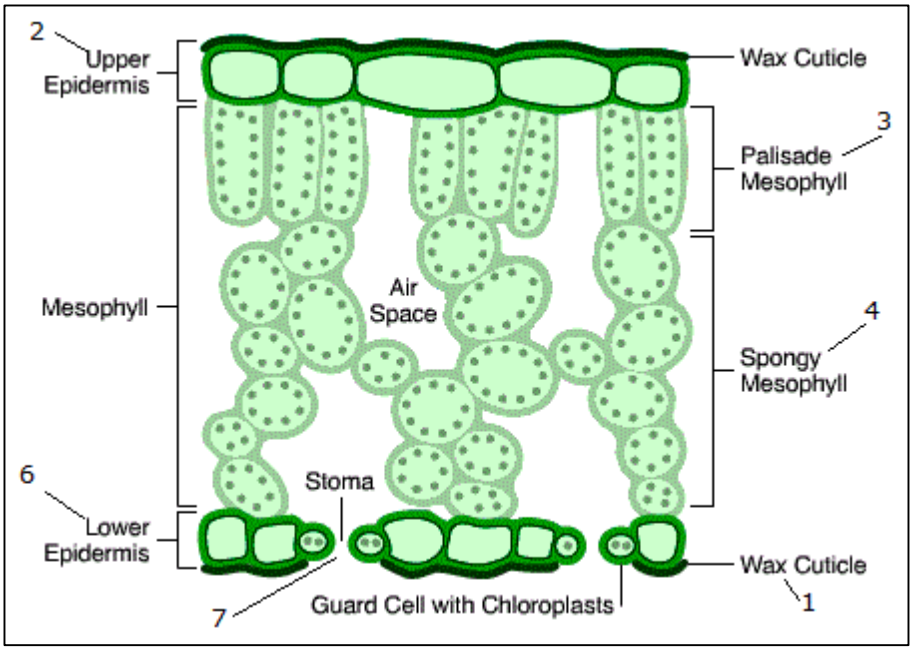
Conclusion

Oxygen is produced during photosynthesis.

Leaf and Photosynthesis

- The external and internal structure of a leaf plays an important role in photosynthesis.
- Leaves are usually flat, covered with a transparent, waxy layer known as cuticle.
- Has a network of veins and is green showing chlorophyll and contains stomata.

Internal structure



Functions of the Parts

- Cuticle layer:- It is a waxy layer on top of epidermis. It is a waterproof and therefore reduces the loss of water from the leaves and also prevents entry of pathogens.
- Palisade layer/mesophyll- : main organ of food production. The cells contain a lot of chloroplast.
- Upper epidermis below the cuticle and forms a protective covering.
- Lower epidermis at the lower surface and contains stomata for gaseous exchange.
- Spongy layer :- have got a lot of air spaces and is important for gaseous exchange.
- Vascular bundle-: contains the xylem and phloem vessels.
  -Xylem vessels -carries water required for photosynthesis.
  -Phloem vessels- carry away soluble food to other parts of the plant.

- Stomata are small pores on the lower epidermis for gaseous exchange during photosynthesis, respiration and transpiration.

Adaptation	Why is it essential?
Supported by stem and petiole	To expose most of the leaf to the maximum amount of sunlight and air
Large surface area	To expose the cells to the largest amount of sunlight as possible
Thin layered	To allow sunlight reach all cells To allow CO_2 to diffuse in To allow O_2 to diffuse out
Palisade cells are arranged end on (vertically)	To keep as few cell walls as possible between sunlight and the chloroplasts
Chloroplasts arranged broadside on (horizontally)	To expose maximum amount of chlorophyll to sunlight
Chlorophyll present in cells in the mesophyll layer	To absorb energy from sunlight So that carbon dioxide combines with water
No chloroplasts in epidermal layer	To allow sunlight to reach the cells in the mesophyll layer
Stomata in lower epidermis	To allow CO_2 to diffuse in To allow O_2 to diffuse out
Air spaces in spongy mesophyll	To allow CO_2 and O_2 to diffuse in and out of the cells during photosynthesis
Chlorophyll arranged on flat membranes inside chloroplasts	To expose maximum amount of chlorophyll to sunlight
Xylem vessels within short proximity of mesophyll cells	To supply water to the mesophyll cells for photosynthesis and other functions
Phloem vessels within short proximity of mesophyll cells	To carry away sucrose and other organic products of photosynthesis

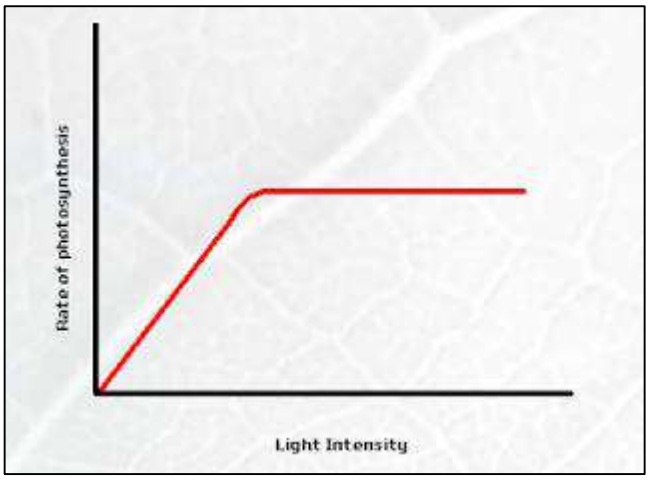
Uses of glucose in the plant's nutrition

Use	Notes
Used for energy	Energy can be released from glucose using aerobic respiration.
Stored as starch (and not as glucose as:	Stored as starch because: • Is a large molecule • Is unreactive

• It is reactive • It is soluble in water • It is a small molecule • It might be lost from plant cells when dissolved in water • It may indulge in unwanted chemical reactions in the cells • It may increase the glucose concentration in the cell and cause damage)	• Is not very soluble • Can be turned into small pieces • Can be easily stored inside chloroplasts
Used to make proteins	Nitrate molecules are mixed with glucose to form strands of amino acids which are bound into proteins
Used to make organic substances	Organic substances such as: • Sucrose • Cellulose • Chlorophyll (using nitrogen and magnesium) • Fats • Oils
Transformed to sucrose for transport	Why sucrose is changed for transport: • Less reactive • Small molecules • Soluble in sap in phloem vessels

Importance of photosynthesis

- Brings the energy of sun into ecosystems
- Essential for maintaining a constant global level of oxygen and carbon dioxide
- Helps to stop level of carbon dioxide to rise too high.

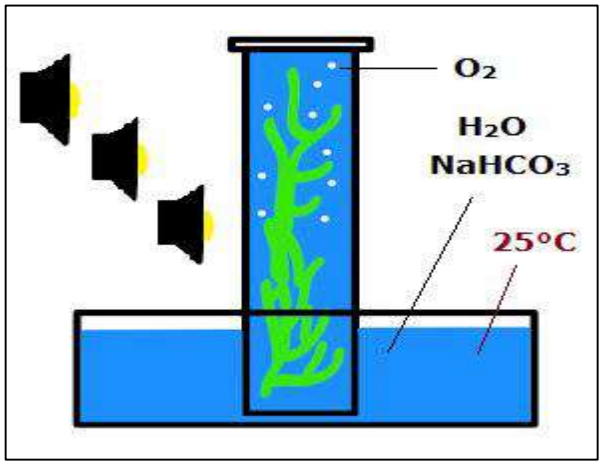


Factors affecting the rate of photosynthesis

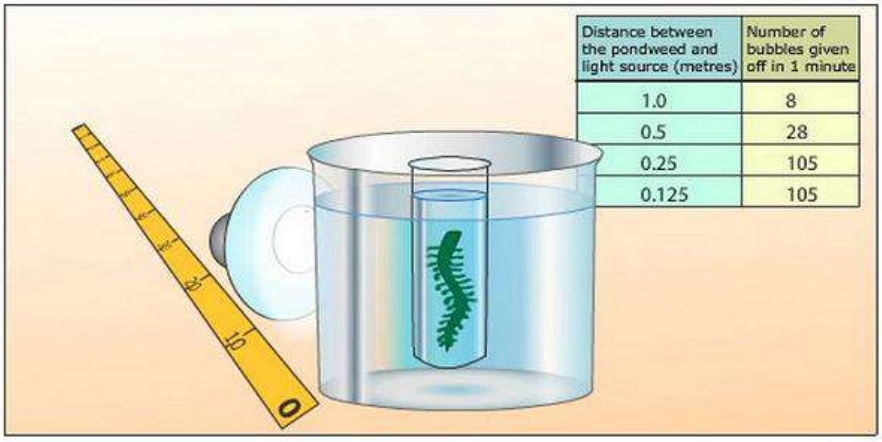
- Plants need light energy to make the chemical energy needed to create carbohydrates.
- Increasing the light intensity will boost the speed of photosynthesis. However, at high light intensities the rate becomes constant.

Experiment

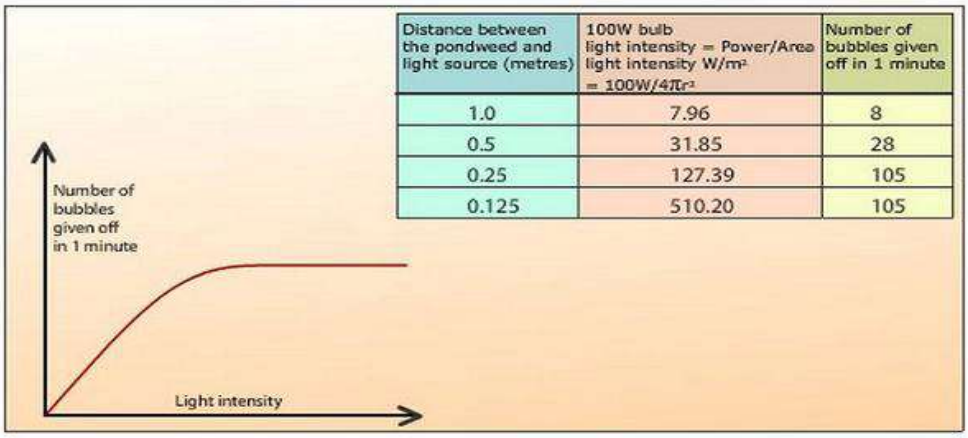
- Place a pond weed Elodea upside in a test tube containing water.
- Place the tube in a beaker of fresh water at 25°C. This helps to maintain a constant temperature around the pond weed.
- Place excess sodium bicarbonate (NaHCO3) in the water to give a constant saturated solution of CO2.
- Place the lamp (the only light source) at distance from the plant.



- Count the number of oxygen bubbles given off by the plant in 1 minute period. This is the rate of photosynthesis at that particular light intensity.
- The gas should be checked to prove that it is indeed oxygen – relights a glowing splint.
- Repeat at different light intensities by moving the lamp to different distances.



Distance between the pondweed and light source (metres)	Number of bubbles given off in 1 minute
1.0	8
0.5	28
0.25	105
0.125	105



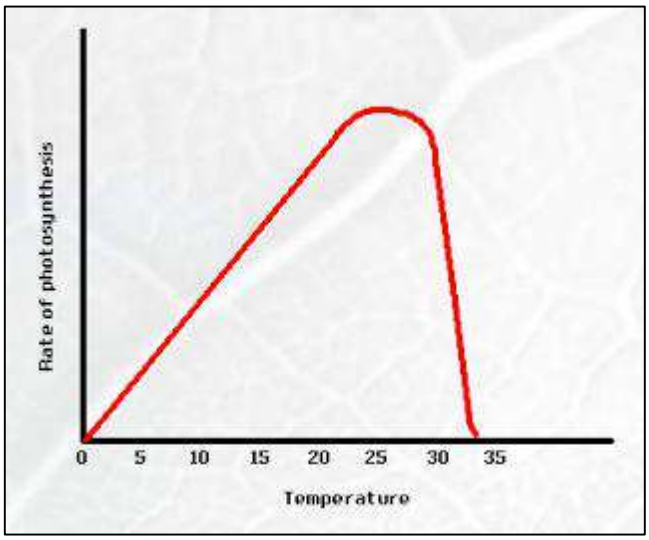
Distance between the pondweed and light source (metres)	100W bulb light intensity = Power/Area light intensity W/m² = 100W/4πr²	Number of bubbles given off in 1 minute
1.0	7.96	8
0.5	31.85	28
0.25	127.39	105
0.125	510.20	105

Explanation

- Light energy absorbed by chlorophyll is converted to ATP and H+
- At very low light levels the plant will be respiring only not photosynthesising.
- As the light intensity increases, the rate of photosynthesis increases. However, the rate will not increase beyond a certain level of light intensity.
- At high light intensities the rate becomes constant, even with further increases in light intensity; there are no increases in the rate.
- The plant is unable to harvest the light at these high intensities and the chlorophyll system can be damaged by very intense light levels.

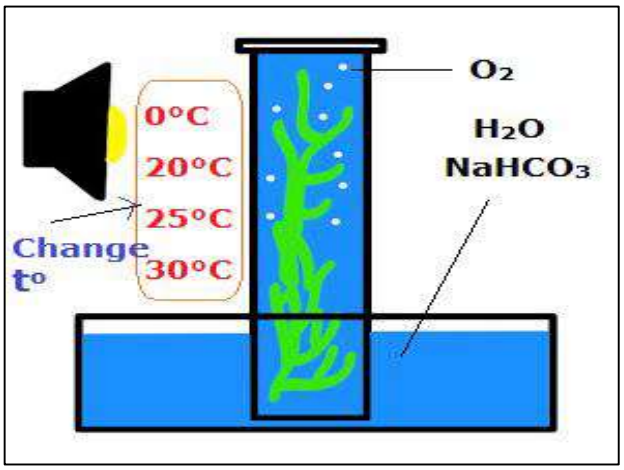
Effect of Temperature on the Rate of Photosynthesis

- When the temperature rises the rate of photosynthesis rises also. There is an optimum temperature at which the rate of photosynthesis is maximum.
- Beyond this temperature, the reaction quickly comes to a halt.



Experiment

- Place a pond weed Elodea upside in a test tube containing water at 25°C.
- Place the tube in a beaker of fresh water.
- Place excess sodium bicarbonate (NaHCO3) in the water to give a constant saturated solution of CO2.
- Place the lamp (the only light source) at a fixed distance from the plant.
- Maintain the room temperature at 20°C.



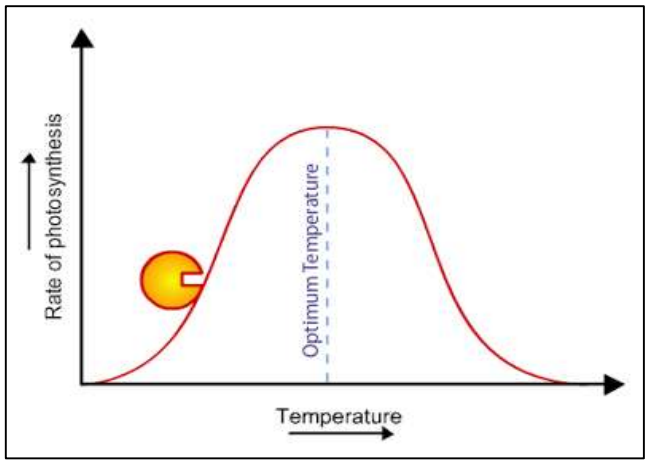
- Count the number of oxygen bubbles given off by the plant in a one - minute period. This is the rate of photosynthesis at that particular temperature.
- The gas should be checked to prove that it is indeed oxygen – relights a glowing splint.

- Repeat at different temperatures: 0°C - surround the beaker with an ice jacket; greater than room temperature (25°C, 30°C, 35°C, 40°C, 45°C, etc.,) by using a hot plate.
- Graph the results placing temperature on the x-axis.

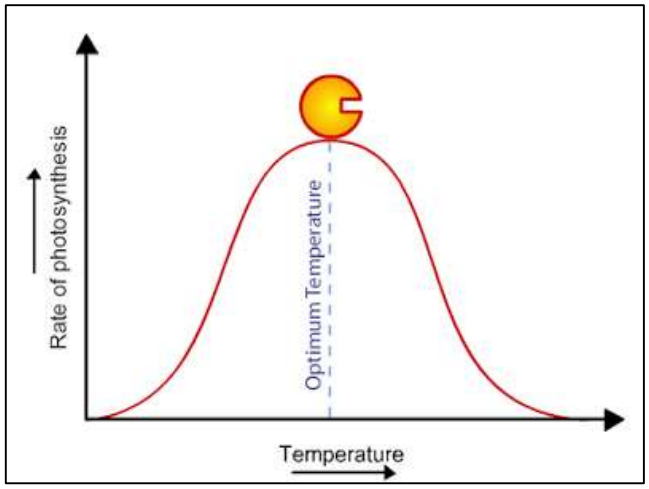
Explanation

- At low temperature, the enzyme does not have enough energy to meet many substrate molecules, so the reaction is slowed.

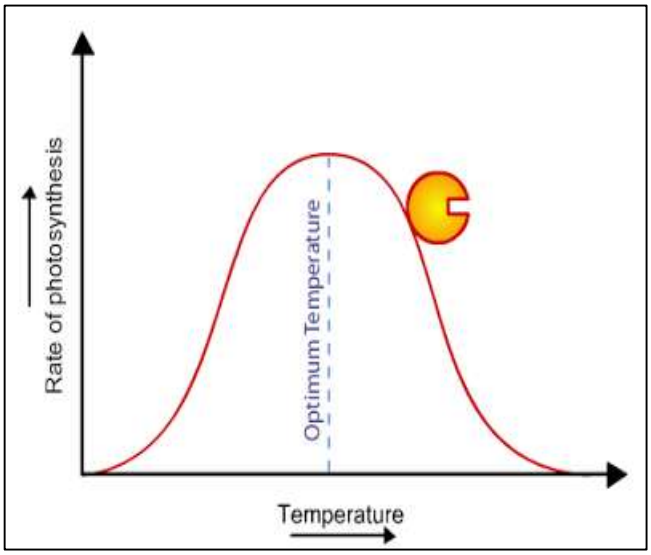
- When the temperature rises, the particles in the reaction move quicker and collide more, so the rate of photosynthesis rises also.



- At the optimum temperature, the enzyme is most efficient and the rate is maximum.

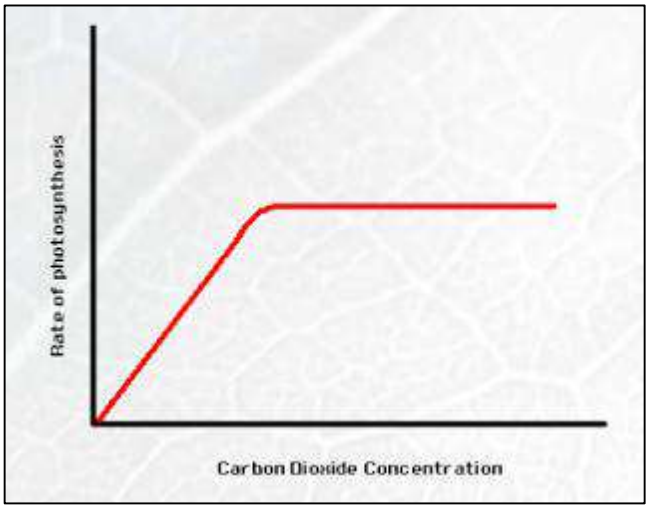


- At temperatures above 40°C the rate slows down. This is because the enzymes involved in the chemical reactions of photosynthesis are temperature sensitive and destroyed (denatured) at higher temperatures.



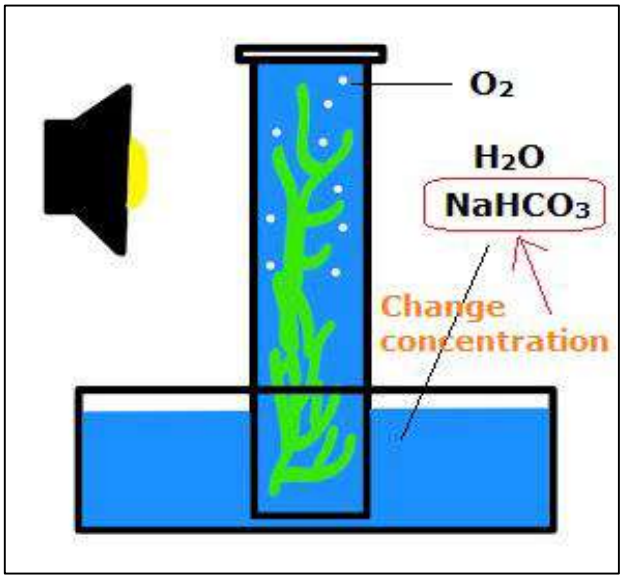
Effect of CO2 on the Rate of Photosynthesis

- When the concentration of CO2 is low the rate of photosynthesis is also low. (the plant has to spend time waiting for more CO2 to arrive). Increasing the concentration of CO2 increases the rate of photosynthesis.



Experiment

- Place a pond weed Elodea upside in a test tube containing water at 25°C.
- Place the tube in a beaker of fresh water.
- Place excess sodium bicarbonate (NaHCO3) in the water to give a constant saturated solution of CO2.
- Place the lamp (the only light source) at a fixed distance from the plant.
- Maintain the room temperature at 20°C.



- Count the number of oxygen bubbles given off by the plant in a one - minute period. This is the rate of photosynthesis at that particular concentration of CO2.
- The gas should be checked to prove that it is indeed oxygen – relights a glowing splint.
- Repeat at different lower CO2 concentrations by using different dilutions of a saturated solution.
- Graph the results placing CO2 concentration on the x-axis.

Explanation

- The rate of photosynthesis increases linearly with increasing CO2 concentration (from point A to B).
- The rate falls gradually, and at a certain CO2 concentration it stays constant (from point B to C). Here a rise in CO2 levels has no effect as the other factors such as light intensity become constant.

Mineral Nutrients

Plants require mineral salts from their environment. These are absorbed as ions in solution.

➢ Each mineral element has a specific function in the plant.

Uses of mineral elements and their deficiencies

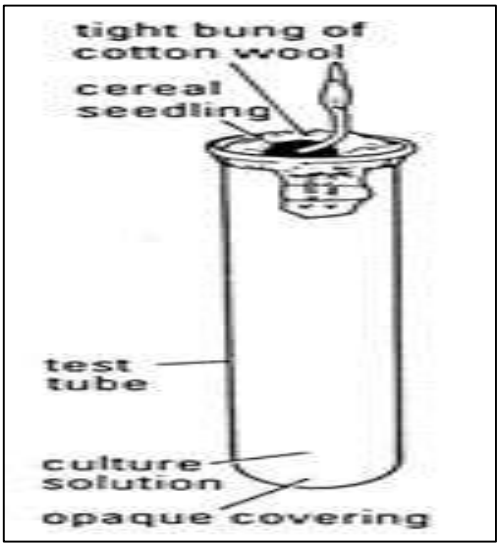
Experiment 1

Investigating the effects of mineral element (NPK) on plant growth.

Materials

Young wheat or pea seedlings, test tubes, mineral solutions / culture solutions, cotton wool, foil or black paper, stands for test tubes.

Method



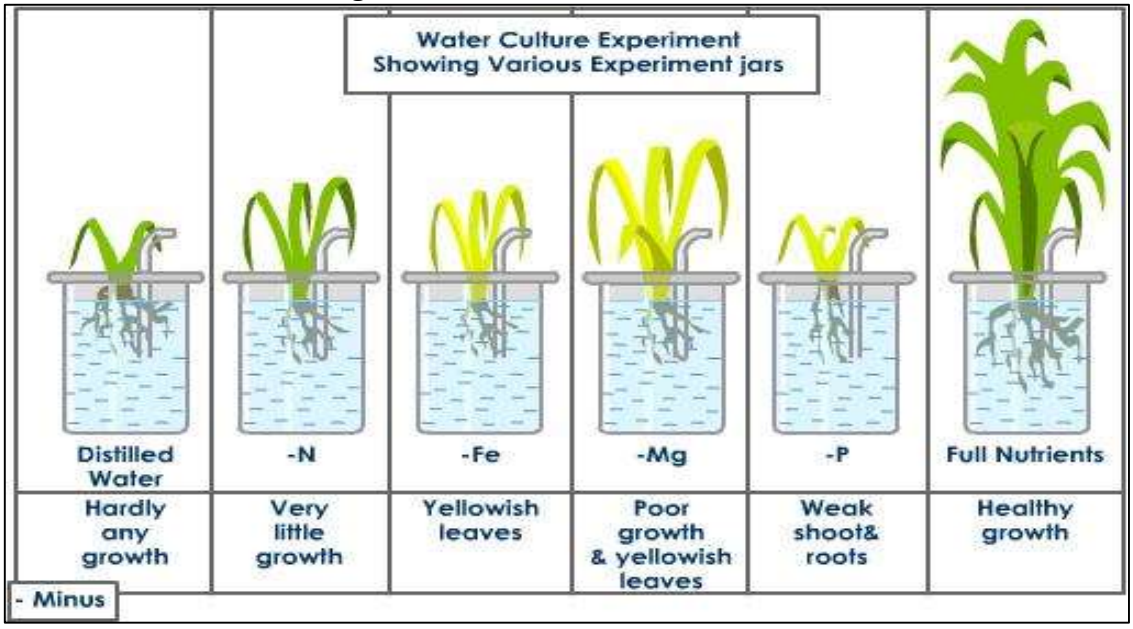
i. Set up the apparatus as above, dark cover prevents growth. Pour culture solutions in test tubes filled with washed sand.
ii. Use five test tubes the first one with all nutrients. The other test tubes have two mineral e except one of each.
iii. Observe the seedling over some weeks.
iv. Examine on daily bases the root length, plant shoots, colour of leaves and number of leaves.
v. Constantly add water where necessary so that there is enough solution.

Results

During the first week all plants in each test tube appear healthy. Because they have all nutrient necessary stored in their leaves.

There will be very little growth in plant with distilled water.

After these mineral deficiency show up and these are as below:



Results explaned:

Mineral element	Uses	Source	Deficiency
Nitrogen (N)	• Protein formation • Good leaf growth	Ammonium compounds	• Stunted growth • Yellowish of leaves(chlorosis)
Phosphorus (P)	• Producing energy carriers • Good root growth	Phosphate compounds	• Purple leaf colour • Stunted root growth
Potassium (K)	• Flower and fruit formation • For respiration and photosynthesis • For osmosis and ionic balance	Potassium sulphate Potassium chloride	• Yellow/brown leaf margins • Early death of fruits and flowers • Poor flower and fruit setting

Productivity

It refers to the amount of organic matter or biomass produced in a certain unit of time. Biomass is the mass of living biological organisms in a given area such as a farm field or ecosystem. It can be expressed as average mass per unit area.

Factors affecting productivity

- Availability of mineral nutrients.
- Supply of water.
- Temperature.
- Pests and diseases.
- Light.

Plant pests and diseases

A pest is an insect or organism that damages plants or food like grains. Pests are classified according to their feeding or their characteristics i.e. we have tissue eating pests, sucking pest and boring pests.

- Tissue eating pests:
  Affect the plant by biting and chewing plant roots, stem and leaves. They have got jaws which leaves holes, gaps and cut edges e.g. locusts, caterpillars, snail, beetles etc.
- Sap-sucking pests
  Affect the plant by sucking the juices. They have got a needle like mouth which piece through the plant tissue to suck the sap. They cause spots on leaves and stem resulting in wilting and premature drop e.g. aphids and red spider.

- Bacterial wilt diseases
  Affect the plant by blocking the xylem vessels of plants so that water and mineral salts cannot be transported e.g. bacterial wilt of tomatoes. Can be controlled by improving drainage and using good seed and rotating crops.
- Fungal rust diseases
  Parasite fungi cause white and brown particles on leaves preventing the plant from photosynthesis. Controlled by using resistant varieties.

Pest control methods

Pests cause damage to plants and spread diseases. This result in a reduction in crop yields. Control measures can be taken as follows:

Cultural- a way of reducing pests and damage that may be caused by using farm operations that make it more difficult for a pest to establish itself. Or which don't make use of chemicals

a) Early planting.
b) Weed removal.
c) Crop rotation.
d) Clean plant environment.
e) Organic manure and fertilizer.
f) Burning and burying crop residues.
g) Fumigation of tobacco seed beds with wood smoke and spraying with a mixture of milk water to reduce disease infection in maize.

Advantages	Disadvantages
Low cost	Their effect takes times to be felt / are slow acting.
Easily accessible natural resources e.g. milk and ashes.	Need to be frequently carried out and applied e.g. crop rotation.
Does not disturb the ecosystem / are safe.	

Chemical - use of chemicals through spraying or dusting. A pesticide is a substance that kills pests. Fungicides are used to kill fungi.

Advantages	Disadvantages
It is a quick method	expensive
Specific (only affects one pest).	Kill or damage other animals.
Pests can be controlled when used correctly.	May stay in the soil affecting other animals in the food chain e.g. DDT
	High and high doses are needed as pest become resistant to chemicals.

Biological – involves the introduction of a parasite or a predator which is an enermy to the pests that need to be destroyed e.g. African marigold (plant) reduces nematodes in soil, a fungus called Trichoderma damage another called Rhizoctonia in potatoes.

Advantages and Disadvantages of Biological Control Methods

Method	Advantages	Disadvantages
Biological	It is cheap to use natural enemies to control pests	A completely different pest may find the so called natural enemy suitable food source

Transport

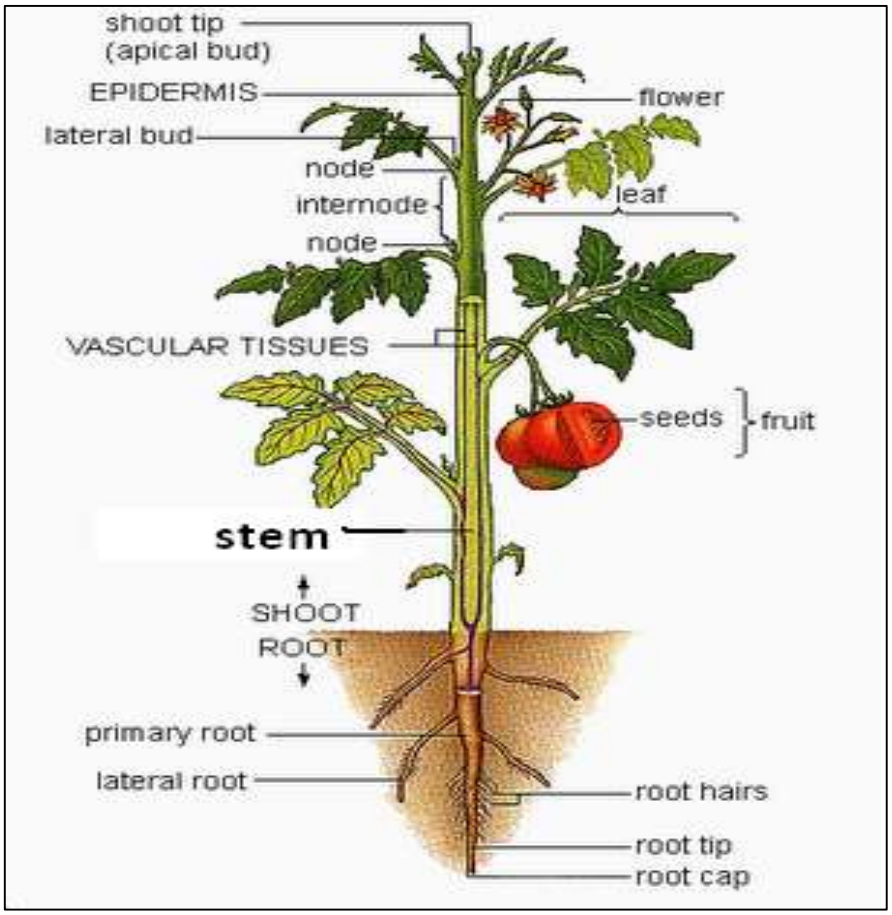
Transport

Is all about passing nutrients from one place to another to favour the living organism's growth.

Plants need some essential substances such as:

- carbon dioxide
- water
- mineral ions etc to photosynthesise and grow.

Plant Structure

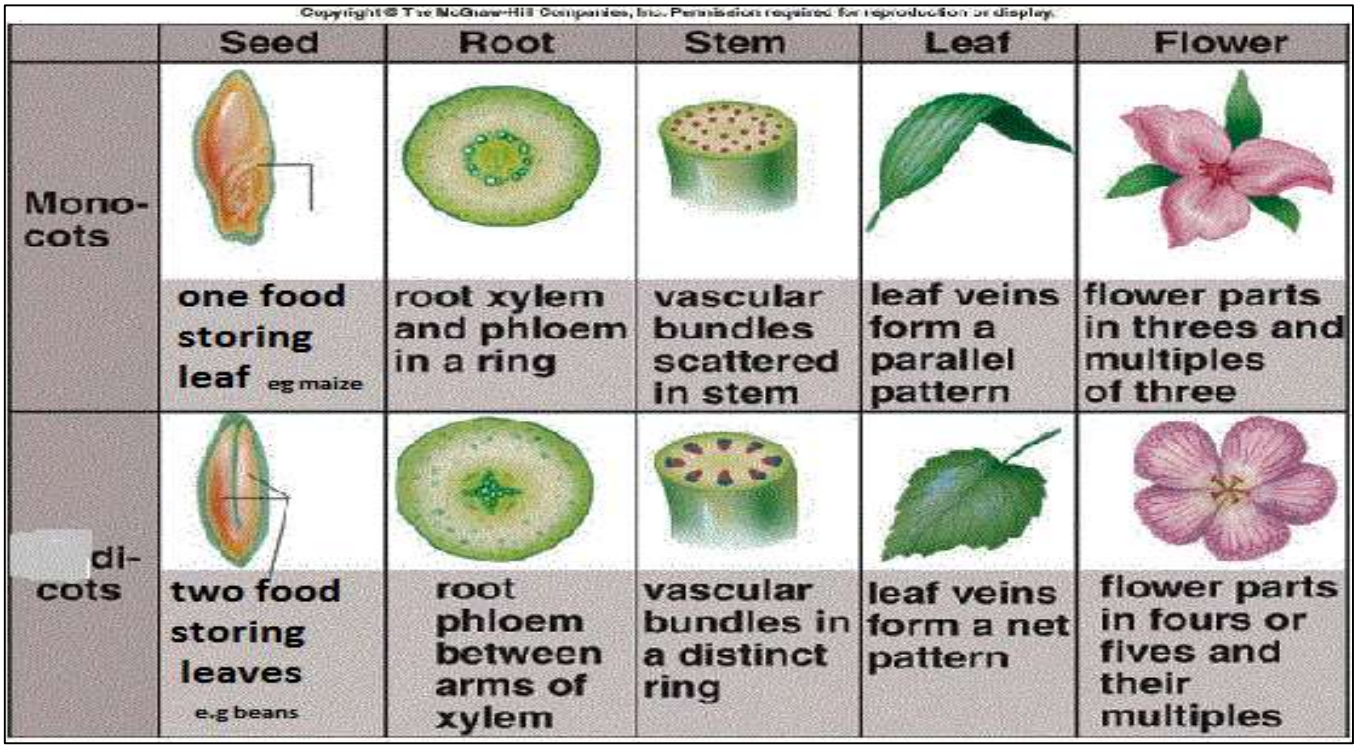


- A plant is divided into two section, whatever is above the soil, is called the shoot, and whatever is below the soil is called the root.
- The root is simple, it is usually a main root with extensions of thinner ones.
- The shoot however, is made of several parts as shown above.
- The roots have the specialised cell, root hair cell, the root hair cells absorbs water from the soil and fixes the plant into the ground.
- In the root also, starts the transports system of the plant which extends all the way from the root up to the tip of the stem.

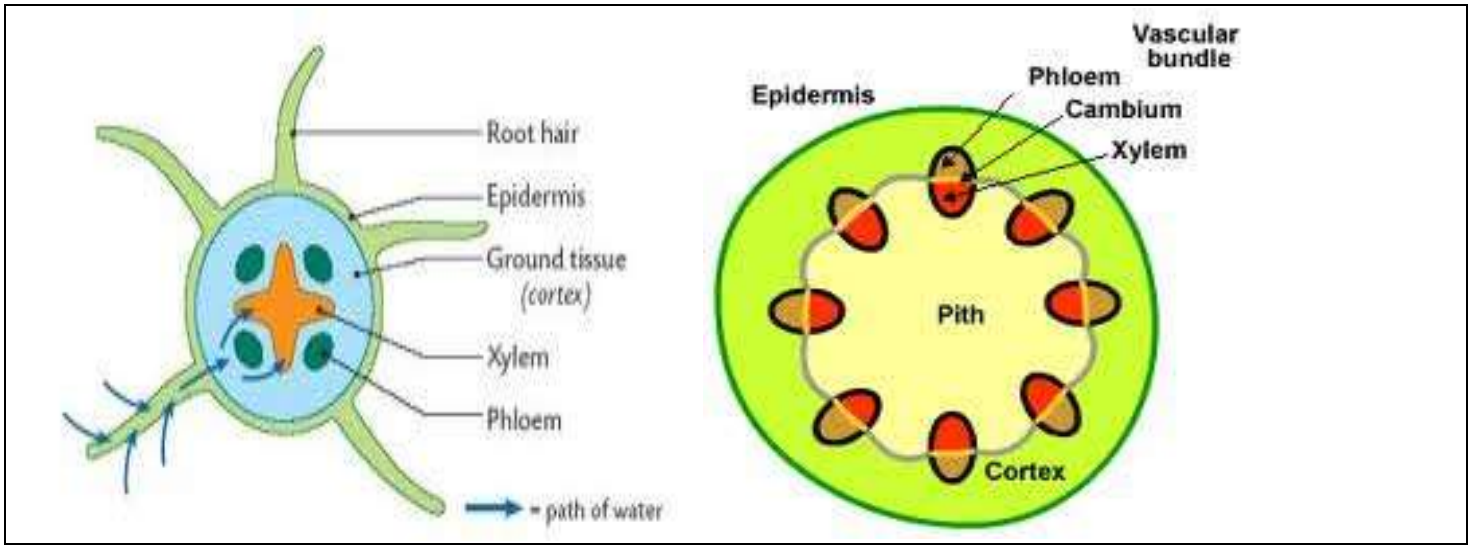
QN: Explain the parts of the shoot and root. [6]

Monocotyledonous and Dicotyledonous Plants

Plant Part	Monocot	Dicot
Root System	Adventitious root only	Adventitious root, Taproot or both
Cotyledons	One	Two
Stem	Vascular bundles scattered	Vascular bundles arranged in a ring
Leaves	Exhibit parallel venation	Exhibit reticulate venation
Flower	Either trimerous, tetramerous, seldom pentamerous	Either pentamerous, tetramerous, seldom trimerous



Root and stem structure

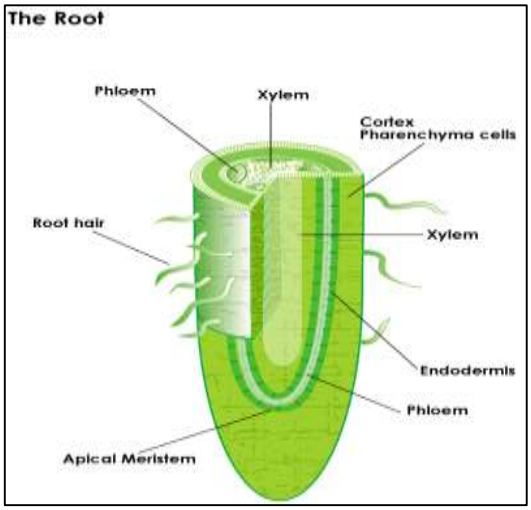


Part	Function
Epidermis	Protection from damage and prevent entry of bacteria and fungi.
Cambium	Produce xylem and phloem vessels.
Phloem	Transports soluble food
Xylem	Transports water and mineral salts.
Cortex and pith	Gives root and stem strength and stability
Root hairs	Absorbs water and mineral salts.

Roots and water uptake

Plants take water from the soil through their roots. Roots have root hairs to absorb water and minerals from the soil.

Structure of a root:



- At the very tip is a root cap. This is a layer of cells which protects the root as it grows through the soil.
- The rest of the root is covered by a layer of cells called the epidermis.
- The root hairs are a little way up from the root tip. Each root hair is a long epidermal cell.

Function of roots:

- Root hairs provide a large surface area and help significantly in the absorption of water.
- They provide anchorage to the plant
- They also absorb mineral ions through active transport
- Water moves through the root hairs through osmosis:

1. The water outside the root is in its dilute form (High water potential)
2. The water inside the root is in concentrated form (Low water potential)
3. Thus the water diffuses from a region of high water potential to a region of low water potential, down their water potential gradients, through a partially permeable cell membrane.

Transpiration

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

Importance of Transpiration

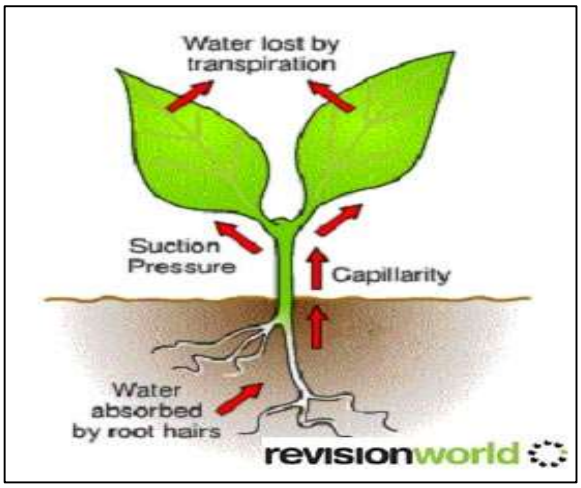
- For continuous absorption of water. The continuous flow of water from the roots up the stems and out of the leaves is called transpiration stream.
- For the plant to take up dissolved mineral nutrients/ions.
- It has a cooling effect on the plant due to evaporation.
- Transpiration has significant importance in the water cycle.

The process of transpiration:

1. The mesophyll cells in the plant's leaves are covered with a thin film of moisture.
2. The sun's heat causes some of this moisture to diffuse out of the stomata and evaporate into the atmosphere.
3. Water from the xylem vessels travel to the mesophyll cells by osmosis and replace the water loss.

The transpiration stream:

- Water enters root hairs by osmosis
- Water moves up the root and reaches the xylem vessels
- The pressure at the top of the xylem vessels is lower than at the bottom
- This causes the water to move upwards through the xylem vessels till the leaf's mesophyll cells
- The water is lost through the leaves through the stoma.



Measuring transpiration rates

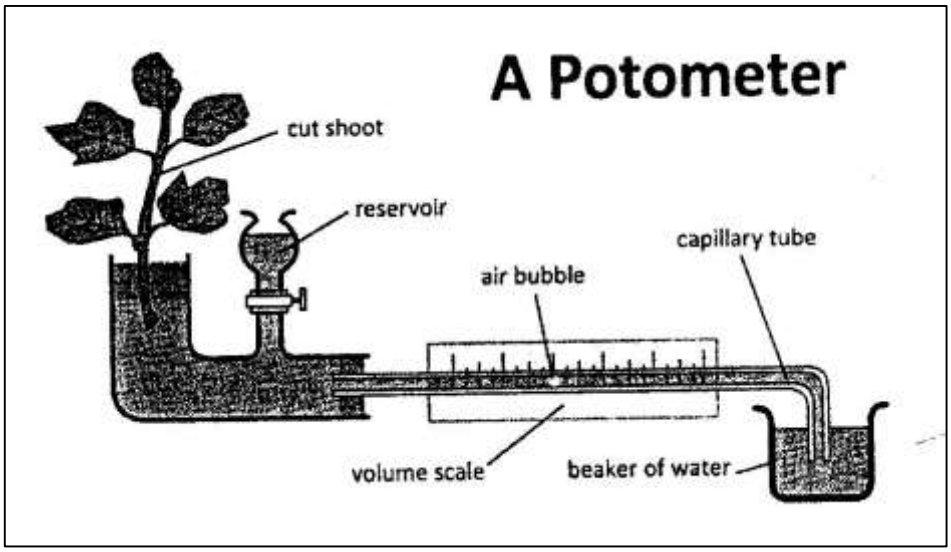
- Transpiration rate in a plant can be measured using apparatus called a potometer
- The rate of transpiration is measured by calculating how fast the air-water meniscus travels through the capillary tube.

Experiment 1

Investigating factors affecting the rate of transpiration

The apparatus shown below is called a potometer. It is used to measure the rate of transpiration.

Method



- Cut a woody shoot and immediately place the cut edge of the shoot under water.
- Immerse the potometer complelely under water in a big bowl or sink with the tap under the reservoir open. Make sure the potometer is completely filled with water and that there are no air bubbles.
- Put the cut stalk of your leafy shoot into the water in the sink and cut off the last centimetre of the stem obliquely under water.
- With the potometer and the stalk of the shoot still under water, fit the stalk into the rubber bung. It must fit very tightly.
- Close the tap under the reservoir and remove the shoot and potometer from the water. Clamp in position if necessary and keep in a still, lit position.
- Any air bubbles in the capillary tube should be expelled by opening the tap to let water run into the potometer bottle from the reservoir.
- At this stage if the apparatus is not air tight, water will be seen oozing out from the sides of the stopper. If necessary smear some Vaseline around the rubber stopper to prevent any leakage.
- Prepare a results table.
- Record the distance the air bubble travelled in mm every minute for at least l0mins
- Calculate and record the distance travelled in mm per min.
- Repeat at least twice and calculate the average distance.

The conditions can now be changed in one of the following ways:

- Move the apparatus into sunlight or under a fluorescent lamp.
- Blow air past the shoot with an electric fan or merely fan it with an exercise book.
- Cover the shoot with a plastic bag.
- After each change of conditions, take three more readings of the rate of uptake and notice whether they represent an increase or a decrease in the rate of transpiration.

Results

- An increase in light intensity should make the stomata open and allow more rapid transpiration.
- Moving air should increase the rate of evaporation and, therefore, the rate of uptake.
- The plastic bag will cause a rise in humidity round the leaves and suppress transpiration.

Limitations of the potometer

- Not all the water taken up will be transpired; some will be used in photosynthesis; some may be absorbed by cells to increase their turgor. However, these quantities are very small compared with the volume of water transpired and they can be disregarded.
- The rate of uptake of a cut shoot may not reflect the rate in the intact plant. If the root system were present, it might offer resistance to the flow of water or it could be helping the flow by means of its root pressure.

Summary

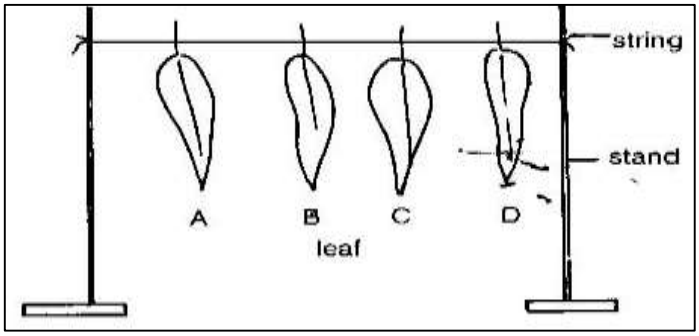
Environmental condition	How transpiration rates are affected
Temperature	Transpiration increases as temperature increases due to increased kinetic energy in water molecules.
Humidity	Transpiration decreases as humidity increases As the difference between the concentration gradients in the leaf and in the atmosphere are similar. (Higher the humidity, greater the water molecules in the air)
Wind speed	The wind increases transpiration rates (as water evaporates more quickly on a windy day)
Light intensity	The greater the light intensity, the greater the chance that a plant will open its stomata to photosynthesise. Hence the greater transpiration will be.
Water supply	In short water supply, a plant will conserve water instead of wasting it. The shorter the water supply, the lesser the transpiration.

Experiment 2

To find which surface of a leaf loses more water vapour

Method

1. Take 4 leaves of similar size.
2. Carefully smear both surfaces of leaf A with petroleum jelly / vaseline.
3. Cover the lower surface of leaf B with petroleum jelly.
4. Cover the upper surface of leaf C with petroleum jelly.
5. Leave the one remaining leaf (D).
6. Weigh each of the leaves on the balance.
7. Place a little vaseline on the cut end of the leaf stalk and suspend a piece of string between two retort stands and attach each of the 4 leaves to the string. Leave until next lesson.
8. Observe the appearance of the leaves and reweigh them.
9. Calculate the loss in mass of each of the leaves.



Observations

- Leaf A does not lose water at all.
- Leaf B loses water.
- Leaf C loses little water.
- Leaf D dries out most or fast.

Results

- More water is lost at D because more stomata are on the lower surface of the leaf.

Conclusion

- The lower surface loses more water than the upper surface of the leaf.

Interpretation

- The vaseline prevents evaporation.
- The untreated leaf and the leaf with its upper surface sealed show the greatest degree of shrivelling, so it is from the lower surface that leaves lose most water by evaporation.
- More rapid results can be obtained by sticking small squares of blue cobalt chloride paper to the upper and lower surface of the same leaf using transparent adhesive tape.
- Cobalt chloride paper changes from blue to pink as it takes up moisture. By comparing the time taken for each square to go pink, the relative rates of evaporation from each surface can be compared.

Translocation

Translocation is the movement of organic food such sucrose and amino acids in phloem; from regions of production (source), to regions of storage OR regions of utilisation in respiration or growth (sink)

- A source is the part of a plant where sucrose and amino acids are being produced by photosynthesis. For example: Leaves

- A sink is the part of a plant where sucrose and amino acids are translocated. For example: flowers, roots, tubers etc.

Uses of sucrose:

- In the Roots: sucrose is changed to starch and may be stored
- In the Flowers: sucrose is converted to sweet tasting nectar (fructose) and is used to attract animals (yum!)
- Developing parts of plant: sucrose and amino acids are translocated to growing parts of the plant for development.

Translocation during different seasons

- Many plants have a time of year when they become dormant.
- During this stage, they wait out harsh conditions in a state of reduced metabolic
- Dormant plants do not photosynthesise, but survive on their stored starch, oils and other materials.
- When the seasons change, they begin to grow again.
- Now the stored materials are converted to sucrose and transported to the growing region.

For example, potato plants are not able to survive the cold frost of winter. Let's see what happens!

Summer	• Leaves photosynthesise and send sucrose down into underground stems. • Here, swellings called tubers develop. • The cells in the root tubers change the sucrose to starch and store it.
Winter	• The leaves and stems wear off (die). • Nothing is left of the potato plant above ground – just the stem tubers beneath the soil.
Spring	• They begin to grow new shoots and leaves. • The starch in the tubers is changed back to the sucrose, and transported in the phloem to the growing stems and leaves. • This will continue until the leaves and stems are above ground and start to photosynthesise.

- So in summer, the leaves are sources and the growing stem tubers are sinks.
- In spring, the stem tubers are sources and the growing leaves are sinks.

FORM 3 TERM 2

TOPIC 5

ENZYMES

Nature and Properties of Enzymes

Enzymes

Enzymes are biological catalysts which speed up the reaction rate without getting involved in the reaction itself. Catalysts are substances that can change the speed of a chemical reaction.

- Examples of enzymes: Salivary amylase, Pepsin, Renin, Lipase, Catalase Maltase, Lactase etc.

Types of Enzymes:

- Carbohydrase- digests carbohydrates (eg:- Salivary amylase)
- Protease- digests proteins (eg:- pepsin)
- Lipase- digests fats (eg:- Enzymes from pancreas)

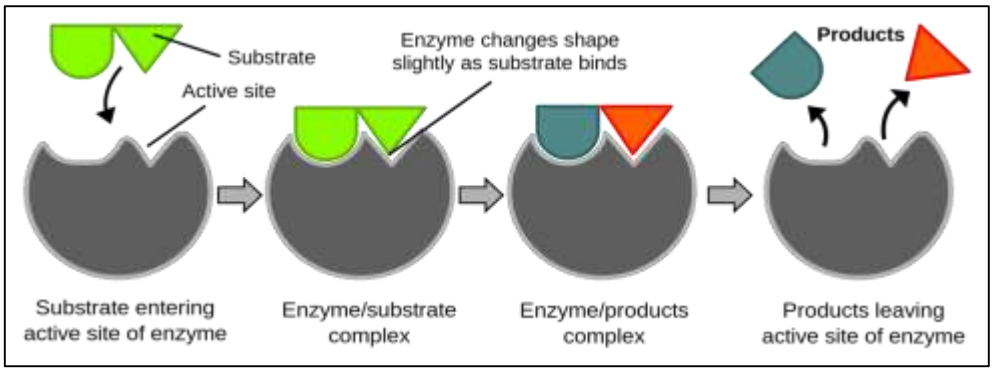
How an enzyme works:

- Enzymes have a structure that is called active site. Only one substance can fit into the active site to be digested, and it is the only substrate that this particular enzyme works with.

The figure below shows how enzymes work:

- The substrate enters the active site of the enzyme.
- The reaction takes place.
- The substrate exits the enzyme as two simpler products.

You can also think of the way enzymes work as a key and a lock, the key is the substrate and the lock is the enzyme. The key should be exactly the right shape to fit in the lock, so does the substrate to fit in the active site of the enzyme. The key could only open only one lock, and the lock could be unlocked by only that key.



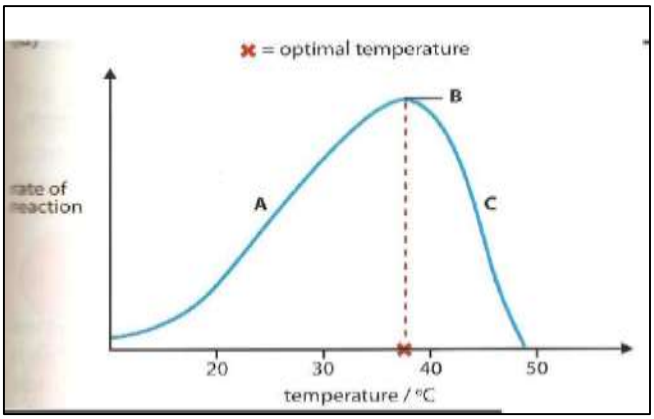
Properties of Enzymes:

- All enzymes are proteins
- All enzymes work best at a specific temperature, known as the optimum temperature
- Enzymes get denatured (lose shape of their active site) if it's optimum temperature is exceeded.
- Enzymes even work the fasted at a specific pH and like temperature, get denatured when the pH exceeds the optimum
- They alter or speed up the rates of chemical reactions that occur in a cell.
- They remain unchanged after a chemical reaction.
- They are specific →"Lock & Key" hypothesis (One enzyme act on one substrate)
- They may need other enzymes to work (Coenzymes).
- They catalyse reversible reactions.

Factors affecting Enzymes:

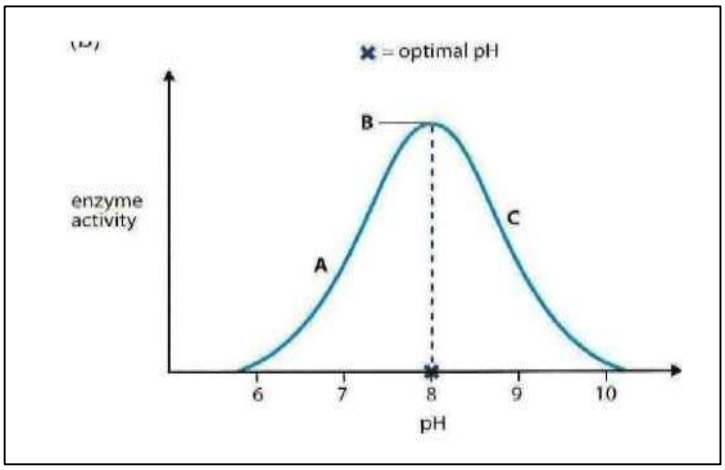
Temperature:

- As the temperature of a reaction mixture increases, the kinetic energy inside the reacting particles increases as well
- This leads to a high collision frequency to build up.
- This causes the substrate and the enzyme to collide more frequently and thus increase the rate of reaction.
- However, at a certain temperature, the enzyme loses the shape of its active site resulting in rate of reaction to drastically fall.



pH

- The pH for any enzyme to work depends upon it's environment of production
- For most enzymes in the human body, the optimum pH is 7 (neutral)
- However, there are a few exceptions such as pepsin the enzyme that works in the stomach where dilute hydrochloric acid is secreted and pH is as low as 2
- Enzymes can work at pH slightly higher or lower than their optimum pH



TOPIC 6

ANIMAL SCIENCE

Nutrition

Diet

A good diet on its own will not make you skillful or fit as a performer or a sportsperson, but will help you make the most of your abilities through nutrition; hence, nutrition is very important. Your body is an endothermic one and has the ability to maintain a constant body temperature and a lot of energy is needed to do so. Moreover, the electrical impulses that are transmitted by the neurones in your body as well need energy to do so. Thus it is important that you should have a good balanced diet to get all the seven nutrients beneficial for nutrition.

Balanced Diet

A balanced diet is a diet that contains all the main nutrients in the correct amounts and proportions to maintain good health. Everyone, whether involved in sport or not should try to eat a healthy balanced diet.

Components of a Balanced Diet

Carbohydrates

They are needed for energy to do all types of work and are required in large quantities. Sugars and starch are important carbohydrates in a diet. Starch includes maize, rice and other cereals. Sugars are in fruits such as mangoes and apples and biscuit and sweet drinks.

Proteins

These are for building of tissue and repair of worn out tissues or cells. Proteins are obtained from lean meat, fish, milk, eggs, round nuts, peanut butter, cow peas and e.tc. When proteins are digested, they are broken down into amino acids. These acids are absorbed into blood stream and build up the cytoplasm of cells and tissues. The unused amino acids are changed to glycogen and then stored or oxidized to provide energy.

Fats

Fats help the body from losing heat therefore, one feels warmer. Fats also provide energy, but fats only contain carbon, hydrogen and oxygen in different proportions as to the carbohydrates. Sources of fats are peanut butter, cooking oil, fat meat and margarine.

Mineral salts

They are sometimes referred to as fast salts or minerals. Protein, carbohydrates and fats provide the body with carbon, hydrogen, sulphur, oxygen and phosphorus. However, there are more elements found in food we eat e.g. calcium, sodium, iron and others. Calcium is for building bones and teeth and other salts maintain the body in shape and function and iron makes up blood. Food such as fish, eggs, dried vegetables, liver meat and ishwa contain mineral salts.

Water

About 70% of most tissues consist of water. The functions of water include:

- ✓ As a solvent which reactants of metabolic reactions are dissolved in.
- ✓ It makes up most of the blood plasma which red blood cells, nutrients, hormones and other materials are carried in.
- ✓ It helps in lowering the body temperature in hot conditions by secreting it as sweat on the skin, the sweat evaporates using heat energy from the body, thus lowering the temperature.
- ✓ water is obtained from fruits such as oranges and cucumbers and melons.

Vitamins

They are needed for many functions including:

- Releasing energy from food
- Resisting infections and diseases
- Repair and growth of tissues
- Regulating chemical reactions in the body
- Fruits and vegetables contain a lot of vitamins for example from cabbages, tomatoes okra, milk, fruits, eggs and carrots.
- Fat soluble vitamins: A, D, E, K
- Water soluble vitamins: B,C

The table below gives important information about vitamins:

- Vitamin A: is found in fish, milk, vegetables, eggs and cheese. It is needed for good eyesight and healthy skin.
- Vitamin C: is found in citrus fruits and vegetables. It is needed for healthy teeth, gums, and to prevent scurvy.
- Vitamin B1: is found in whole-grain food, nuts and meat. It is needed for breaking down carbohydrates.
- Vitamin D: is found in animal products such as milk and egg. It is also made in the presence of sunlight by the skin. It is crucial for absorbing calcium and phosphorous and to avoid rickets.

Minerals:

- Minerals are basic elements that are found in the air and in the earth's crust.
- Our body needs certain minerals in small proportions in order to maintain the nutrient stability.

Below are the names of some minerals needed by our body, where they are found and their importance:

- Calcium: is present in vegetables, dairy products and dried fish. It is significant for keeping our bones strong.
- Iron: is found in red meat, liver, beans, lentils and green leafy vegetables. It is crucial for making blood and for the prevention of anaemia.
- Iodine: is found in seafood and dairy products. It is needed as it maintains the thyroid gland.

Fibre

Fibres are actually a substance called cellulose. It is found in the cell walls of plants. Fruits, vegetables, whole grain cereals are good sources of dietary fibre. Fibres cannot be digested, but it is beneficial for the smooth

working of the digestive system. People who eat too little fibre often suffer from constipation and may acquire high risk of bowel cancer. Define the term constipation. (2)

Food Tests

Test for Starch: with Iodine solution. If result is positive, a blue-black precipitate forms.

Glucose

A little glucose is heated with some benedict solution in the test tube. The heating is done by placing the test tube in a beaker of boiling water. The solution changes from clear blue to cloudy green, then to yellow and finally to a red or brown.

Protein

Add few drops of biuret solution (sodium hydroxide soln and copper sulphate soln) to sample of food. The blue colour shows presence of protein.

Fat

Two drops of cooking oil are shaken with about 5 cm^3ethanol in a dry test tube until the fat disappears or dissolves. The alcohol is poured into a test tube with water (few). A cloudy white emulsion is formed, this shows that the solution contained some fats or oils.

Foods and Energy

Comparing energy values of foods

Experiment : Comparing energy values of foods.

a) Aim: To investigate energy released by carbohydrates.

Apparatus: mealie- meal, grain, spatula, test tube, water, stand, container, thermometer, string rod, matches e.t.c

Method (see focus on Biology Bk 4 pg45)

Observations

Meali- meal or grain burns but, was difficult to heat.

Produces heat energy which raised the temperature of water gradually.

Results

Carbohydrates burns to give heat energy lower than that when burning fats and oils.

b) To investigate the energy released by oils.

Apparatus: water, c/oil, stand, thermometer, glass tube, container, evapo dish, string and e.t.c

Methods: (See Focus on Biology Bk 4 pg 45)

Observations and results

Oils burns and it was easy to light.

Produce heat energy which raises the temperature of water quickly.

Oils produce high heat value energy) as to carbohydrates.

Test for Vitamin C: with DCPIP. A blue to a colourless liquid forms in presence of vitamin C.

Malnutrition is the result of not eating a balanced diet. There may be:

- wrong amount of food: too little or too much.
- incorrect proportion of main nutrients.
- lacking in one or more key nutrients

Effects of malnutrition

1. Obesity - Too much food (carbohydrate, fat or protein)
2. Coronary heart disease
 Too much saturated/animal fat in the diet results in high cholesterol levels.
 Cholesterol can stick to the walls of arteries, gradually blocking them.
 If coronary arteries become blocked, the results can be angina and coronary heart disease.
3. Starvation
 Too little food can result in starvation.
 Extreme slimming diets, such as those that avoid carbohydrate foods, can result in the disease anorexia nervosa.
4. Childhood protein-energy malnutrition (Kwashiorkor)

Wrong proportion of nutrients e.g. too much carbohydrates (starchy foods) and a lack of protein can lead to kwashiorkor in young children.
Kwashiorkor characterized by edema, anorexia, ulcerating dermatoses.

Energy Calculations:

- 1g of carbohydrates gives 17.1 kJ of energy
- 1g of protein gives 18.2 kJ of energy
- 1g of fat gives 38.9 kJ of energy

Individual energy needs:

- The amount of energy required depends from person to person, depending on a number of factors such as: Age, Size, Sex, Lifestyle, Diet

Summary

Vitamin, minerals, fibre and water

Nutrient	Function	Deficiency	Food sources
Vitamin C	Maintain healthy **skin** and **gums**	**Scurvy**- bleeding under skin, bleeding gums	Citrus fruits, cabbage, blackcurrants, guava, mango, tomato
Vitamin D	-Maintain hard bones -Help to absorb **calcium** from small intestine	**Rickets** - soft bones that become deformed (e.g. bow legs)	-Milk, butter, cheese, egg yolk, fish-liver oil. -Made by **skin** when exposed to sunlight
Calcium	-Formation of healthy **bones** and teeth - Normal **blood clotting**	-Rickets, brittle bones and teeth -Slow blood clotting	Milk, cheese, fish
Iron	-Formation of **haemoglobin** in red blood cells	**Anaemia** (not enough red blood cells → not enough O_2 delivered to tissues): constant tiredness, lack of energy	Red meat, liver, kidney, eggs, vegetables (spinach, cabbage…) , chocolate
Fibre	**Cellulose** adds bulk (mass) to undigested food passing through the intestines, maintaining **peristalsis** (constriction and relaxation)	-**Constipation** -Long-term deficiency leads to **bowel cancer**	Vegetables, fruit, whole meal bread
Water	-Formation of **blood**, **cytoplasm** -Solvent for transport of nutrients and removal of wastes (**urine**) -**Enzymes** only work in solution	**Dehydration**	Drinks, fruit, vegetables

The Digestive System

Processes:

Ingestion

Taking food into the body through the mouth is called as ingestion.

Digestion

The breakdown of large insoluble molecules to small water soluble molecules using mechanical and chemical digestion is called as digestion.

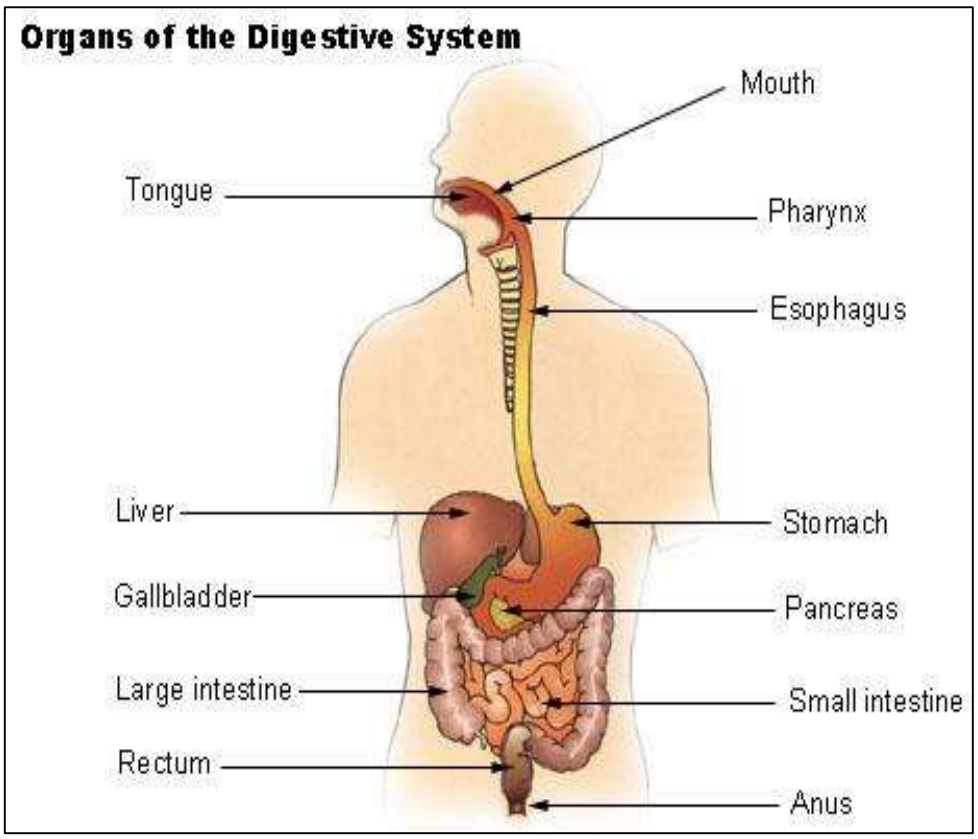
Absorption

The movement of digestive food molecules through the wall of the small intestine, into the blood or lymph is defined as absorption.

Excretion

The removal of waste products of metabolism or nutrients in excess is termed as excretion.

The Alimentary Canal



The alimentary canal runs from the mouth to the anus. It also includes the liver and the pancreas.

Peristalsis is the longitudinal movement of the muscles in the oesophagus that help the food bolus to travel through the alimentary canal.

Sphincter muscles act as valves and are found throughout the canal. they help regulate the movement of food through it.

The Mouth

1. The teeth bite and grind the food into smaller pieces.
2. The tongue helps move the food and mixes it evenly with the saliva.
3. This forms a food bolus.
4. Salivary glands produce saliva containing amylase.
5. Amylase breaks down starch containing food such as bread into maltose.

Amylase

Starch ————————> Maltose

The Oesophagus

Originally, when the food moves through the mouth, there are two tubes leading to different destinations:

1. The trachea
2. The Oesophagus

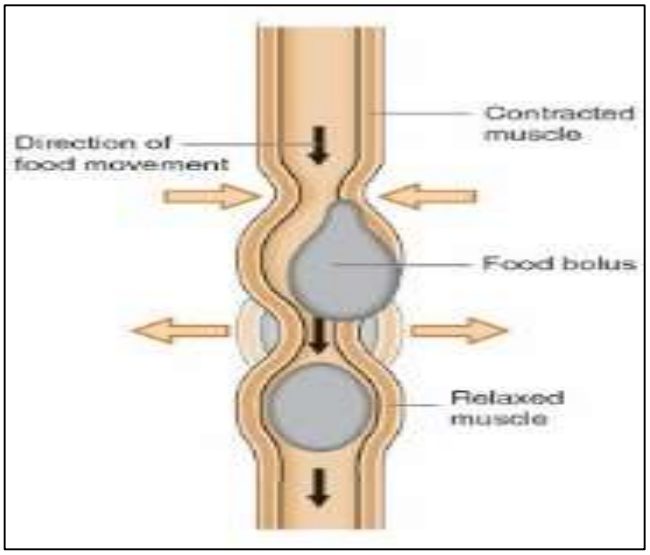
Food needs to pass into the oesophagus and not through the trachea which leads to the lungs.

- To regulate this passage, the epiglottis is used.
- The epiglottis is a cartilage that stops the food from entering into the trachea.

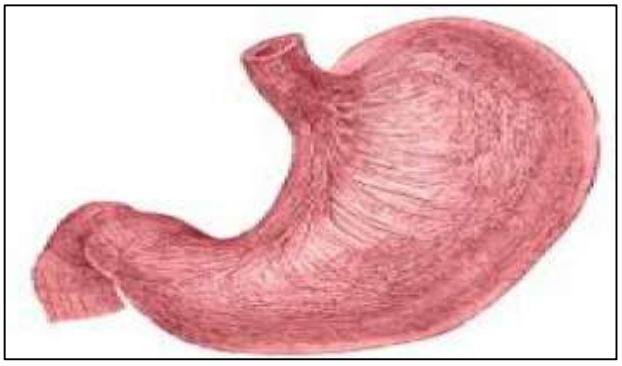
Note: There are no enzymes in the oesophagus and so the food bolus moves unchanged into the stomach.

Peristalsis

- The walls of the alimentary canal have an inner, circular muscle fibre coat and an outer, longitudinal muscle fibre coat.
- As the ball of food (bolus) formed in the mouth enters the pharynx, a reflex action is initiated.
- This produces slow, wave-like contractions in the walls of the oesophagus and later along the whole length of the tract (peristalsis).
- Peristaltic waves involve the contraction of the circular muscle fibres behind the bolus and their relaxation in front of the bolus.
- Longitudinal muscles provide the wave-like action. The two functions together push the ball down the tract.



The Stomach



- It pummels food with its strong muscular walls.

- Dilute hydrochloric acid is also produced and it acts as a barrier by killing any pathogens that may have got into the food.
- The mucus is secreted by goblet cells that are present on the walls of the stomach. the mucus prevents the stomach to get digested by the hydrochloric acid it produces!
- It produces pepsin (an enzyme for digesting proteins) and renin (an enzyme for digesting milk proteins and used to clot milk.), they are also called the protease enzyme.
- To give the right pH for pepsin and renin to work (pH2-acidic).
- To neutralise the alkaline effect of saliva.

Enzymes present:

1.Pepsin: helps the breakdown of proteins to polypeptides

Pepsin

Proteins ——————> Polypeptides

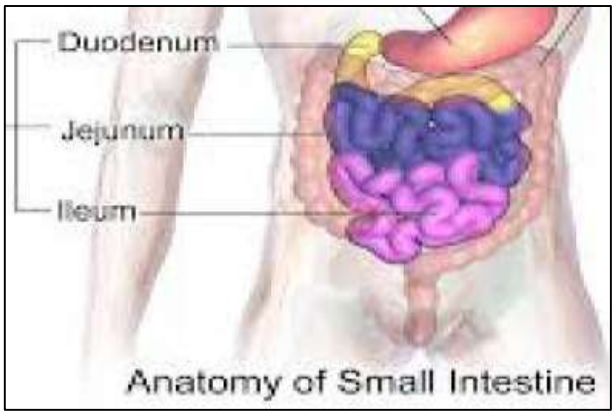
2. Renin: helps the clotting of milk in young mammals

Renin

Milk ——————> Coagulate

- The pyloric sphincter opens the stomach and lets the chyme move into the duodenum.

The Small Intestine

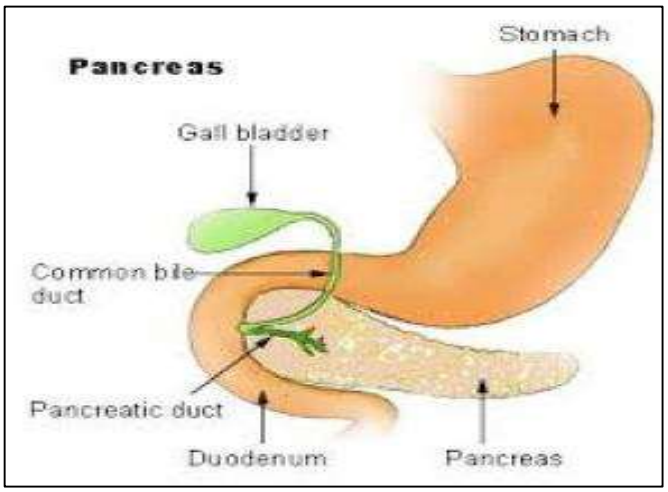


The small intestine is present between the stomach and the colon.

It consists of 3 parts:

1. Duodenum
2. Jejunum
3. Ileum

The Duodenum and the Pancreas



- The duodenum has a duct leading from the pancreas that carries the pancreatic juice to it.
- The Pancreas is a cream coloured gland which is also important for blood glucose concentration control.
- The pancreatic juice contains sodium hydrogen carbonate, which is used to neutralize the acidic chyme so that the enzymes in it can work efficiently.

Enzymes in pancreatic juice:

1. Amylase: Breaks down starch containing food to maltose

Amylase

Starch ——————> Maltose

2. Trypsin: like pepsin, it breaks down proteins into polypeptides

Pepsin

Proteins ——————> Polypeptides

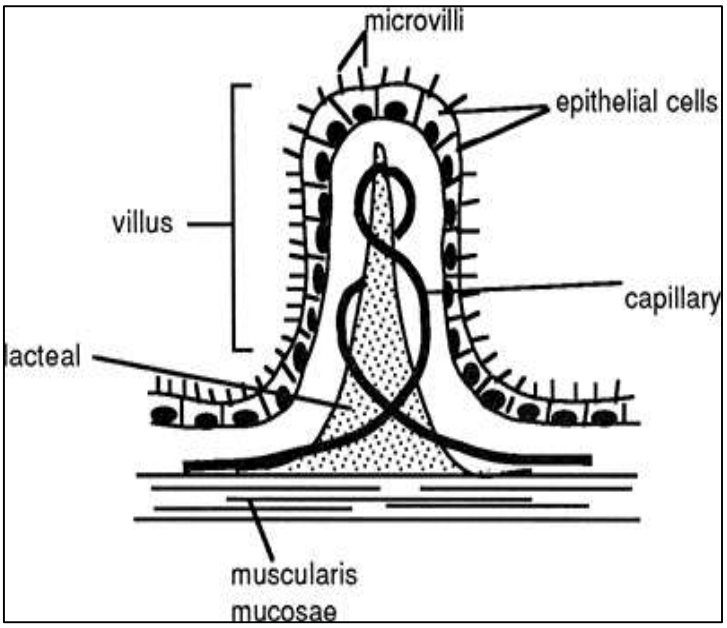
3. Lipase: breaks down fats into fatty acids and glycerol

Lipase

Fats ——————> Fatty acids + Glycerol

- Bile is a yellowish-green, watery liquid, which is made in the liver.
- It is stored in the gall bladder.
- It flows to the duodenum along the bile duct.
- There are no enzymes present in bile but it does contain bile salts that emulsify fats.
- Bile also contains bile pigments which are produced when red blood cells are broken down in the spleen.

Villi



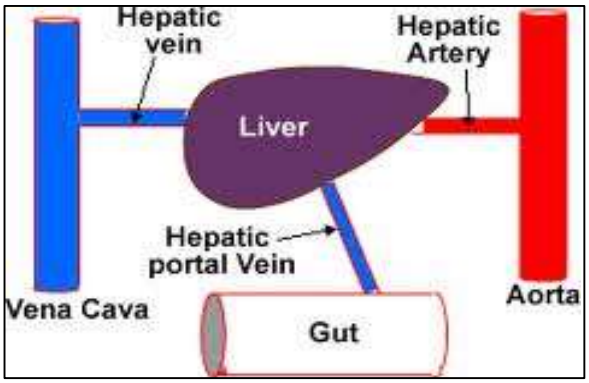
- Food is completely digested and absorbed in the parts of the small intestine.
- This happens with the help of the villi which is present on the walls of the stomach.
- The villi has special features that makes it efficient in absorption of food. Some include:
- It has a large surface area
- It has microvilli on its surface that again, amplifies the surface area.
- It has goblet cells on its surface that produce mucus and lubricate the intestine walls.
- It can secrete a wide range of enzymes in order to break the food in its simplest form.
- It is structured in such a way that the enzymes are recycled and don't go waste in a single digestion cycle.
- It has a lacteal that can absorb fats and take it to the hepatic portal vein to the liver.

Absorption

Absorption is the process by which digested food are transferred into the blood stream through the villi of the ileum.

- The capillaries of the villi will join up to form the hepatic portal vein which carries blood to the liver. When the absorbed nutrients reach the hepatic portal vein, the liver:

- produces urea
- transports the absorbed nutrients to the cells.
- converts glucose to glycogen.



Assimilation

Assimilation is the process by which some of the absorbed food materials are converted into new protoplasm or used to provide energy.

Uses of glucose and fats:

- For energy (to respire).
- Making new cells.
- Repair & replace damaged tissues.

- Production of other proteins such as enzymes and hormones.
- Fats are used to form part of a cell such as the cell membrane and the nuclear membrane.
- Fats are used as insulators.

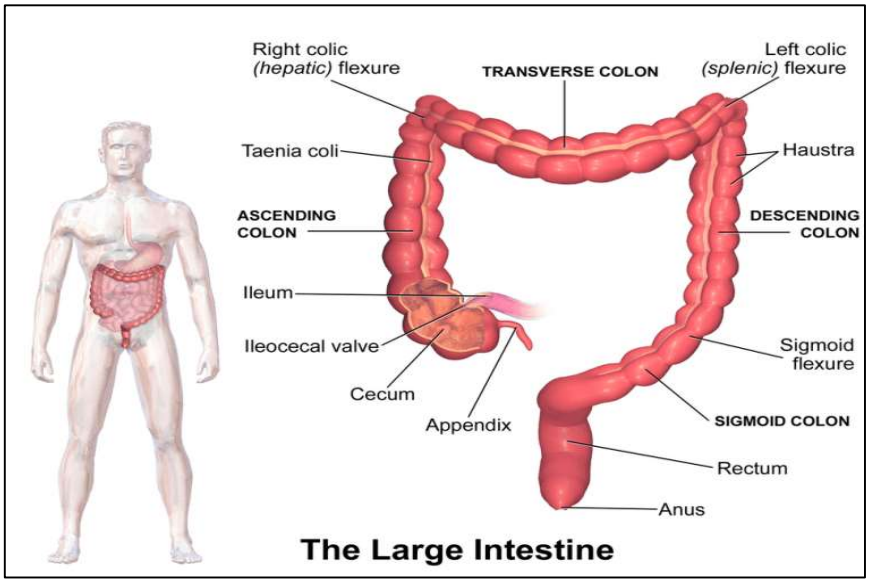
Role of the liver

- ❖ Synthesis of proteins, immune and clotting factors, and oxygen and fat-carrying substances.
- ❖ Its chief digestive function is the secretion of bile, a solution critical to fat emulsion (emulsification) and absorption.
- ❖ The liver also removes excess glucose from circulation and stores it until it is needed. It converts excess amino acids into useful forms(glucose and urea) i.e. deanimation and filters drugs and poisons (alcohol, pills etc) from the bloodstream, neutralising them and excreting them in bile.
- ❖ Urea is a nitrogenous substance which is sent to the kidneys for disposal.

Enzymes present:

1. Maltase: breaks down maltose into glucose
Maltose
Maltose ————-> Glucose
2.Sucrase: Breaks down sucrose into glucose and fructose
Sucrase
Sucrose ————-> Glucose + Fructose
3. Lactase: Breaks down lactose into glucose and galactose
Lactase
Lactose ————-> Glucose + Galactose
4. Peptidase: Breaks down polypeptides into amino acids
Peptidase
Polypeptides————> Amino acids
5. Lipase: Breaks down fats into fatty acids and glycerol
Lipase
Fats ————> Fatty acids + Glycerol

Large Intestine



- In the large intestine, caecum and appendix have no functions.
- The Colon specializes in the absorption of water and salt.

- In the rectum, faeces are formed, which is an undigested mixture of undigested food, bacteria, bile pigments and some dead cells.
- Faeces are disposed out of the body, at the end of the alimentary canal.

Experiment 3

Gut Model to illustrate chemical digestion and absorption

- Collect a 15 cm length of visking tubing which has been softened in water.
- Tie one end tightly. Use a syringe to introduce 2% starch solution into the visking tubing, to about two thirds full.
- Add 2 cm3 of 5% amylase solution (or saliva if it is permissible).
- Pinch the top of the visking tubing to keep it closed, before carefully mixing its contents by squeezing the tubing.
- Rinse the outside of the visking tubing thoroughly with tap water, then place it in a boiling tube, trapping the top of the tubing with an elastic band.
- Add enough distilled water to cover the visking tubing.
- Test a small sample of the distilled water and the contents of the Visking tubing for starch and reducing sugar, using iodine solution and Benedict's solution.
- Place the boiling tube in a beaker of water or a water bath at 37 °C.
- After 20 minutes, use clean teat pipettes to remove a sample of the water surrounding the visking tubing and from inside the visking tubing.
- Test some of each sample for starch, using iodine solution, and for reducing sugar, using Benedict's solution.
- Also test some of the original starch solution for reducing sugar, to make sure it is not contaminated with glucose.

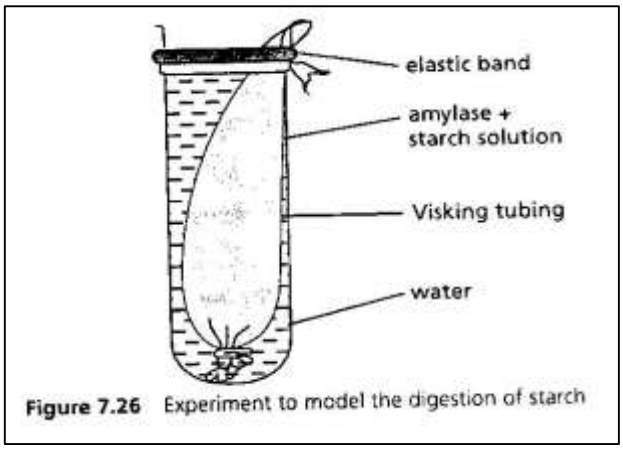


Figure 7.26 Experiment to model the digestion of starch

Results

- At the start of the investigation the distilled water tests negative for starch (stays brown) and reducing sugar (stays turquoise). The contents of the visking tubing are positive for starch (blue-black), but negative for reducing sugars (stays turquoise).

- After 20 minutes, the contents of the visking tubing are yellow/brown with iodine solution, but turn orange or brick red with Benedict's solution. The water sample stays yellow/brown with iodine solution, but turns orange or brick red with Benedict's solution.

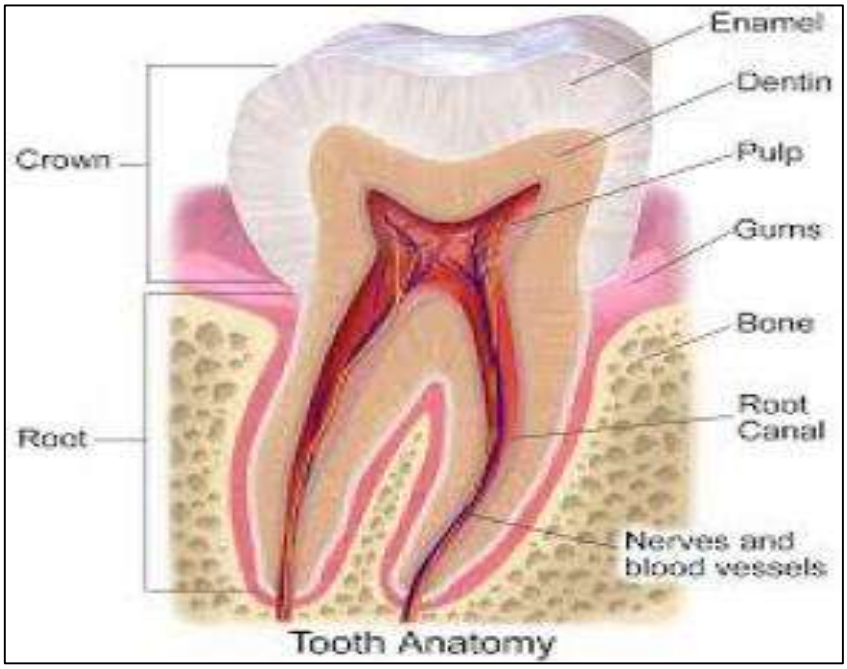
Interpretation

- The amylase digests the starch in the visking tubing, producing reducing sugar.
- The complete digestion of starch results in a negative colour change with iodine solution.
- The presence of reducing sugar (maltose or glucose) causes the Benedict's solution to turn orange or brick red.
- The reducing sugar molecules can diffuse through the visking tubing into the surrounding water, so the water gives a positive result with Benedict's solution.
- Starch is a large molecule, so it cannot diffuse through the tubing: the water gives a negative result with iodine solution.

This model can be used to represent digestion in the gut. The starch solution and amylase are the contents of the mouth or duodenum. The visking tubing represents the duodenum wall and the distilled water represents the bloodstream, into which the products of digestion are absorbed.

Teeth

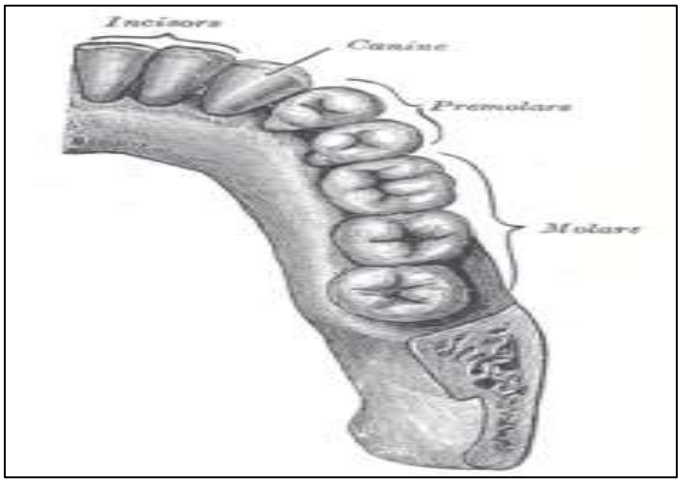
The structure of teeth:



- The teeth specialise in mechanical digestion of food.
- They can grind, chomp, tear and crush food in order to break it down to smaller and simpler pieces of food,
- The part of the tooth which is embedded into the gum is called the root.
- The part which can be seen is known as the crown.
- The crown is covered by the enamel which is the hardest naturally produced substance amongst animals.
- Beneath the enamel is a large layer of a less hard bone, called the dentine.
- The dentine has channels in it containing living cytoplasm.

- Beneath the dentine is the pulp cavity. It contains nerves and blood vessels.
- The root of the tooth is covered with cement. It has fibres growing out of it. It attaches the tooth to the jawbone, but allows it to move slightly when chewing.

Types of teeth in mammals:



1. Incisors: are chisel shaped for biting off pieces of food.
2. Canines: are similar to incisors but instead of a chisel shape, they have a sharp pointed crown and are used to tear off meat.
3. Premolars: are plateau shaped teeth which specialise at grinding food.
4. Molars: are like premolars and are also used to grind food.

Animals have two sets of teeth in their lifetime:

1. Milk teeth: the teeth which form during 5-30 months of your life. There are usually 20-22 milk teeth.
2. Permanent teeth: the teeth that replace milk teeth when you grow towards your teens. There are usually 32 permanent teeth.

Plaque

Some of the bacteria, together with other substances in your mouth, form a sticky film over the teeth, especially next to the gums and in between the teeth. This substance is known as plaque.

Tartar

Plaque is soft and easy to remove at first. However, if it is left, it hardens to form tartar, which cannot be removed by brushing.

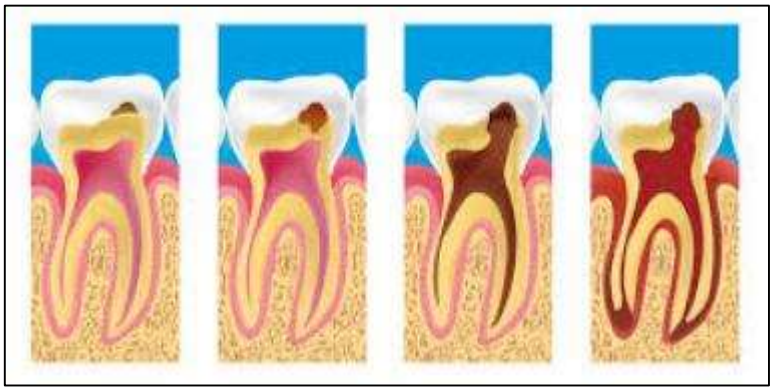
Gum Disease

If plaque is not removed, the bacteria may infect the gums.

- The gums swell, becoming inflamed.
- They may even bleed when you try brushing your teeth.

- this is normally painless; however, if bacteria are allowed to grow, they may work their way down to the root of the tooth!
- the tooth will then become loose and will need removing.

Tooth Decay



If sugar is left on the teeth, bacteria in the mouth will feed on it. Soon, due to the metabolic reactions going in the bacteria's body, an acidic solution will be produced which lowers the pH of the mouth and has the potential to dissolve the enamel.

As the bacteria grow, greater volumes of acidic solution are produced. The acid gradually reaches the dentine which gets dissolved even faster and then worms its way down the pulp cavity.

The bacteria can grow up to such an extent that an abscess is created by it at the root of the tooth, causing excruciating pain!

A person suffering from tooth decay usually is recommended for a root canal treatment.

Dental Care

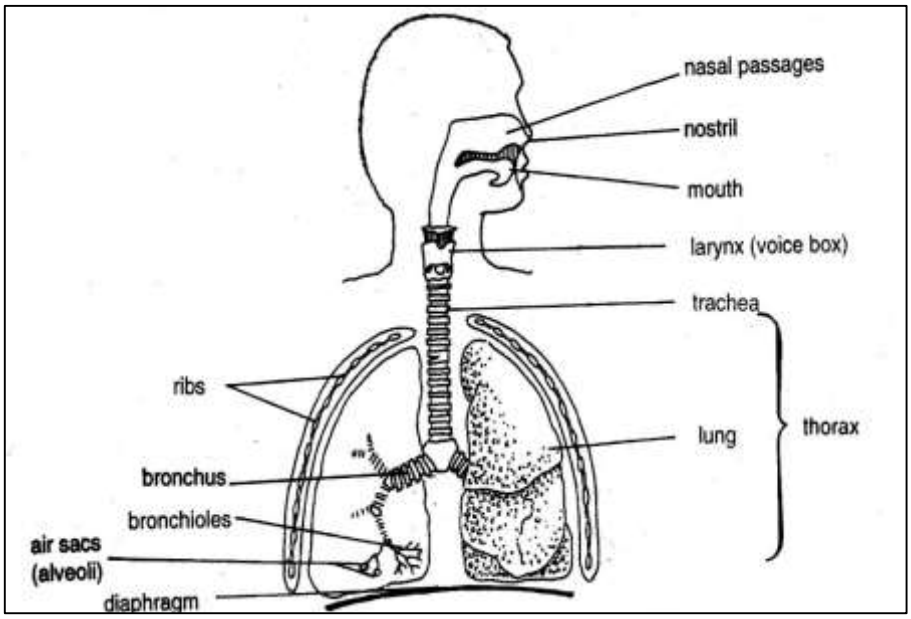
- Avoid consuming too much of sugar
- Use a fluoride toothpaste regularly as research has revealed that having fluoride ions in the mouth produces a tough protective layer on top of the enamel and prevents tooth decay.
- Visit a dentist twice a year.
- Don't use too much of fluoride toothpaste as it may cause blackening of your teeth.

Gaseous Exchange

The respiratory system is responsible for gaseous exchange and breathing. Gaseous exchange occurs in the alveoli. Oxygen diffuses from the lungs into the blood and carbon dioxide diffuses in the opposite direction.

Human Respiratory System

The respiratory system consists of the lungs, organs inside the head and of the chest.



On the diagram, identify an organ which is not responsible for gaseous exchange (1)

Functions of parts

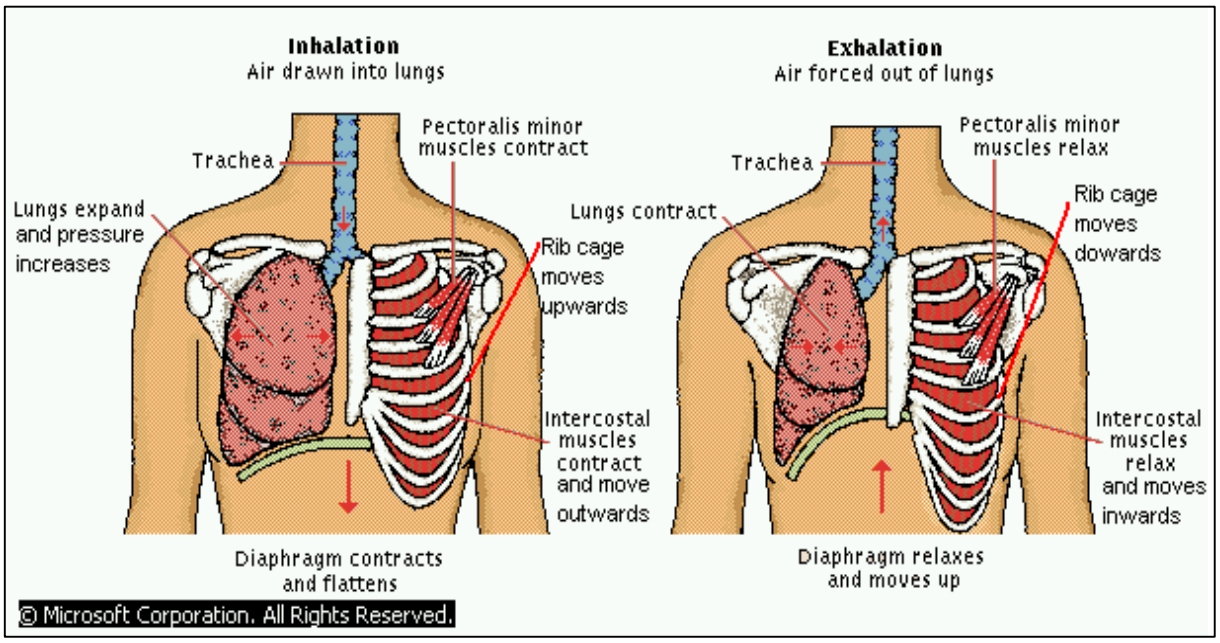
Part	Function
Larynx(voice box)	Is held open by the trachea for air passage.
trachea	This is a tube that connects the nasal cavity and larynx to the lungs. It is lined with a layer of ciliated epithelium cells and goblet cells which secrete mucus that traps bacteria and dust from inhaled air and gets moved upwards to the larynx by the cilia. It is then either spit out or swallowed to the stomach where it is eliminated by acid.
Bronchus and bronchioles	Channel air to and from the alveoli. Contains mucus and cilia to trap dust and micro-organisms.
Alveoli / air sacs	Where gaseous exchange takes place. These are tiny bags full of gas, they are present in the lungs in large amounts (several million alveolus in each lung). They give the lungs a much larger surface area (about 70 m^2) for faster diffusion of gases between them and the blood.
Diaphragm	This is a sheath of muscles that separates the thoracic cavity from the abdominal cavity. Together with the ribs and the inter-costal muscles, it plays a big role in breathing and gas exchange.

Path taken

- Inhaling occurs, air enters the mouth and nose where bacteria and dust in it are trapped by mucus and warmed by blood capillaries.
- The air enters the trachea where it is cleaned again by cilia.
- The bronchi take the air from the trachea to each lung.
- Bronchi divide into several bronchioles, each one has a group of alveoli at the end of it.
- In the alveoli gas exchange takes place where the oxygen rich air diffuses into the blood capillaries of the pulmonary arteries and the carbon dioxide rich gas diffuses into the alveoli to be exhaled.

Experiment 1

Breathing mechanism



Observations

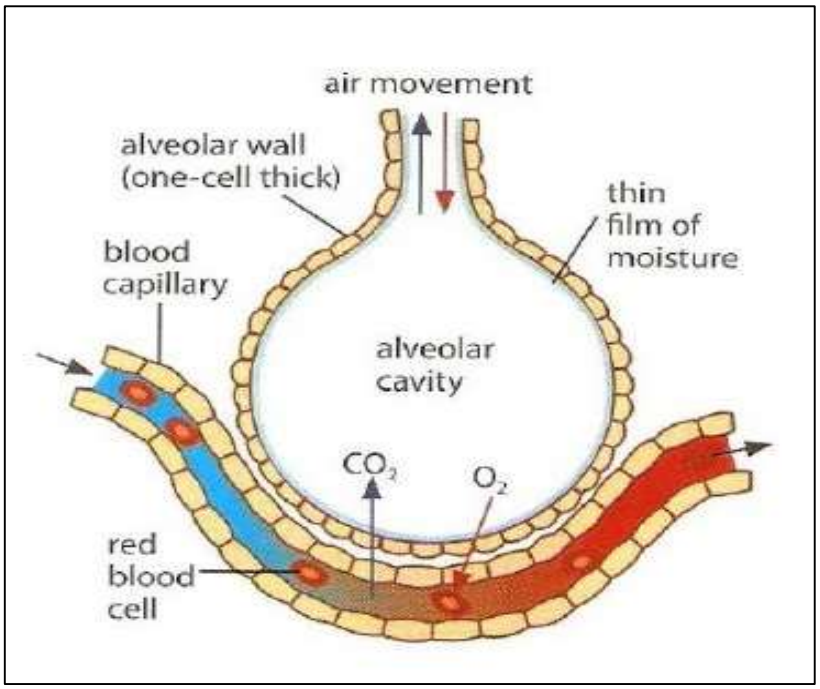
While breathing in, the rib cage moves upwards and outwards, the diaphragm flattens and the volume in the chest increases. Since the volume increases the pressure decreases and the air is drawn into the lungs.
While you exhale, the rib cage moves inwards and downwards, the diaphragm relaxes (dome shaped) and the volume in the chest decreases. Since the volume decreases pressure increases and the air is expelled out of the lungs.

Features of a Surface for Gaseous Exchange

- The alveolar walls are very thin to make diffusion of oxygen and carbon dioxide easier.
- They are moist because the oxygen must go into solution before diffusion can take place.
- The alveolus are balloon shaped which gives it a very large surface area and have a rich blood supply so that blood which has absorbed oxygen is immediately carried away to deliver oxygen to the body cells.

The concentration gradient in the alveoli is maintained by an efficient ventilation or breathing mechanism. Fresh air rich in oxygen are taken in at each breath. Air is drawn in the air sac by contraction of muscles between ribs and diaphragm. The muscles relax when air is breathed out.

The Alveoli or Air Sacs



- The alveoli are air sacs where gaseous exchange takes place.
- Each alveolus is supplied with blood capillaries.
- These come from the pulmonary artery and they contain deoxygenated blood rich in carbon dioxide.
- The concentration of oxygen is very high inside the alveolus and very low in the blood, so oxygen molecules diffuse from the alveolus to the red blood cells and combine with haemoglobin.
- At the very same time this occurs, carbon dioxide diffuses from the blood to the alveolus because the concentration of it is very high in the blood and low in the alveolus.

Adaptations

✓ Very thin wall of both the alveolus and the capillary, they are one cell thick which makes the diffusion distance shorter, increasing the rate.

✓ The difference in concentration of gases between the alveolus and the capillary is very large, increasing the diffusion rate of gases.

✓ The alveolus are balloon shaped which gives it a very large surface area for faster diffusion.

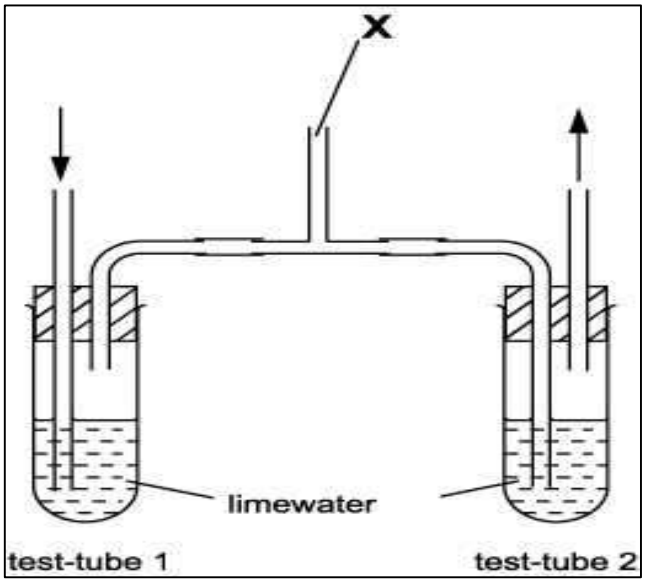
✓ The walls of the alveolus are lined by a thin film of water in which gases dissolve in during diffusion, this makes it faster.

Experiment 2 (a)

Comparing inhaled and exhaled air

Apparatus: carbon dioxide indicator, two test tubes, mouth piece,

Method



i. Set up the apparatus.
ii. Breathe in and out of the mouth piece X while closing pipe 1 and 2 to help the movement of air.
iii. Observe any colour change.

Observations

Lime water in 1 remains clear and in 2 turns milky.

Results

Lime water changes colour to milky showing the presence of carbon dioxide.

Conclusion

There is more carbon dioxide in 2 than in 1.

Percentage composition of air (not all gases)

	Inhaled	Exhaled
Oxygen	20%	16%
Carbon dioxide	0,03%	4%
Water vapour	variable	higher

Experiment 3

Measuring the effect of exercise on breathing and blood circulation.

Materials: students, stop watch / clocks.

Method

- ✓ Work in groups of three.one is a patient and the other two to measure pulse rate and breathing rate.

NB: Pulse rate is measured by pressing gently on the thumb side of the wrist with two fingers.

The breathing rate is measured by watching movement of the chest – one up and down is one breath or holding a feather in front of the nose and watching it move at each breath.

- ✓ Count the number of pulses and breaths in 30s while at rest / lying on the ground.
- ✓ Repeat the measurements and calculate an average pulse and breathing rate.
- ✓ Take measurements, the patient standing, after walking for 3 mins and after running for 3 mins.
- ✓ Record results in table.
- ✓ Use your data to construct a graph.

Results

The pulse rate and breathing rate may increase / double during heavy exercise to ensure that muscles receive adequate supplies of oxygen – rich blood.

Smoking and the Circulatory System

The effects of smoking can be short or long term effects:

- Smoke particles contain drug nicotine which is poisonous. Smoke irritates the lining of tubes and lung tissue, the cilia is destroyed hence lead to coughing and chest infections.
- Smoke contains high carbon dioxide and monoxide which reduces diffusion of oxygen into the blood
- The tar collects in the microscopic tubules and alveoli and over a long period leads to lung cancer.
- Over a long period, the smoke and chemicals break down the alveolar walls so that the surface area inside the lungs is reduced. Fluids build up in the lung tissue leading to emphysema. A person has difficulty in breathing and cannot absorb much oxygen.
- The lining of the bronchioles are irritated and inflamed to cause bronchitis.
- Smoking cause heart diseases. Smoke particles are deposited on the arteries and this cause high blood pressure and finally will lead to heart failure.
- Pregnant women bear babies with below average birth weight so they should not smoke.
- Smoking on the public is discouraged since it affect even non – smokers – their lives are shortened.

Qn classify the above effects into short and long term effects. (6)

Respiration

Respiration is the release of energy from break down of food in cells. The chemical break down is controlled by enzymes. There are two forms of respiration which are aerobic and anaerobic respiration.

Aerobic Respiration
It is the complete breakdown of food (glucose) to release a relatively large amount of energy. The food is oxidized or burnt using oxygen to release energy.

Word equation

$$\text{Glucose + oxygen} \xrightarrow{\text{enzymes}} \text{carbon dioxide + water + energy.}$$

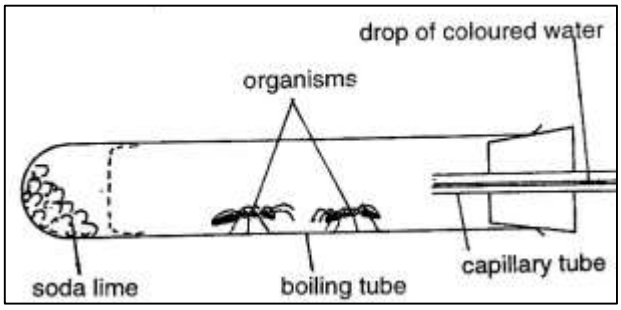
Glucose is the soluble food which enter the blood from the digestive system and is readily broken down during respiration. Glucose and oxygen are delivered to cells by the blood and the wastes are carried away by blood. The metabolic processes which uses oxygen include: active transport, growth, protein synthesis, digestion, cell division and excretion.

Experiment 1

Measuring oxygen uptake by small organism.

Materials: boiling tube, soda lime, small invertebrate such as an insect, capillary tubing, bung, mesh or bag, coloured liquid / food colouring in drop of water.

Method



i. Set up the apparatus as shown above.
ii. Introduce a small drop of coloured liquid into the capillary tube and observe the movement of the liquid.
iii. Set up a suitable control for this investigation. How could the rate of oxygen consumption be measured?

Observation and results

The insect takes oxygen from the air inside the sealed container and releases carbon dioxide. The carbon dioxide is absorbed by the soda lime. This causes a drop in pressure inside the apparatus which results in the liquid moving towards the tube.

Anaerobic Respiration
Respiration takes place without oxygen. The food is not completely broken down and small amount of energy is released.

Yeast, a fungus, respires anaerobically. Human muscle is able to respire anaerobically when the demand for oxygen exceeds the supply.

Anaerobic Respiration in Yeast

$$\text{Glucose} \xrightarrow{\text{enzymes}} \text{carbon dioxide} + \text{alcohol} + \text{energy}.$$

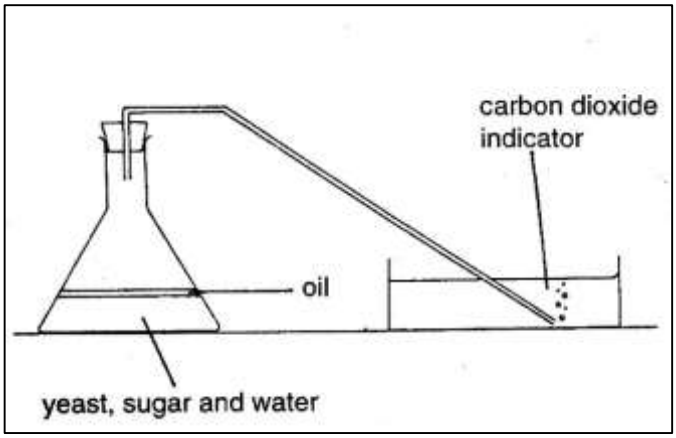
Yeast is used in making bread because it releases carbon dioxide which makes the dough very light. It is also used to brew beer, and used to break down sugars in fruits and other plants into alcohol.

Experiment 2

Fermentation of sugar using yeast

Materials: sugar, yeast, water, glassware, cooking oil, carbon dioxide indicator (lime water or bicarbonate indicator).

Method



i. Mix 5g yeast into a solution with 20ml boiled and cooled water.
ii. Add 5g sugar and mix well.
iii. Set up the fermentation apparatus as shown above.
iv. Add yeast and water solution to the flask and pour a thin layer of cooking oil.
v. Leave the set up in a warm place over night.

Observation and results

Gas bubbles are seen rising in the beaker with lime water.

Lime water turns milky to show that the gas produces is carbon dioxide.

Ethanol burns with blue flame when heated in oxygen to give out carbon dioxide and water.

$$\text{Glucose} \xrightarrow[\text{zymase}]{\text{enzymes}} \text{carbon dioxide} + \text{alcohol} + \text{energy}.$$

Conclusion is that ethanol is produced by fermentation of glucose.

Production and Effect of Lactic Acid

- When someone runs a race without having done a period of training, the body muscles respire anaerobically.
- The muscles do not have enough oxygen to oxidise glucose fully. The glucose is broken down into lactic acid.
- The advantage of being able to do this is that the muscles can still function and obtain some energy even though there isn't much oxygen available.
- Lactic acid causes stiffness in muscle (muscle fatigue).
- The lactic acid is broken down after the exercise when oxygen becomes available.
- The oxygen is used to break down the lactic acid to release energy.

$$\text{Glucose} \xrightarrow{\text{enzymes}} \text{lactic acid} + \text{energy}.$$

Transport

The Circulatory System

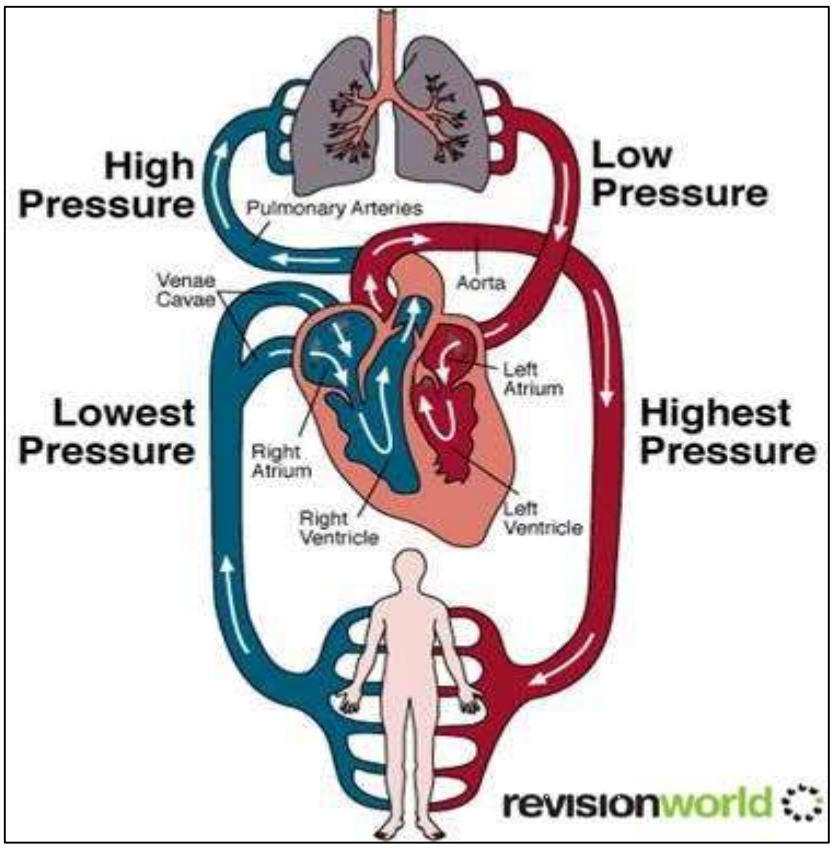
The main transport system of human is the circulatory system.

The circulatory system consists of:

- Blood vessels– a network of tubes
- The heart– a pump
- Valves– that ensures the flow of blood is in the right direction.

Functions of the circulatory system:

- To transport nutrients and oxygen to the cells
- To remove waste and carbon dioxide from the cells
- To provide for efficient gas exchange



Oxygenated and deoxygenated blood

The blood from the left side of the heart comes from the lungs

The blood capillaries surrounding the alveoli get oxygen that diffuses into the blood

This blood now contains oxygen and thus it is called as oxygenated blood

The oxygenated blood is transported all around the body

The oxygen in the blood is used up by body cells in metabolic reactions

Now, the blood that remains is called as deoxygenated blood

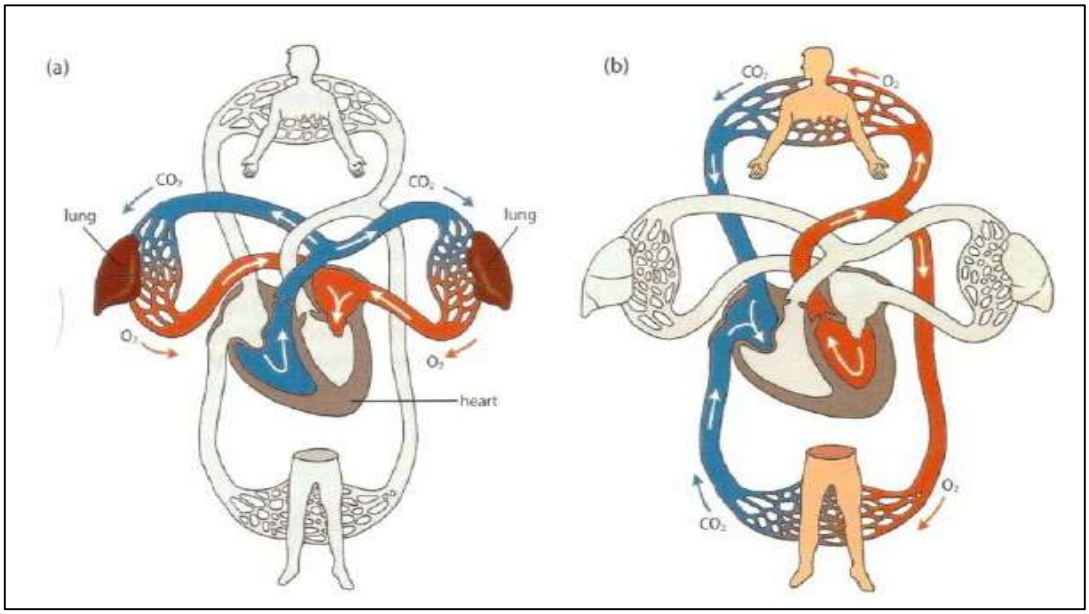
The deoxygenated blood is returned back to the right hand side of the heart, and is sent to the lungs to get oxygenated once again.

Double circulatory system

The human circulatory system is a double circulatory system.

A double circulatory system is one where blood is transported through the heart twice in one complete cycle.

Beginning at the lungs, blood flows into the left-hand side of the heart, and then out to the rest of the body. It is brought back to the right-side of the heart, before going back to the lungs again.



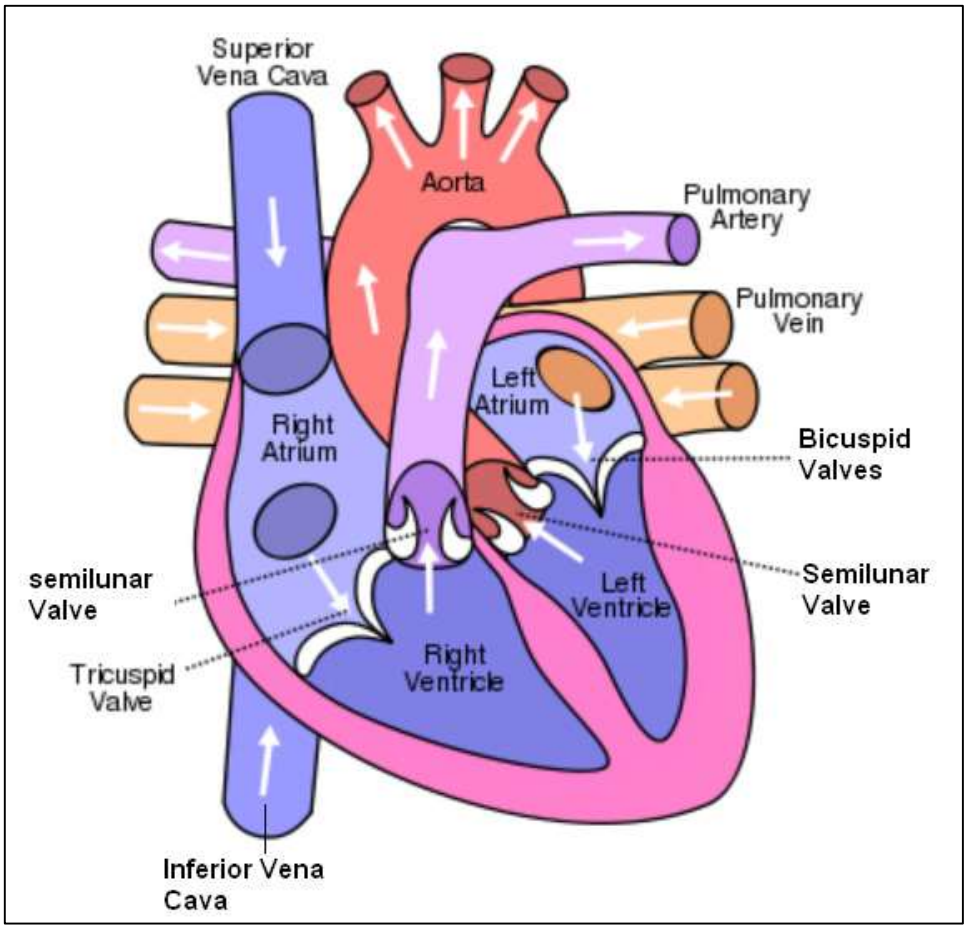
The importance of a double circulatory system

The pressure applied to pump the blood all over the body is not lost; it is returned to the heart to raise the pressure again.

In a double circulatory system, the oxygenated blood is transported at a faster rate through the body's organs.

Transporting blood at a faster rate is particularly important as tissues that are metabolically active will require oxygen in abundance. A double circulatory system ensures that the oxygenated blood reaches the tissues on priority.

The Heart



Is made up of the cardiac muscle which contracts and relaxes throughout life

Is divided into 4 chambers:

Left Atrium	Receives oxygenated blood from the lungs and passes it to the left ventricle
Left Ventricle	Receives oxygenated blood from the Left Atrium and pumps it all over the body
Right Atrium	Receives deoxygenated blood from the body and passes it to the Right Ventricle
Right Ventricle	Receives deoxygenated blood from the right atrium and pumps it over to the lungs to get oxygenated

Has 4 associated blood vessels:

Pulmonary vein	Brings oxygenated blood to the left atrium from the lungs
Aorta	Receives oxygenated blood from the left ventricle and pumps it all over the body
Vena cava	Brings deoxygenated blood to the right atrium from the body

Pulmonary artery	Receives deoxygenated blood from the right ventricle and pumps it over to the lungs to get oxygenated

Important: the reason why the walls of the ventricles are thicker than those of the atria is due to the fact that the atria just receive the blood; the actual task of pumping it out of the heart is done by the ventricles.

Important: the reason why the left ventricle's walls are thicker than those of the right ventricle is due to the fact that the right ventricle pumps the blood to the lungs, which are in close proximity to the heart. The left ventricle has the job of transporting the blood all over the body.

The Pacemaker: is a patch of muscle in the right atrium which controls the rate at which the heart beats according to the needs of the body.

If you are exercising, then the body will need a lot of oxygen; you soon take up an oxygen debt which causes a drop in the ph of blood (due to the production of lactic acid)

The brain senses the drop in pH and sends electrical impulses to the pacemaker to make the heart beat faster.

Atrioventricular valves: are valves between the atria and ventricles in the heart that prevent the blood from flowing from the ventricles, into the atria.

The valve on the left hand side of the heart is made of 2 parts and thus is called the bicuspid valve

The valve on the right hand side of the heart is made of 3 parts and thus is called the tricuspid valve

Coronary Arteries

The muscles of the heart are so thick that the nutrients and oxygen in the blood inside the heart would not be able to diffuse to all the muscles quickly enough.

The heart muscles need a constant supply of oxygen and nutrients so that it can keep transporting and pumping blood. The coronary arteries are responsible for it.

If a coronary artery gets blocked (e.g. by a blood clot), the cardiac muscles run short of oxygen and they cannot respire to obtain energy to contract causing the heart to stops beating. This is called a heart attack or cardiac arrest.

Causes of Coronary Heart Disease

Smoking	Nicotine damages the circulatory system by narrowing and stiffening blood vessels
Blood Cholesterol levels	Diets rich in animal fats containing Low Density Lipids (LDL) cause CHD to develop
Age	As you grow older, the risk of developing CHD increases
Stress	Unmanageable and long term stress leads to the development of CHD

High Blood pressure	Is caused due to heavy amounts of stress and again leads to the development of CHD
Gender	CHD often develops in males than in females. (It may be due to sex-linked genes)

Preventing Coronary Heart Disease

Stop smoking.
Keep the diet based on saturated fatty food in control.
Have a diet based on fish and vegetable oils.
Exercise Regularly.
Take drugs such as 'statin' under the guidance of a physician.

Treating Coronary Heart Disease

Statins	Help lower blood pressure Lower the chances of a blood clot forming
Coronary Operation	A blocked or severely damaged coronary artery is replaced by another length of blood vessel taken from other parts of the body
Angioplasty	A balloon is inserted in the damaged coronary artery and is inflated using water This pushes the artery open.
	In the rarest and the worst cases of CHD, a heart transplant operation may be undertaken.
HeartTransplant Operation	The patient will have to take immune suppressants for life if the operation is successful and if the tissue types don't match!

Blood Vessels

Blood vessels are an important part of human transport system.

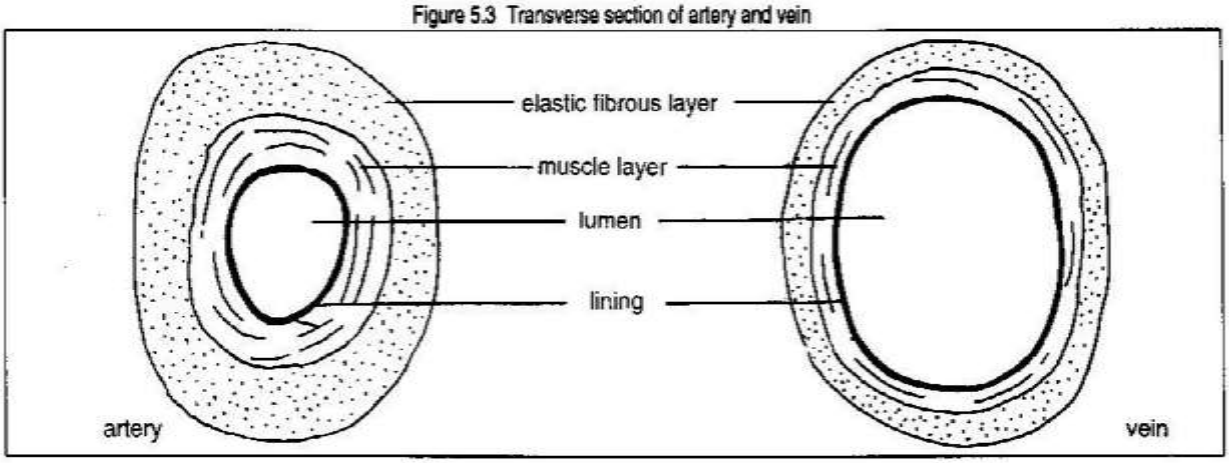
There are 3 major types of blood vessels in the human transport system:

Qn Draw and label these three blood vessels (9)

Blood vessel:	Function	Structure of wall	Width of lumen
Arteries	Carry blood away from the heart	Thick and strong Contains muscles and elastic tissues	Relatively narrow Varies with heart beat due to recoiling and stretching capacity
Capillaries	Supply all cells with their requirements Take away their waste products	Very thin Only one cell thick	Extremely narrow Wide enough for red blood cells to pass through
Veins	Carry blood towards the heart	Quite thin Contain lesser amounts of muscles and elastic tissues than arteries	Wide Contains valves

Blood Vessel	How structure fits function
Arteries	Strength and elasticity needed to withstand the pulsing of the blood as it is pumped through the heart
Capillaries	No need for strong walls as most of the blood pressure has been lost. Thin walls and narrow lumen bring blood into close contact with body tissues
Veins	No need for strong walls as most of the blood pressure has been lost. Wide lumen offers less resistance to blood flow. Valves prevent backflow of blood.

Figure 5.3 Transverse section of artery and vein



Components of blood plasma

Component	Source	Destination
Water	Absorbed from small intestine and colon	All cells
Fibrinogen	Liver	Remains in the blood
Antibodies	Lymphocytes	Remains in the blood
Lipids	Absorbed in the ileum Derived from fat reserves in the body	To the liver- for breakdown To adipose tissue- for storage To respiring cells- as an energy source
Carbohydrates	Absorbed in the ileum Derived by breakdown of glycogen in the liver	To all cells for energy release by respiration
Urea	Liver- by deamination	Kidneys- for excretion
Mineral ions	Absorbed in the ileum and colon	To all cells
Hormones	Endocrine glands	Target hormones
Carbon dioxide	Released by all cells as a waste product of respiration	To the lungs for excretion
Oxygen	Lungs	Whole body
Heat	Abdomen and muscles	Whole body

Blood cells – structure and functions

Draw the Structure

There are 3 types of blood cells:

1. Red blood cells

- Made in the bone marrow
- Transport oxygen from lungs to all respiring tissues.
- Transport CO2 from all respiring cells to lungs.
- Contain a red pigment- Haemoglobin which contains iron
- Haemoglobin carries oxygen by combining it with iron, to cells that are actively respiring
- Are biconcave disc shaped (this increases the surface area and thus diffusion of oxygen and carbon dioxide)
- Have no nucleus (hence live up to only 4 months)
- Broken down in the liver, spleen and bone marrow
- Some of the iron from the Haemoglobin is stored, and used for making new haemoglobin; some of it is turned into bile pigment and excreted.

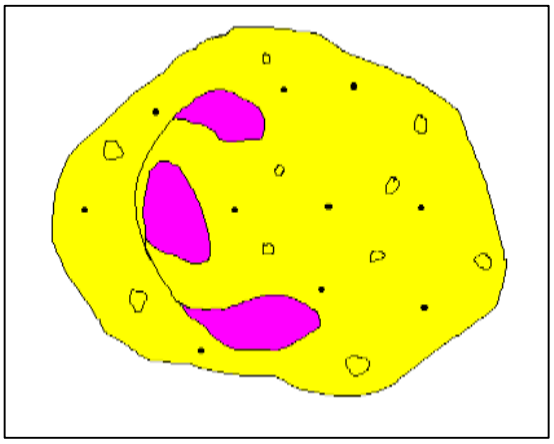
2. White blood cells

- White blood cells are made in the bone marrow and in the lymph nodes.
- Have a nucleus, often large and lobed.
- Can move around and squeeze out through the walls of blood capillaries.
- They have the function of fighting pathogens

White blood cells are of two major types:

Phagocytes:

- Have lobed nuclei and granular cytoplasm.
- Can move out of capillaries, to the site of an infection.
- Remove any microorganisms that invade the body and might cause infection by engulfing and digesting.

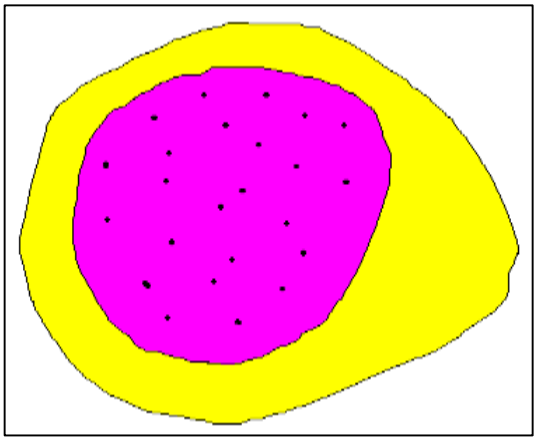


Lymphocytes:

- produce antibodies to fight antigens
- Have large nuclei

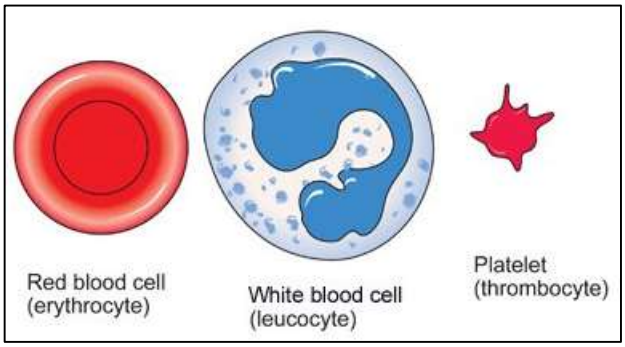
There are two different types of lymphocytes:

- B-lymphocytes: secrete antibodies in response to contact with their particular antigen, which may be an invading pathogen or a foreign tissue that has been transplanted.
- T-lymphocytes attack foreign or infected cells and kill them by binding onto their surfaces.



3. Platelets

- Small fragments of cells, with no nucleus.
- Made in the bone marrow.
- Involved in blood clotting: form blood clot, which stop blood loss and the entrance of pathogens.



Substances transported in the blood

Substance	Source	Destination
Oxygen	Lungs	Whole body
Carbon dioxide	Whole body	Lungs
Urea	Liver	Kidneys
Hormones	Endocrine glands	Target organs
Digested food	Intestine	Whole body
Heat	Muscles and abdomen	Whole body

Blood clotting

Till now, we have learnt that platelets help in the clotting of blood. Let's see how this happens now!

- There is cut in the skin.
- Blood vessels are damaged.
- Damaged blood vessels and tissues begin secreting chemicals.
- This activates blood clotting factors.
- The soluble plasma protein- fibrinogen changes to an insoluble substance called fibrin.
- Fibrin causes fibres to be made in the damaged blood vessel and tissue
- Red blood cells and platelets get trapped in the fibres.
- This forms a blood clot!

Importance of blood clotting

- Prevent excessive blood loss
- Maintain the blood pressure.
- Prevent the entry of pathogens
- Help in healing

Genetic disease where blood does not clot– Haemophilia

The lymphatic system and tissue fluid

Capillaries leak! Their cell walls don't fit together properly and thus there are small gaps between them.

Substances that leak out from the capillaries:

- White Blood Cells (WBCs)- can easily change their shape unlike red blood cells.
- Blood Plasma

So the substances that leak out from the blood capillaries are known as tissue fluid.

The tissue fluid simply surrounds the body cells.

Importance and functions of tissue fluid

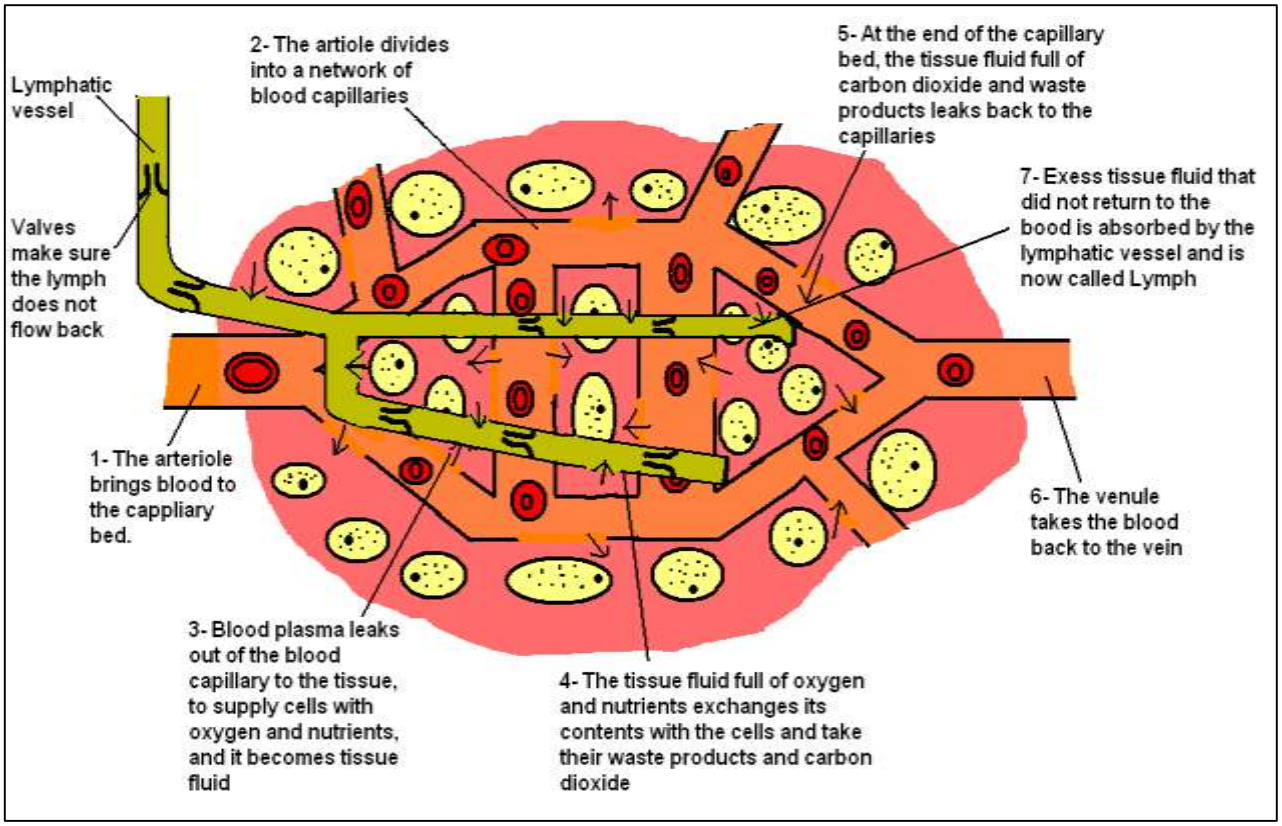
- Supply cells with all their requirements (such as oxygen and nutrients that diffuse)
- Take away the waste products of metabolism out from the cells
- Immediate environment of every cell in the human body

Lymph

- The tissue fluid surrounding the body cells ought to be eventually returned to the blood.
- To make sure this happens, there are another set of capillaries in our body called as lymphatic capillaries.
- The tissue fluid slowly drains into the lymphatic capillaries.
- It is now called lymph
- The lymphatic capillaries eventually join up to form larger lymphatic vessels which empty themselves into the subclavian veins.
- Here the lymph enters the blood.

Features of the Lymphatic system and lymph nodes

- Have valves to ensure the flow of lymph is in one direction
- Run close to the muscles so that muscular contractions squeeze the lymph and for it to move along the vessels.
- Have structures called lymph nodes where new white blood cells are produced
- The white blood cells help in destroying most toxins in the lymph before entering the blood from the subclavian vein.



Immunity

Immunity - is the ability of the body to resist infection

Body barriers and mechanisms

- Includes tears for cleaning eyes.
- Skin to prevent entry of pathogen.
- Mucus/hairs to trap dust and bacteria.
- Wax/hairs in ears to prevent entry of pathogens.
- Stomach acids that kill bacteria.
- Vaginal secretions which kill bacteria.
- White blood cells for engulfing bacteria and producing antibodies that destroy bacteria.
- Blood clotting to prevent blood loss and entry of bacteria.
- The body can produce antibodies, chemicals that destroy bacteria.
- Saliva is alkaline, kills bacteria.

1. Acquired Immunity/Active Immunity
-When one suffers from a disease like small pox or measles, they develop immunity. One will not suffer from the disease again. This is because antibodies are produced against the pathogen and they remain active in the blood ready for new attack.

2. Natural Passive Immunity
-Passed on through the placenta or from mother to child during breast feeding.
-Antibodies are transferred from the mother to the child to gain immunity.

3. Artificial Immunity
-Antibodies are produced after vaccination. A vaccine containing dead and weakened pathogen of a disease. When they are injected into the body, the body produces antibodies that destroy the weak pathogens.

Immunisation
-Is to offer artificial immunity.
In Zimbabwe children are vaccinated to:
a) Eliminate diseases e.g. to eliminate measles.
b) Protect children against the killer diseases such as Polio, Diphtheria, Measles, whooping cough, Tetanus, T.B. Hepatitis B.
c) Introduce a vaccine of certain diseases for the first time e.g. rubella vaccine.

N.B. B.C.G is a vaccine against T.B.
Vitamin A supplements are provided to prevent vitamin A deficiency in children (6 months to 59 months).
The programmes are carried out for free.

NB: H.IV. Causes a destruction of the immune system (bodies defence system) that is why a person suffers from many diseases. It interferes or destroys the white blood cell that produces antibodies.

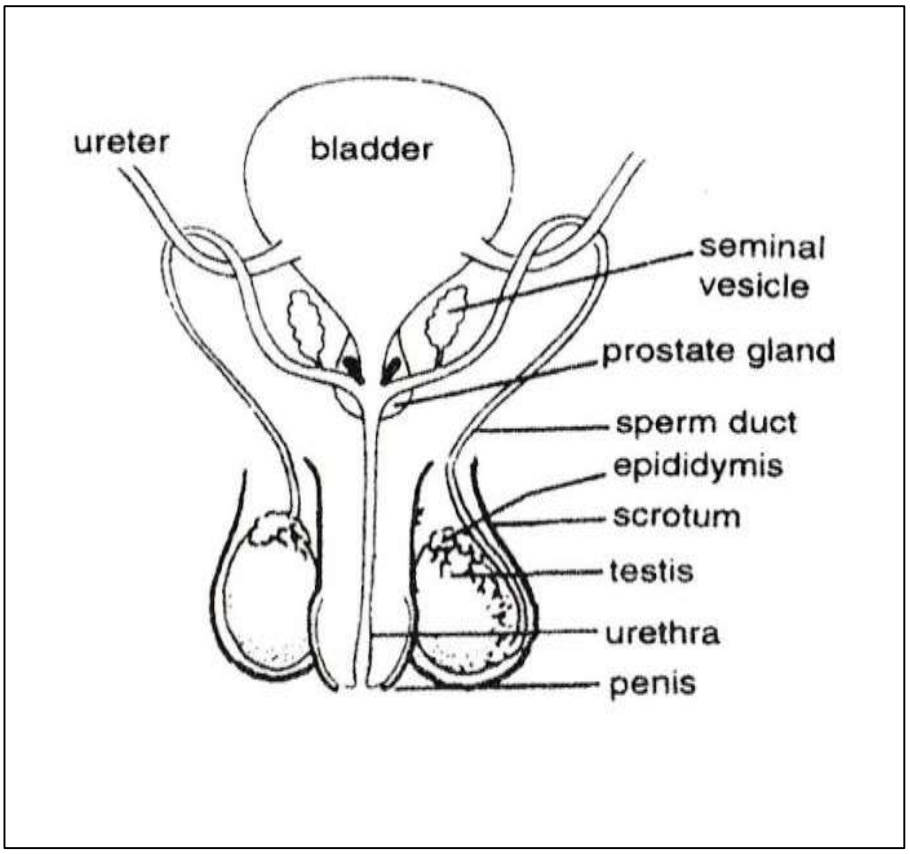
Reproduction in Humans

-Reproduction is a characteristic of all living things.

-In sexual reproduction, two gametes fuse, the sperm (male sex cell) and the ovum produced by the female reproductive system.

-Male and female bodies become sexually mature at puberty when the body undergoes changes in appearance and behaviour.

Male Reproductive System

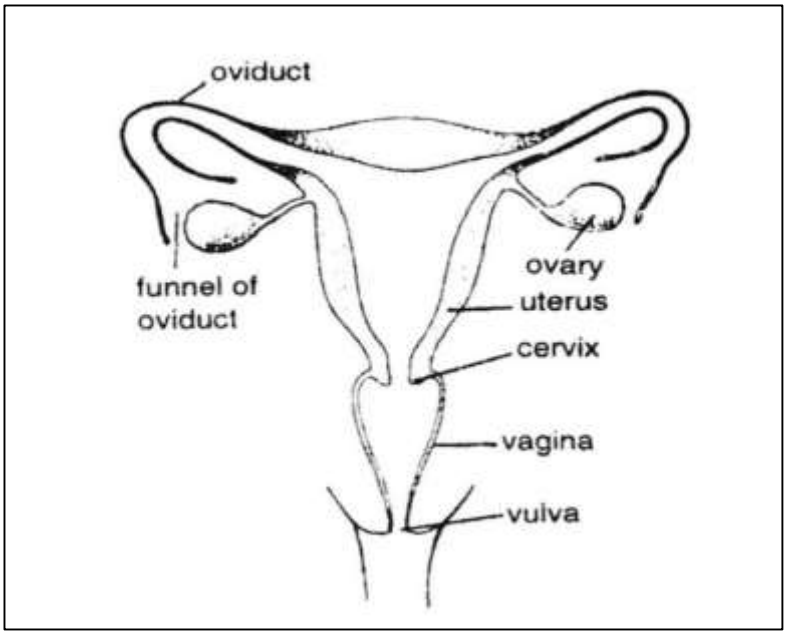


Functions of the male reproductive system

Structure	Function
Testes	Sperms are made in the testes and stored in the epididymis. Produces male sex hormone, testosterone.
Sperm duct (Vas deferens)	They are two muscular tubes, each connected to a testis. They carry the sperms from the testis to the urethra.
Epididymis	Storage of sperms temporarily.
Penis	It is the male sex organ which ejaculates semen into the vagina during sexual intercourse.
Scrotum	Bag of skin, outside the body which protects the testes at lower temperature. This encourages sperm production.
Urethra	It is a tube inside the penis which is the pathway of semen and urine out of the body.
Prostate gland And seminal vesicles	Both secret nutrients and enzymes to stimulate the sperm, the fluid from glands together with sperm is called semen.

The Female Reproductive System

Functions of the Female Reproductive System



Structure	Function
ovary	To release egg cells(ova)during ovulation to secrete hormones called oestrogens. They stimulates the uterus lining to build up.
Oviduct	Narrow tube through which egg cells travel to the uterus.
Uterus	Wide muscular tube where the foetus develops.
Cervix	Ring of muscle that closes the neck of the uterus from the vagina.
Vagina	Muscular tube that links the uterus to the outside, and through which a baby is born.

Structure of Male and Female Gametes

A gamete is a special cell (sex cell) that has only half the number of chromosomes of the parent cell. After fertilisation, the full number of chromosomes is restored as two gametes join to form a zygote.

Ova	Sperm
Small spherical cell with a nucleus, cytoplasm and thick membrane.	Single cell, with oval shaped head.
Larger than sperm-this is because it needs space to store nutrients on which the embryo feeds on before it reaches the uterus.	Smaller than an ovum and in larger quantities to increase the chance of successful fertilisation. Has small middle part and a tail.
Does not move by itself – they are swept to the uterus by cilia in the walls of the oviduct.	Can swim to meet the ovum because it has a large number of mitochondria to release lots of energy to be used in swimming.
Once a month – puberty to menopause.	Million produced.

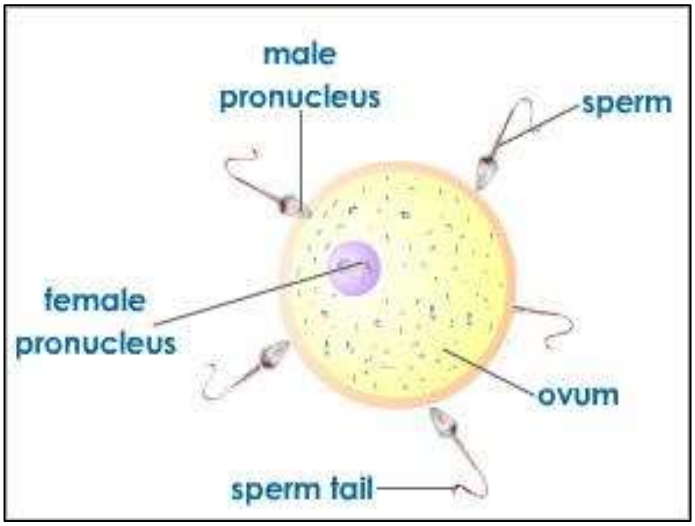
Sexual Intercourse

- When the man is sexually excited, blood is pumped into his penis. This causes it to become erect.
- Simultaneously, mucus is produced from the woman's vagina to lubricate the passage of the penis
- The erect penis is inserted into the woman's vagina.
- At a point, thrusting movements are made which stimulate the tip of the penis with the clitoris.
- This results in a reflex action to take place:
- The walls of the tubes containing the sperm contract rhythmically and sperm is ejaculated into the vagina.
- This biological process is known as sexual intercourse and is the beginning of reproduction.

Fertilisation

- This refers to the fusion of the male and female gamete nuclei to form a zygote; it takes place in the oviduct or fallopian tube.
- Ejaculation deposits the semen at the neck of the vagina (cervix).
- Sperm swim through the cervix into the uterus by wriggling movements of their tail.

- They pass through the uterus to the oviduct, one of the sperm may bump into it and stick to its surface.
- The sperm then enters the cytoplasm of the ovum.
- Then the nucleus fuses with the female nucleus.
- A single ejaculation may contain about 5 hundred million sperms, only one sperm fertilizes the ovum.
- When one sperm enters the ovum, it forms a barrier such that other sperms will not enter and will die after fertilization.
- Before fertilisation the released ovum can survive for about 24 hours and a sperm for 2 to 3 days.



Puberty

The point in a person's life where sexual maturity is reached is defined as puberty or adolescence. Puberty prepares a boy or a girl for adulthood and reproduction.

When a person reaches puberty:

- Sperm production begins in a boy
- Ovulation begins in a girl

Along with these, the secondary sexual characteristics develop as well during this time. These all are caused by certain sex hormones.

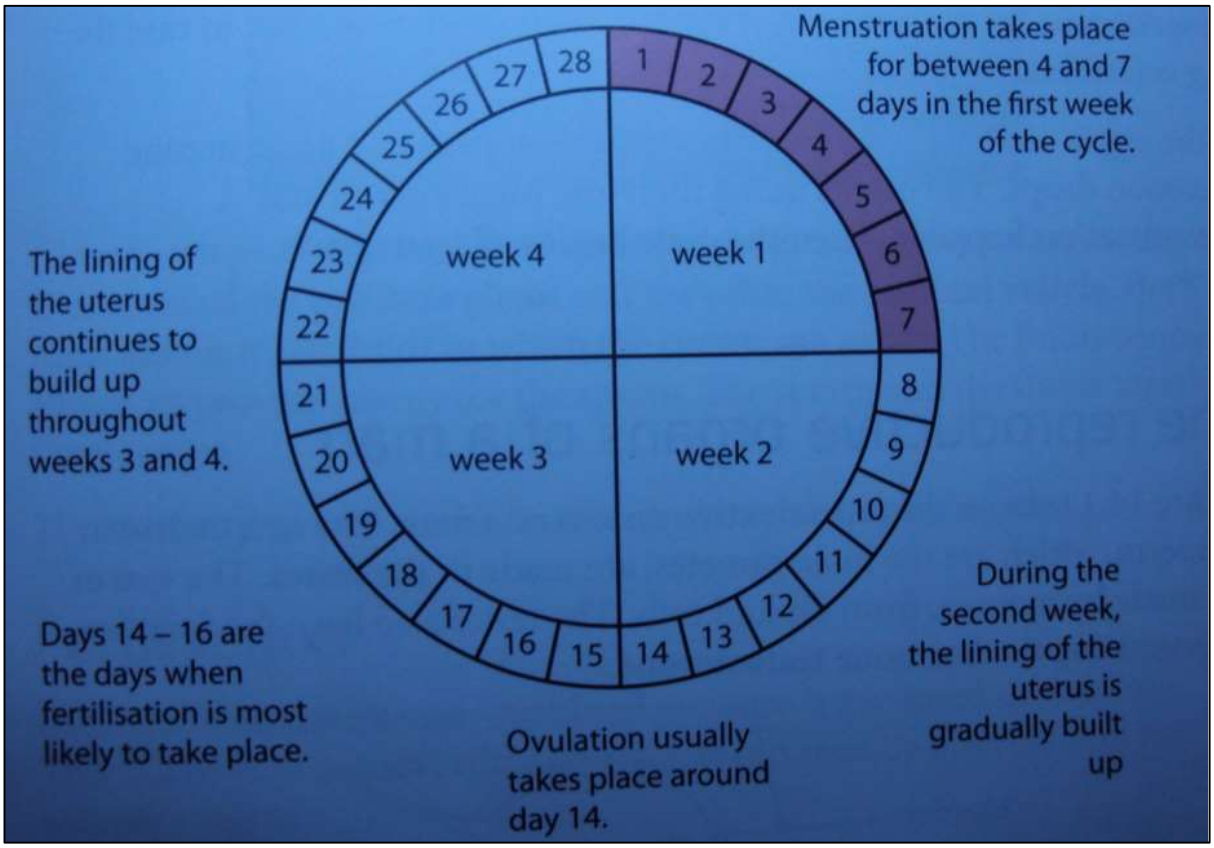
	Adolescent Males	Adolescent Females
Sex Hormone	Testosterone	Oestrogen
Function	• Development of secondary sexual characteristics	• Development of secondary sexual characteristics • Making the uterus lining thick and spongy during menstruation

Secondary Sexual Characteristics

Secondary sexual characteristics in males	Secondary sexual characteristics in females
Voice breaks (Becomes harder)	Breasts develop and grow bigger
Penis begins to grow	Vagina becomes larger and wider
Facial hair, pubic hair, hair in armpits emerge	Hairs emerge in armpits and in pubic areas
Body becomes more muscular and stronger	The pelvis (hip) widens
Testes begin sperm production	Menstruation begins

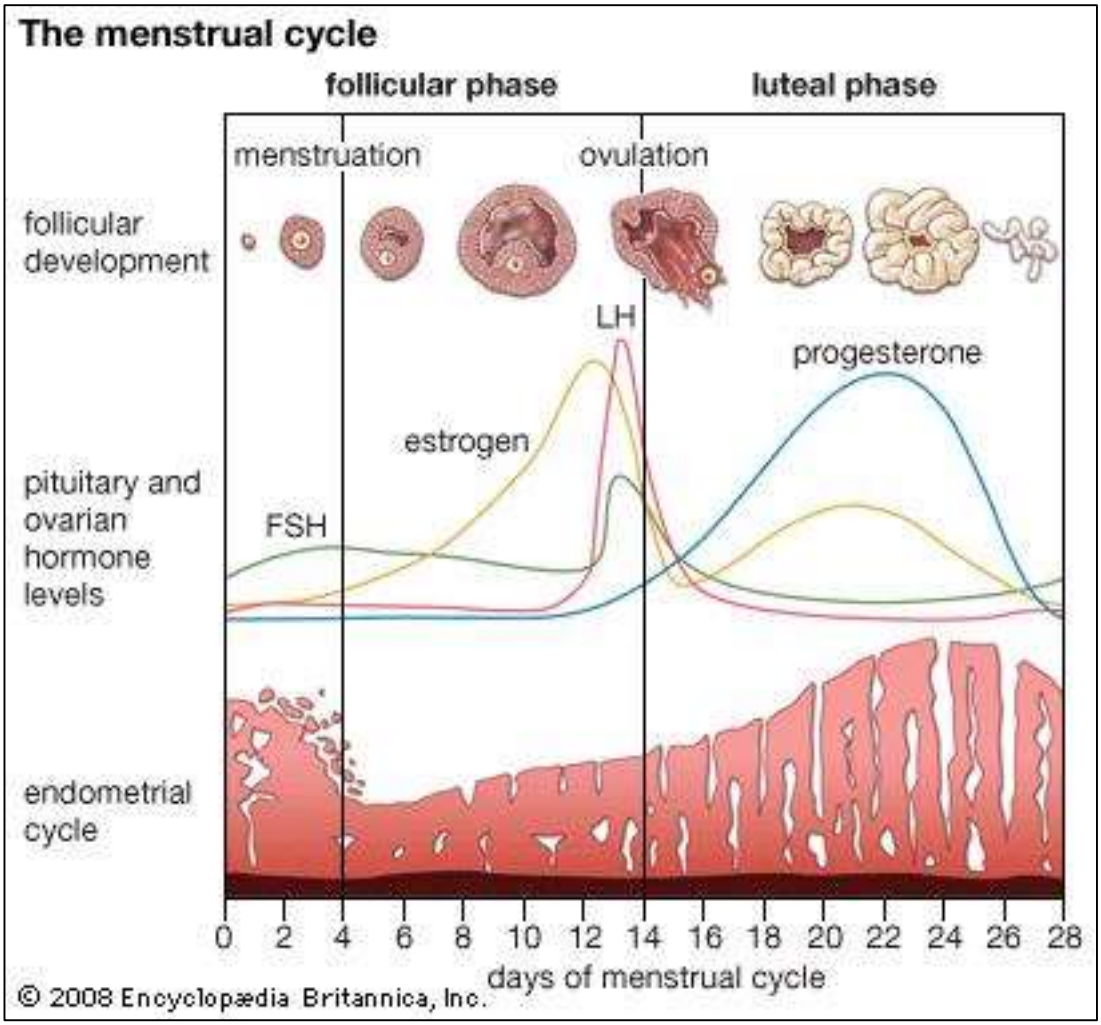
The Menstrual Cycle

Diagram 1



- Is a cycle which occurs in human female from puberty to an age of 50.
- It is a cycle designed to release one ovum each month into a prepared uterus.
- The cycle is maintained by the interaction of two hormones which are oestrogen and progesterone.
- Oestrogen is responsible for producing the uterus lining, it becomes spongy and rich in blood vessels in preparation for receiving a fertilized ovum.
- Progesterone maintains the uterus lining in place if the ovum is fertilised.
- At day 14, ovulation takes place.
- When an ovum is not fertilised, it breaks down as does the prepared lining of the uterus and passes out blood and mucus which make up the lining (Menstruation).

Diagram 2



Causes of Infertility

- Low sperm count
- Poor quality of sperm
- Physical conditions
- Cancer e.g. prostate cancer
- Damage by sexually transmitted diseases (STDs)
- Blockage of the oviducts or sperm ducts.
- Alcohol and drugs if in excess lead to the production of poor quality sperms.

Solutions

- Consult a specialist doctor.
- Avoid casual sex and promiscuity (having sexual contact with many partners).
- Use of fertility drugs to stimulate ovulation and use of donor sperm or eggs and adoption.

Implantation

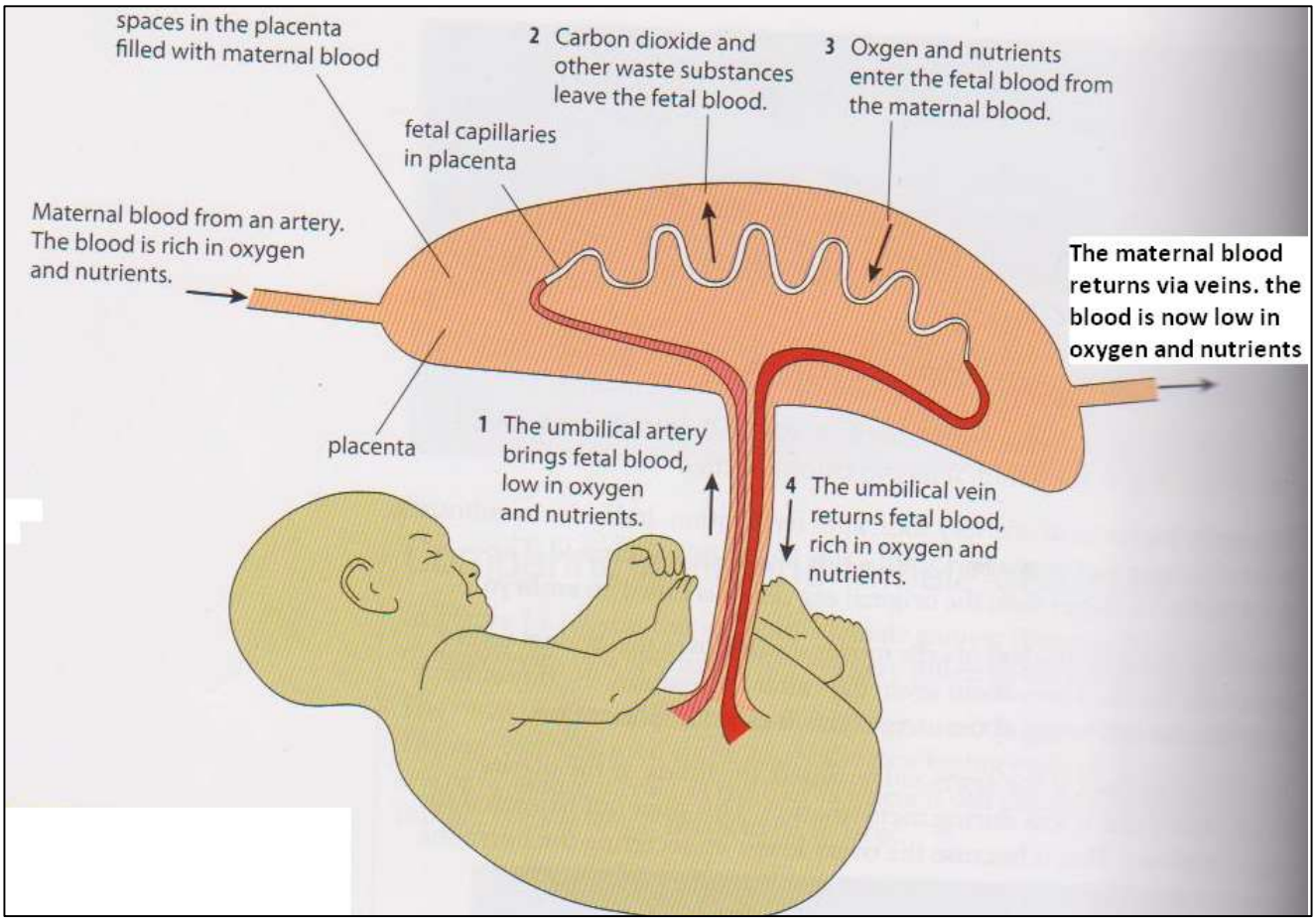
-After fertilisation, a zygote is formed in the oviduct or fallopian tube. The zygote under goes rapid cell division. It takes about 7 days to travel to the uterus. It develops into hollow ball containing many cells and now called an embryo. The uterus develops its thick inner lining cell and blood vessels. Then implants itself into the lining

of the uterus and begins to develop on placenta. In the early days the embryo absorbs oxygen from nearby capillaries in the uterus wall by diffusion. The embryo begins to develop features such as a heart, head and limbs, at this stage is called foetus (foetus).the period between fertilisation and birth is called gestation and normally takes about 40 weeks.

Functions of the Placenta, Umbilical Cord and Amnion.

1. Placenta

The placenta has two sets of villi, the foetus's set which contains the foetus's blood capillaries, and the mother's set which contains the mother's blood capillaries. The blood flows from the foetus to the foetus's blood vessels in the placenta through umbilical arteries and veins.



The function of the placenta and the umbilical cord is to exchange substances between the mother and fetus without mixing their bloods together. This is because they might have different blood groups or the mom might have a disease that could be passed to the foetus. The blood circulation of the foetus includes the placenta. When the blood reaches the blood capillaries of the foetus in the placenta, waste substances like carbon dioxide and urea diffuse from it to the maternal (mother's) blood. The mother then gets rid of these waste materials. Useful substances also diffuse from the maternal blood to the foetus's blood. These include oxygen, amino acids, glucose, vitamins, water, minerals, fatty acids & glycerol. These nutrients are used in

building the body of the foetus. Some useful substances also diffuse from the maternal blood to the foetal (foetus's) blood like antibodies and antibiotics.
The placenta has another very important function. That is making oestrogen and progesterone hormones which are essential to keep the uterus in good condition and stimulate milk-producing tissues in the mother.

2. Umbilical Cord – attaches the foetus to the placenta and contains the umbilical vein (carries oxygenated blood) and umbilical artery (carries deoxygenated blood).
3. Amnion fluid - is a fluid filled sac that supports the foetus and protects it from physical knocks and mechanical damage. The foetus needs no space to breath because it doesn't, gets its oxygen from the mother and gets rid of the carbon dioxide through her too.

Development

After fertilization the ovum is the size of a full stop.
A few weeks it is 10mm long.
At 2 months it is 6cm long and has fore limbs with finger sand toes and well formed face.
After 6 months its about 30cm, hair, finger and toe nail, milk teeth are developing from its growth.
After birth the baby weighs 3 – 3,5 kg an average and is 50cm long.

Ante-natal care

Ante-natal (before birth) care is a routine care for the healthy pregnant woman.

Dietary needs

The mother needs to take care of her diet as everything she will eat will diffuse across the placenta to her baby.

Some of the nutrients that are necessary for the mother and her baby are:

Nutrient	Why needed
amino acids	Healthy growth and development of foetus
carbohydrates	To give the mother energy to walk around
calcium	Development of foetus's bones
Iron	To make Haemoglobin

Exercise

- Gentle exercise (swimming or walking)
- Special exercises (that will prepare the mother when giving birth to the baby)

Dangers of taking drugs, alcohol and smoking

✓ Under weight babies are born of smoking mothers i.e. below 2, 5 kg.

- ✓ Cigarettes smoke contains carbon dioxide which is absorbed into the mother`s blood – it forms carboxy haemoglobin in the baby`s blood and this reduces the capacity of that blood to carry oxygen during foetal development.
- ✓ Babies are more prone to diseases than normal weight babies.
- ✓ High rate of miscarriages.
- ✓ Alcohol consumption damage the developing brain of the fetus.
- ✓ Studies done have shown that babies that receives oxygen during foetal development tend to be more intelligent.

Factors affecting mass of the baby during pregnancy

- ➢ Smoking.
- ➢ Alcohol.
- ➢ Nutrition.
- ➢ Illness of the mother.

Birth

- The uterus wall begin rhythmic muscular contraction which become more and more powerful and more frequent.
- The cervix opens and the baby`s head passes into the vagina.
- The burst of the amnion and its fluid escapes. Soon the contraction of the uterus aided by voluntary contraction of the abdominal muscles propel the baby out.
- In humans the umbilical cord is cut and tied to prevent excessive bleeding and infections.

After Birth

- Shortly after the baby is born, the contraction of the uterus expels the placenta from the mother`s body as after birth.

Breast feeding and Bottle feeding (Formula Milk)

	Advantages	Disadvantages
Breast feeding	• Sterile • Free of cost • Improves bond between mother and baby • Perfect composition of nutrients needed for the baby • Composition of nutrients naturally changes according to baby's growth • Contains antibodies • Gives baby passive immunity	• Father is unable to bond and spend time with baby • Sometimes the mother is unable to produce sufficient breast milk • It can be difficult for mothers to breast feed babies in certain situations • Keeps mother preoccupied
Bottle feeding (Formula milk)	• Helps father to bond with baby • Gives mother time to relax and do other jobs	• Expensive • Needs extra effort to maintain sterility • Probability of getting infected is high

Birth Control Methods

Birth control is important in order to keep families small and limit the increase of the human population exponentially.

There are many birth control methods practiced by people worldwide. These birth control methods usually come into 4 categories: Natural, Chemical, Mechanical and Surgical:

Natural methods		
How they work	Abstinence	Woman avoids sexual intercourse completely
	Other methods	Woman keeps track of her body temperature (that rises at ovulation) and doesn't have sex during this period Woman checks if the mucus produced in her vagina has become slippery or not
Advantages	Useful for couples who don't want to use other measures of birth control for religious or other reasons	
Disadvantages	It is never possible to be 100% certain about ovulation period.	

Chemical Methods		
How they work	Spermicides	• Spermicides can be used to kill sperm that enter the vagina • They can be effectively used in combination with another method- a diaphragm
	Contraceptive Pills	• Contraceptive pills containing sex hormones can be taken by the woman; this stops the production of egg cells in the ovaries
	IUD (Intra-Uterine-Device)	• Sometimes contains copper • A similar device called as an IUS can be used. • An IUS releases hormones that prevent implantation and development of any fertilized egg cell.
Advantages	• A very effective method only when contraceptive pills are taken at the right time. • The IUS and IUD lasts till 10 years	
Disadvantages	• It is important to have regular check-ups by a doctor as some women do experience side effects of contraceptive pills	

- Contraceptive pills play a vicious part in river pollution and cause some male fish to change gender as well!

Mechanical Methods

How they work	Condom	• A condom is a piece of rubber sheath • A condom is placed upon the erect penis and acts as a barrier between the sperm and the vagina.
	Femidom	• A femidom is a female version of a condom and is used similarly
	Diaphragm (or cap)	• A diaphragm is a circular and slightly domed piece of rubber • Inserted into the vagina on the top of the cervix • Diaphragms are often used with spermicide for the best results
Advantages	Condom is a very safe method of contraception only if it is used correctly. Condom helps in the prevention of HIV and gonorrhoea Diaphragm is also a very safe and reliable method IF used with spermicide	
Disadvantages	Care must be taken when using a condom or a femidom; no sperm should escape through it.	

Surgical Methods

How it works	Vasectomy	• In a man the sperm ducts are cut and tied, thus preventing the passage of any sperms produced. • In a woman the oviducts are cut or tied, sopping egg cells from travelling down the oviduct.
Advantages		• Extremely reliable and sure method of contraception. • Have no side effects.
Disadvantages		• The tubes cannot be often opened. • Not suitable for young couples who may wish to have children later.

Sexually Transmitted Diseases

These are caused by micro organisms' i.e. viruses or bacteria that can not usually survive outside the body. They are transmitted from one person to another when people have sexual intercourse.

Symptoms and effects of some S.T.DS

disease	Causative organism	signs	symptoms	Treatment/cure
chancroid	Bacterium	*Sores on penis or vagina *Swollen glands in groin	Pain from sores and glands	Antibiotics
Gonorrhoea	Bacterium	Male *inflammation of penis *Yellow discharge Female *Pus and discharge	*pain during urination *But may be unnoticed	Antibiotics
Syphilis	Bacterium	*Sore on pennies or vagina (a week after infection) *Spots on skin *Blindness and insanity (long term)	Mild fever	Antibiotics(if attended to early)
H.I.V/AIDS	Virus	*Skin sores *Weight loss *Persistent cough *Diarrhoea *Swollen glands *Low white blood cell count	*Pneumonia *No immunity *Fevers *Fatigue	No cure Use of ARVs to prolong life.

HIV transmission methods

- Unprotected sexual intercourse with infected people
- Drug usage involving sharing needle used by infected people
- Transfusion of infected blood
- Infected mother to baby through placenta
- Feeding a baby with breast milk from an infected mother
- Unsterilised surgical instruments

Preventing HIV and some mentioned diseases

- Abstinence from sexual contact.
- Never have more than one sexual partner.
- Use condoms.
- Never have unprotected sexual intercourse
- Always sterilise needles before injecting drugs into your blood.
- Screen blood for HIV when donating blood.
- Always wear protective clothing when dealing with road accidents, if you are a policeman or a paramedic.

Most STDS can be controlled by antibiotics if a person goes on the doctor in the early stages. There is however no known cure for the H.I.V.

TOPIC 7
BIODIVERSITY

Biodiversity

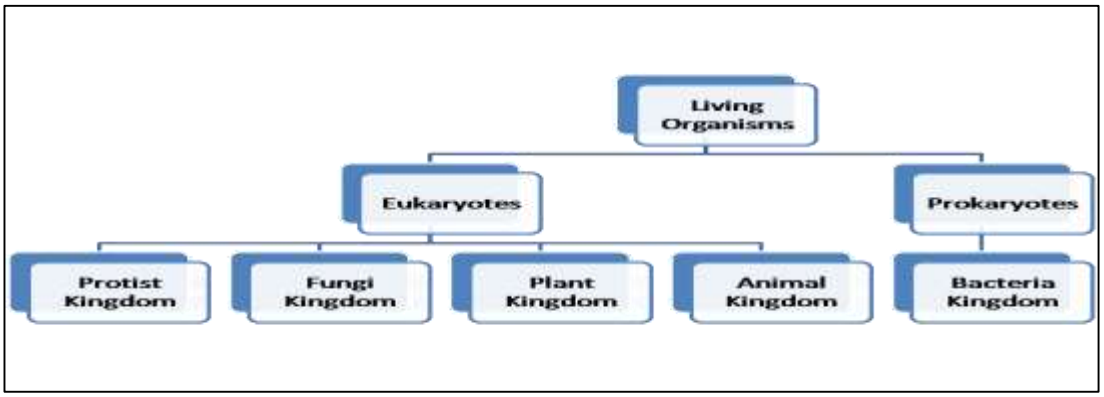
The classification of living organisms

- The classification is based on body structure, method of obtaining food and method of reproduction.

Ranking system of the five kingdoms

- The kingdoms are divided into phyla.
- The phyla is divided into classes.
- Each class into orders
- Each order into family.
- Each family into genera.
- Each genus into species.

Five kingdoms of living organisms.



Eukaryotes:

a) Protoctista kingdom

Protoctista: are organisms with a nucleus, and many flexible organelles amongst their species (for example, some have chloroplasts and cell walls like plants and some like animal cells without these distinguishing characteristics). Their main characteristics include:

- unicellular or multi-cellular bodies
- cells with or without cell wall and chloroplasts
- some species are autotrophic, rest are heterotrophic
- all species have cells with nucleus
- reproduce asexually

Examples of Protoctista

- Diatoms
- Amoeba
- Seaweeds

b) Fungi kingdom

Fungi: are organisms which do not have chlorophyll, thus are heterotrophic and feed on dead organic matter parasitically. The most common known is the edible mushroom; others include fungi causing diseases like athlete's foot, ringworm, panama disease etc. Their characteristics include:

- Multicellular bodies (very few are unicellular)
- Have nuclei
- Reproduce by spore production
- Are heterotrophic

- Don't have chloroplasts
- Feed by parasitic or saprophytic means on organic dead matter

Examples include:

- Saccharomyces cerevisiae
- Penicillium.
- Mushroom.
- Yeast and moulds.

c) Animal Kingdom
   - ✓ The animal kingdom contains many phyla.
   - ✓ Some of them are vertebrates, arthropods, annelids, molluscs, nematodes.

Phylum Arthropoda:

- ✓ Hard exoskeleton
- ✓ Segmented bodies
- ✓ jointed appendages
- ✓ exoskeleton composed of protein and chitin
- ✓ Open circulatory systems in which heart pumps hemolymph through short arteries into open spaces (sinuses)
- ✓ Aquatic members have gills for gas exchange
- ✓ terrestrial members have tracheal system of branched tubes leading from their surface throughout body

Crustaceans:

- ✓ More than 4 pairs of jointed legs
- ✓ Breathe through gills
- ✓ Antennae present
- ✓ Mostly marine

Examples of crustaceans: Crabs, lobsters etc.

Arachnids:

- With 4 pairs of jointed legs
- Breathe through gills and book lungs
- Mostly terrestrial

Examples of arachnids: Scorpion,spider etc.

Insects:

- ✓ Have 3 pairs of jointed legs
- ✓ Have 2 pairs of wings
- ✓ Breathe through trachea
- ✓ Antennae present
- ✓ Mostly terrestrial

Examples of insects: Locust, Moth, House Fly, Grasshopper etc.

Myriapods:

- ✓ Body consists of many segments
- ✓ Each segment has jointed legs
- ✓ They can be both herbivores and carnivores
- ✓ Terrestrial

Examples of myriapoda: Centipede, Millipede etc.

Phylum Annelida

- They are worms
- Have bodies made up of ring like segments
- Live in water and moist soil

Example of Annelids: Earthworm

Phylum Mollusca

- Soft bodied animals
- Have unsegmented bodies
- With or without shell

Examples of Molluscs: Octopus, Jellyfish, Squid etc.

Phylum Nematodes

- They are worms
- Bodies are not divided into segments
- Usually white, long and thin bodied
- feed by parasitic means

Examples of Nematodes: Hookworm, Roundworm etc.

Phylum Vertebrates

- Internal skeleton with spine
- Their nervous system has encephalon (brain) and a spinal cord.
- The encephalon is placed inside the skull and spinal cord is placed inside the spine.

Class Fish

- ❖ Are cold blooded
- ❖ Have streamlined bodies
- ❖ Aquatic
- ❖ Have scales on their bodies
- ❖ May be Herbivores or Carnivores
- ❖ Lay eggs in water
- ❖ Have fins
- ❖ Breathe through gills

Example of Fish: Mackerel, Pomfret, Tuna, Salmon etc.

Class Amphibians

- Give birth to offspring by laying eggs
- Have 4 limbs
- Their habitat is both terrestrial and aquatic
- Have moist skin
- Breathe through gills when young; when mature, breathe through lungs
- Adult often lives on land

Example of Amphibian: Frog, Salamander etc.

Class Reptiles

- ✓ Have scales on body
- ✓ Are cold blooded
- ✓ Terrestrial
- ✓ Lay eggs to give birth to offsprings
- ✓ Egg shells are rubbery

Examples of Reptiles: Lizard, Snake etc.

Class Birds

- ✓ Don't have teeth, instead have a beak
- ✓ Have hollow bones
- ✓ Are warm blooded
- ✓ Lay hard shelled eggs
- ✓ Forelimbs replaced by wings
- ✓ Breathe through lungs

Examples of Birds: Flamingo, Eagle, Hawk, Sparrow etc.

Class Mammals

- Warm blooded
- Can maintain a constant body temperature
- Have different types of teeth
- Have skin covered by Hair
- Give birth to live young offsprings
- Have sudoriferous (sweat) glands
- Females have mammary (milk secreting) glands that produce milk to feed young ones.

Example: Human being

d) The Plant Kingdom

✓ Plants are multicellular organisms, with cell wall made of cellulose.

✓ They include small organisms such as mosses, ferns and flowering plants, trees and grass.

✓ At least some parts of a plant have chlorophyll.

✓ Chlorophyll absorbs energy from sunlight for plant to make glucose.

✓ They reproduce asexually by means of spores and sexually through fusion of male and female gametes.

✓ They are divided into 2 groups, depending on number of seed leaves (Cotyledon):

a. Monocotyledonous (Monocots).

b. Dicotyledonous (Dicots).

Prokaryotae

e) Monera Kingdom

Bacteria are prokaryotic and unicellular. They have cell walls and circular DNA called plasmids. They are Heterotrophs or Autotrophs. They make use of chemicals or sunlight to make their food. They reproduce by simple cell division,

Example: bulgaricu, cyanobacteria,

Naming of organisms

- Linnaeus` naming system is well accepted.
- It is called the binominal system (two – name system). The first word identifies the genus or group to which the organism belongs. The second word refers to the species (kind).
- A species is a group of closely related organisms interbreed and produce fertile offspring.
- The genus name and species name form a scientific name for example adansonia digitata (Adansonia – genus name, digitata – species name); colophospermum mopane (colophospermum – genus name and mopane – species name).

Table 23.2 Classification hierarchy of the African baobab tree and the lion

	African baobab	Lion
Kingdom	Plantae	Animalia
Phylum/Division	Magnoliophyta	Chordata
Class	Magnoliopsida	Mammalia
Order	Malvales	Carnivora
Family	Malvaceae	Felidae
Genus	*Adansonia*	*Panthera*
Species	*digitata*	*leo*
Scientific name	*Adansonia digitata*	*Panthera leo*

TOPIC 8

MICROBIOLOGY AND BIOTECHNOLOGY

Microbiology and Biotechnology

Viruses and Bacteria

- Micro-organisms are very small and cannot be seen by a naked eye and these include viruses, bacteria fungi and uni-cellular animals.
- They live in water, air, soil, on plants or animals.

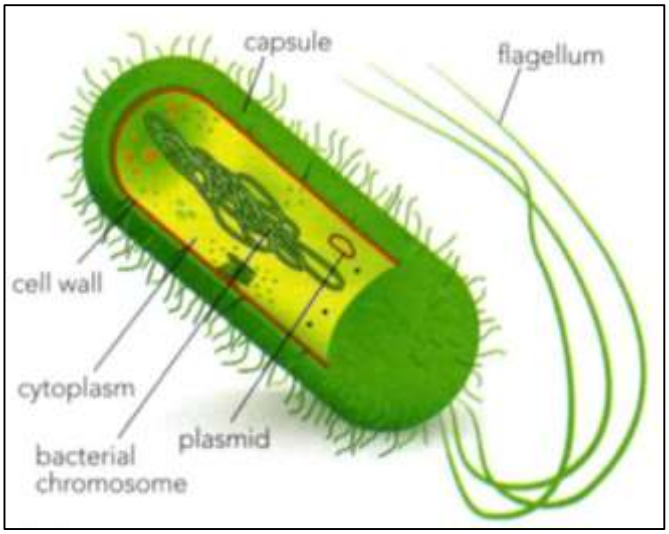
Characteristics of microorganisms

i. They are very small or microscopic.
ii. Are made up of one cell (unicellular)
iii. They contain genetic material in form of DNA.
iv. Reproduce, grow and affect other living organisms.
v. They are capable of carrying out all functions of life such as reproduction, respiration, growth, movement however viruses cannot carry all these independently.

Types of microorganisms

Bacteria

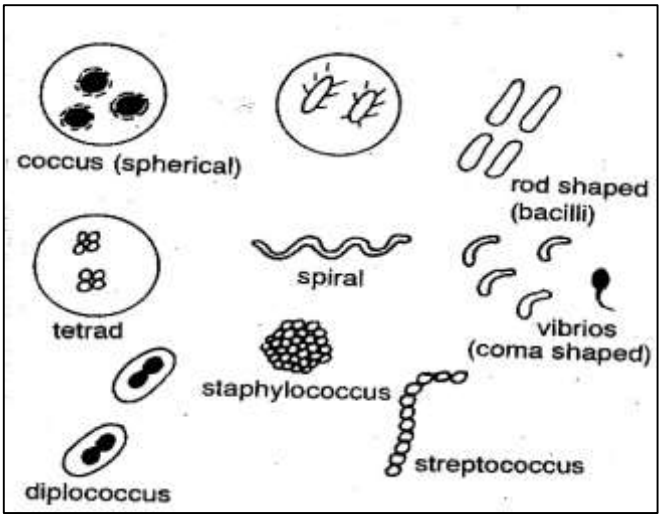
- Are single-celled organisms.
- Small (between 2 &0.2 of a micron in diameter) and can be seen under a microscope.
- No distinct nucleus seen although bacteria have a nucleus without a nuclear membrane.
- Many bacteria are called saprotrophs. They feed on plants and animals.
- Are often parasites causing harm to their hosts.
- Most bacteria reproduce by simple cell division called binary fusion. It involves simple pinching of one cell into two. The DNA duplicates so each new cell has the same DNA as the original cell.
- They need moisture to survive, alkaline conditions of pH 7, 4 and temperature of 24 to 45 degrees Celsius.
- They need a suitable food source and adequate supply of oxygen.



Types of Bacteria

Are classified according to their shapes as below:

1. Rod shaped bacteria (bacilli) - are seen under a microscope as rods. They form chains e.g. Mycobacterium tuberculosis causing TB and Salmonella typhoid causing typhoid.
2. Round shaped /spherical (cocci) – these can exist as singly and are called cocci, as pairs (diplococcic), as chains (streptococci) and as clusters (staphylococci).
3. Spiral shaped (spirilla) – are free living and others are parasitic and pathogenic e.g. treponema palidum causing syphilis.
4. Coma shaped (vibrio) – they reproduce asexually by binary fusion.



Effects of Bacteria

- Are involved in the production of vitamin B and K in the alimentary canal e.g. Escherichia coli.
- Breakdown organic matter into simple nutrients.
- Tobacco industry uses bacteria in the curing of tobacco – they ferment carbohydrates in the moist leaves to produce special flavours.
- They causes diseases for example vibrio causing cholera and others causing tooth decay.
- Anaerobic bacteria act on organic solids to release organic compounds.
- Important in producing foods such as yoghurt and cheese but are also responsible for spoiling of food.

NB: Humans should prevent bacteria so as to avoid harmful effect of it.

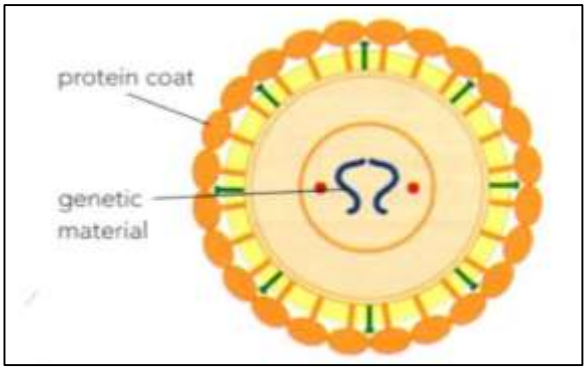
Viruses

- They are non – cellular and are below the level of cellular organisms.
- They are very small ranging between 20 and 300 nanometres.
- They are made up of a core of genetic materials (DNA or RNA) surrounded by a protein coat called capsid.
- The capsid is made up of parts called capsomeres.

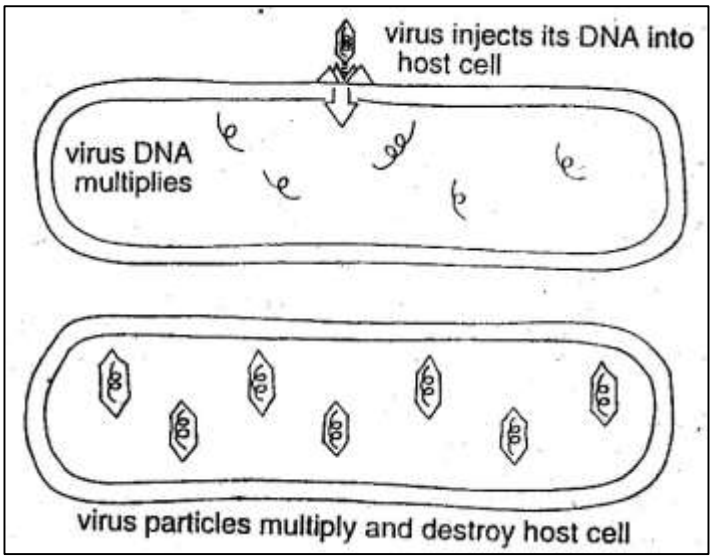
- They are parasitic and can destroy the cells / cause diseases. Virus that causes diseases in bacteria are called bacteriophages.

Examples include HIV, influenza, cold, chicken pox, measles.

They have no cure because the viruses are so small multiply and change so quickly that it is impossible for research to keep up.



Reproduction in Viruses



- If a virus comes in contact with a cell it injects its genetic molecule of nucleic acid into the host cell.
- They reproduce inside a living cell.
- The virus genetic instructions take over the cell and produce more virus particles.
- They burst out of the now destroyed cell and infect more cells.
- They spread rapidly through groups of cells.

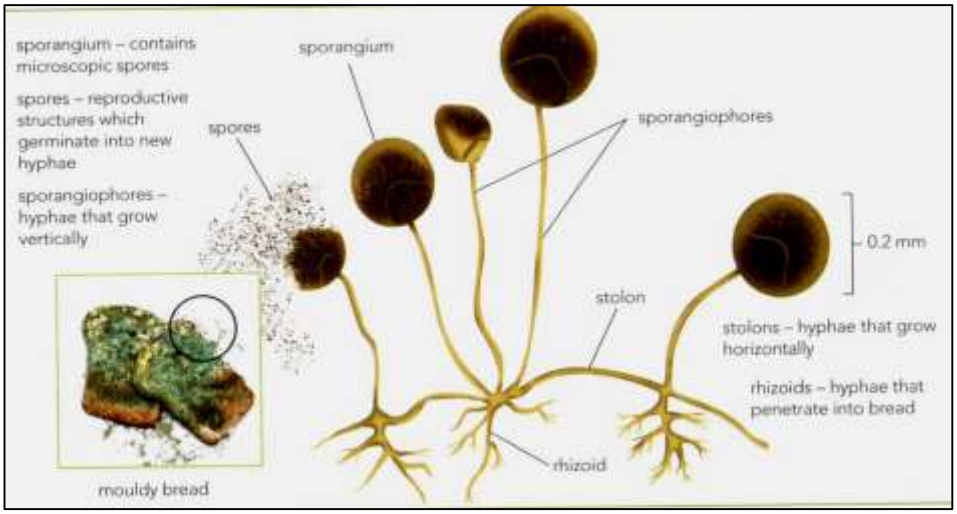
Fungi

- Are organisms not capable of making food. They are heterotrophs.
- They do not have chlorophyll.
- Their cell wall made up of chitin.
- Are made up of thread like filaments called hyphae.
- Some are parasitic and cause diseases like athlete`s foot while others are saprophytes which decompose dead organic material.

Action of Fungi

- The threads or hyphae grow and spread into the food creating a large surface area for absorption of food.
- When the fungus is ready to reproduce, some hyphae grows into the air forming spore cases (thousands of them) inside the sporangium.
- The sporangium bursts to release spores into the air.
- Some spores will land on suitable substrate and germinate into more hyphae form another fungal growth.

- Those that land on stony ground will not germinate.
- Fungi feeds by secreting extra – cellular digestive enzymes onto organic food.
- The food is broken down into soluble form which is then absorbed by the hyphae.



Home work

Qn 1. State and explain the economic importance of microorganisms. [8]

Answer

1. Are used to make products like wine, beer and bread.
2. Some are used in genetic engineering to increase the production of useful genes.
3. Help in break down bodies of dead organisms (decomposition of matter).
4. However, microorganisms cause diseases (pathogen).

Refers to the development of techniques using biological processes to produce materials that we use in medicines and food industries.

Application of bio – technology

1. Making compost.
2. Making bread with yeast.
3. Fermentation to produce wine and beer.
4. Production of drugs such as penicillin.
5. Improving crops using genes (Genetically Modified Organisms).
6. Treating sewage.
7. Producing transgenic organism by altering their gene make up.
8. Gene cloning etc.

Bio- Remediation

Refers to waste management technique using microorganisms to remove contaminants that may be harmful to the environment and health

Biotechnology

Some examples are:

a) Cleaning up an oil spill.
b) Cleaning up contaminated soil.
c) Cleaning up blood and bodily fluids that may be harmful at a crime scene.
d) Cleaning waste water so that it can be reused.

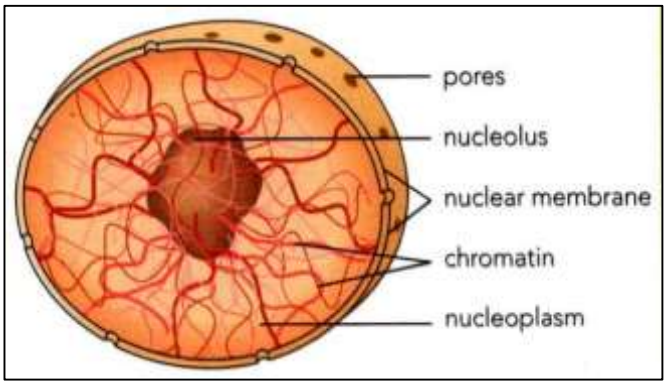
FORM 3 TERM 3

TOPIC 9

GENETICS

Chromosomes and genes

- The cell function are controlled by the nucleus.
- It house the cell`s deoxyribonucleic acid (DNA).
- It stores the cell`s hereditary information. Hereditary simply means information is passed from one generation to another or parent to offspring.
- The DNA in the cells determines all characteristics such as hair colour, height and the shape of the ears.
- DNA has a structure like twisted ladder called double helix.
- They are found in a network of threads known as chromatin network in the nucleus.

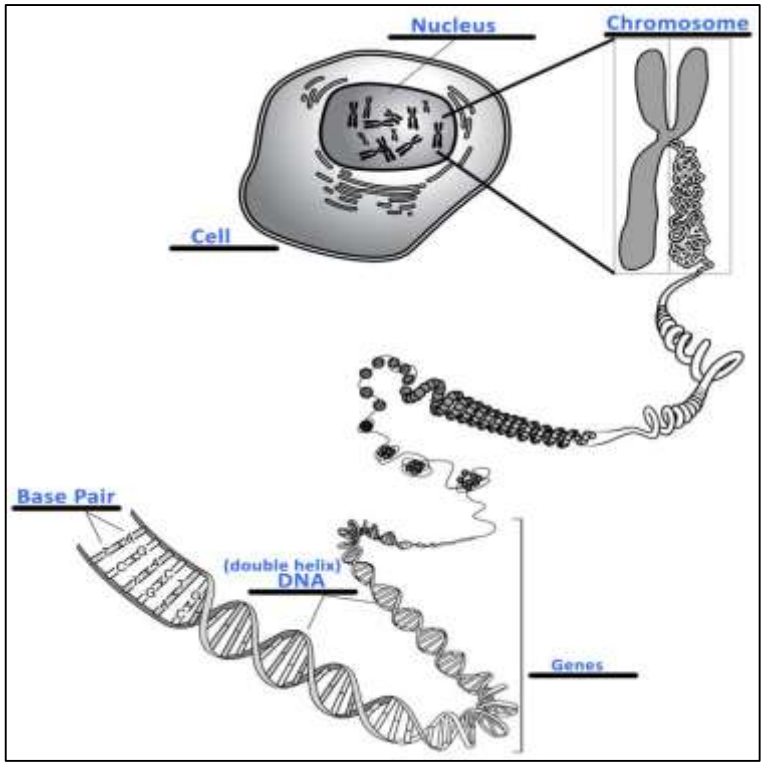


Chromosomes

- When cell divide, the chromatin threads get shorter and thicker to form X – shaped structures.
- Are packages of long strings of DNA.
- They are made up of pairs of identical chromatids or sister chromatids.
- A centromere is a region on the chromosome that joins sister chromatids.
- In humans there are 46 chromosomes (23 in pair) in the nucleus of all body cells except the sex cells. The sex cells have half the number so that at fertilisation the normal number is resumed.

Genes

A gene is a structural unit of inheritance responsible for one specific feature. These are sections on a DNA molecule which code or instruct for every specific features and characteristics such as eye colour and earlobe.



Genetics

- Genetics is the study of heredity, the process in which a parent passes certain genes onto their children.
- Children inherit their biological parents' genes that express specific traits, such as some physical characteristics, natural talents, and genetic disorders.
- The hereditary material is located on the chromosomes in the nucleus of every cell.
- Heredity is when animals have offspring that resembles them in many respects/the transmission of characteristics from parent to offspring. When these characteristics are handed from parent to children, it's called inheritance.

- In all cells except sex cell chromosomes are present in pairs.
- These pairs are known as homologous chromosomes and one chromosome in a homologous pair is passed from one parent and the other chromosome when their sex cells fuse at fertilisation.

Alleles

- Genes exists in two copies. That is, a gene has a copy on each chromosome pair.
- Alleles are different versions of the same gene representing a specific trait such as colour of flowers.
- Alleles can occupy same position or locus on a homologous chromosome for example the purple allele and white allele for flower colour in peas.

Genotype and Phenotype

- Genotype is the genetic combination that gives rise to that phenotype. For example, with respect to dimple , Dd or DD and no dimples, dd and tongue rolling, a person may have the genotype (RR), (Rr), or (rr) because alleles are present in pairs.
- Phenotype is the physical appearance that is a result of a particular combination of alleles. E.g. curved thumbs, dangly earlobes. Dimples, colour etc.

Homozygous and Heterozygous

- The gene that controls dimples has two possible forms – an allele for dimples and no dimples. Dangly earlobes and for attached earlobes.
- If one inherits identical alleles, whether dominant or recessive, its homozygous.
- If one inherits one of each type of allele is heterozygous for that trait.

Dominant and recessive

- A dominant allele is the one that is expressed in the observable traits of the organism.
- A recessive allele expresses itself only under homozygous conditions or cannot be observed in the offspring.
- A capital letter represents a dominant allele and a small letter or lower case represents a recessive allele
- e.g. 1. RR, Rr for tongue rolling and rr for non-tongue rolling.
  2. BB, Bb for black fur and bb for white fur.

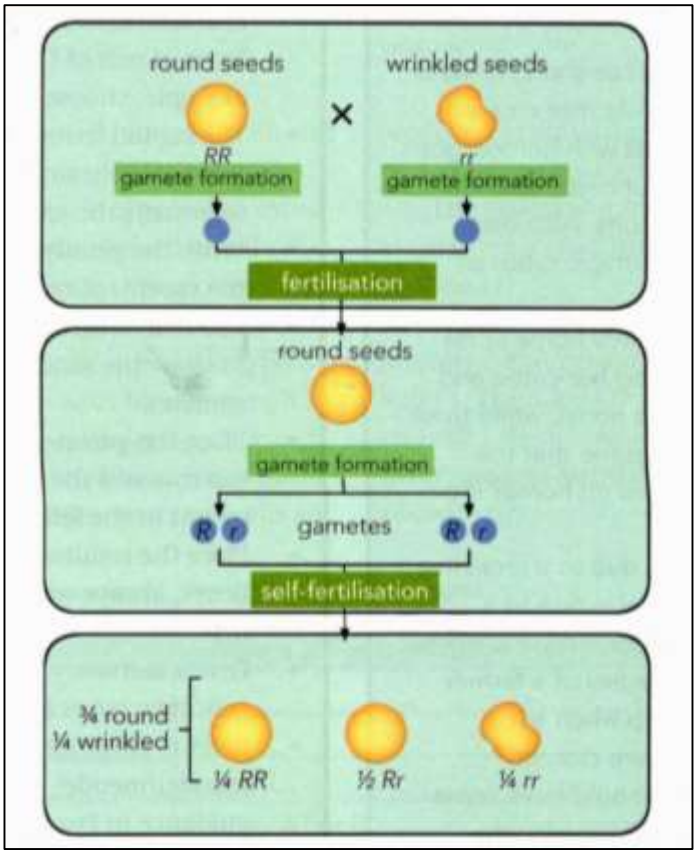
  Some genetic traits: Dominant alleles are on the left side:

Monohybrid inheritance

- Mendel `s first law of inheritance
  - Alleles for a trait will separate during production of gametes.
  - The gamete will contain one of the allele of the trait, these can be the same or different.
- Gametes fuse during fertilisation and become two alleles of the trait which may be different from those of either parents.
- This segregation or recombination yields genetic variation.
- Alleles can be dominant or recessive. If you cross parent 1 (identical alleles for purple flower) and parent 2 (identical allele for white flower), one of these trait may dominate the other.
- In first generation (F1) , purple will be present in all offspring.

Monohybrid Cross

This kind of crosses involves a cross using one characteristic (mono) and the resultant offspring will have a genotype with two different alleles (hybrid).



Punnet Square

F1 generation

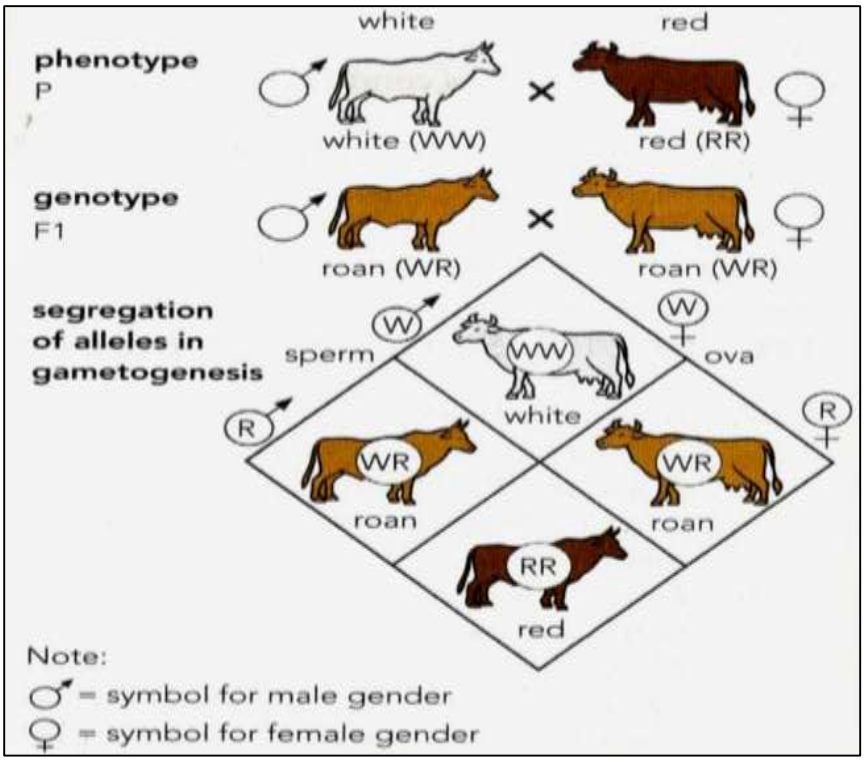
gametes	R	r
R	RR	Rr
r	Rr	rr

Parent's phenotypes:	round peas		round peas
Parents' genotype:	rR	×	Rr
Gametes:	Rr		Rr

F1 phenotypic ratio:	3 round peas : 1 wrinkled pea
F1 genotypic ratio:	1XY : 1 XX

Co – dominance

- This is where by one allele is not completely dominant over the other but they share their expression in the phenotype.
- The phenotype is not a blend of the traits, but rather both of the traits are seen in the offspring.



- Co – dominance is shown in the genetics of human blood groups (A, B, AB and O).
- Blood types result due to proteins called antigens present on the surface of red blood cells.
- Blood A has A antigens, B has B antigens and AB, antigens AB are each coded by dominant alleles.
- Blood O has neither A nor B antigens.
- The genetics of blood has three allele not two: I^A, I^B, and i .
- The alleles show co- dominance and I allele is recessive.

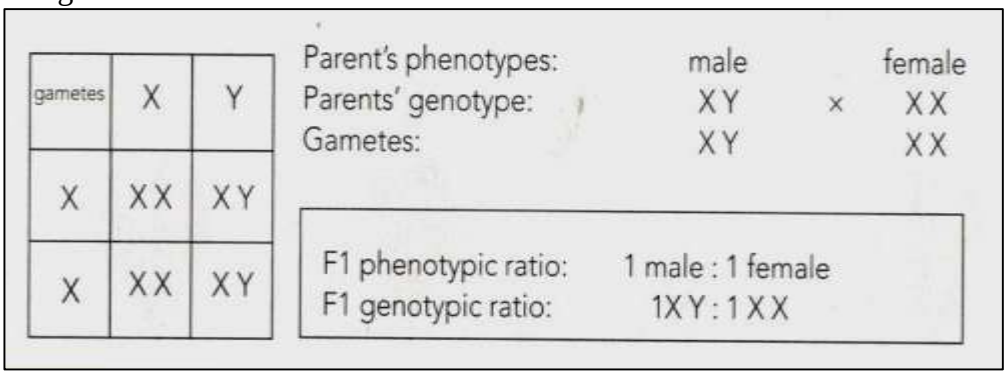
- People with blood type A will respond to B as foreign and will start to clump. This is the same when blood B is given to A antigens.
- People with AB blood can be given either blood types as they are no antibodies expressed in their red blood cells.
- The i allele produces neither antigens, so can be given to people of any blood type but only done on emergency situations.

Genotype	Blood type	Antigens present on blood cells	Antibodies present in plasma
I^AI^A or I^Ai	A	A	B
I^BI^B or I^Bi	B	B	A
I^AI^A	AB	A and B	Neither A nor B
ii	O	Neither A nor B	A and B

Sex chromosomes

- Sex chromosomes are called X and Y.
- Males and female differ in the last pair of their chromosomes.
- Females have XX sex chromosomes and males have XY.

- Gametes separate and join during fertilisation.
- This means that each time a sperm meets an ovum there is 50% chance of the zygote developing into a boy or a girl.



gametes	X	Y
X	XX	XY
X	XX	XY

Parent's phenotypes: male × female
Parents' genotype: XY × XX
Gametes: XY XX

F1 phenotypic ratio: 1 male : 1 female
F1 genotypic ratio: 1XY : 1XX

Mutation

Is the sudden change in the nature of a gene / DNA. In HIV, it refers to change in RNA. The change in the genetic material due to mutation is permanent and heritable.

Harmless mutations – these change the physical feature of an organism without causing any harm for example when one is borne with extra digits (polydactyl).

Harmful mutation – when there is change in physical appearance, behaviour or physiology of an organism.

Useful mutations – they can be introduce beneficial changes that increases survival chances of species.

Types of mutations

Are of two types i.e. gene and chromosome mutations.

Genetic mutations

- Mutations causes changes in genes with either no effect or may alter or stop the function of the gene.
- Most mutations occur as a result of mistakes during DNA replication. Sometimes the DNA can repair itself but if the mistake is not corrected, it will be added to the DNA structure.

Autosomal dominant mutations

- A chromosome other than sex chromosome is called autosome.
- If mutation occurs in the dominant allele of an autosome it is called autosomal dominant disorder.
- The trait can be passed either from the mother or father.
- Huntington `s disease is an example of autosomal dominant disorder. Mutation causing disorder is located on chromosome 4 which results in gradual degeneration of a person `s brain hence loss of physical, mental and emotional control.

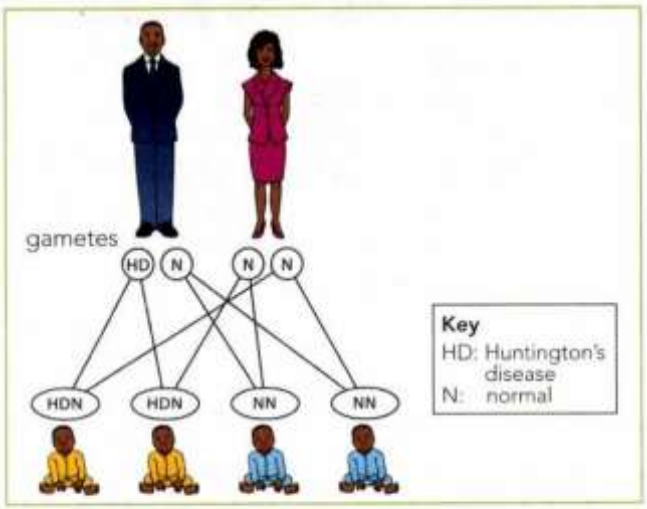


Figure 22.3 There is a 50% chance of inheriting this autosomal dominant disorder

Autosomal recessive mutations

- The changes occur on the recessive allele and the disorder will only be expressed when an individual inherits two identical copies of the gene.
- If only one copy of the gene is inherited, the person will be termed a carrier for the disorder.
- Examples are cystic fibrosis, albinism and sickle cell anaemia.

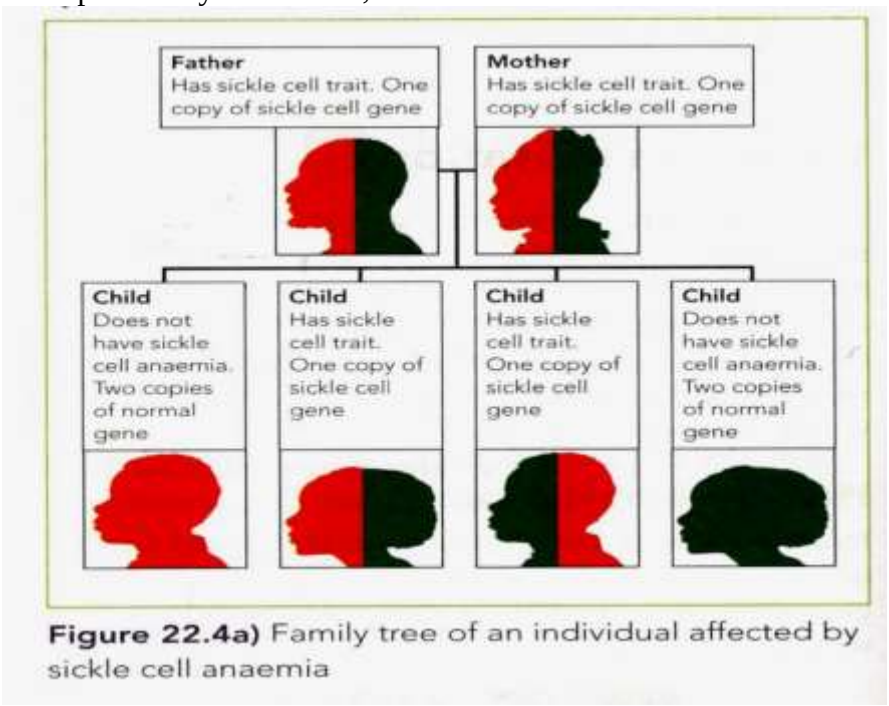


Figure 22.4a) Family tree of an individual affected by sickle cell anaemia

Inherited disease	Notes
Cystic fibrosis	In cystic fibrosis, the cells in the lungs make mucus thicker than usual. It decreases the efficiency of the gas exchange surfaces due to the trapped mucus

	The mucus made blocks the pancreatic duct and prevents digestive juices from flowing, affecting digestion.
Sickle cell anaemia	Is a genetic disease where the red blood cells losses oxygen and become sickle shaped. Red blood cell get stuck in blood capillaries, causing pain, fever swelling, tissue damage and eventually death.
Albinism	Is a genetic disorder that results in a lack pigmentation in the eyes, skin and hair. It results when a person inherits an albinism gene from both parents. The gene is recessive and therefore, an albino has no parents with the disorder. However, if a person inherits two of these recessive genes, he or she will suffer from albinism. The two recessive genes result in a lack of **melanin production.** Melanin is the pigment that gives colour to the skin, hair and eyes and protects us from the sun. People with albinism suffer from skin cancer due to exposure to direct sun and have problems with their eyesight.

Chromosome mutations

This results in chromosomes being added or deleted or being broken up or rearranged. A person with Down syndrome has an extra copy of chromosome 21. This hugely impacts on a person `s physical characteristics.

Factors that increases rate of mutations

- The rate at which mutations occur and the associated expression in the phenotype is increased by substances called mutagens.
- These are external factors that causes changes in the DNA for example ultraviolet rays, cigarette smoking and radioactive substances.

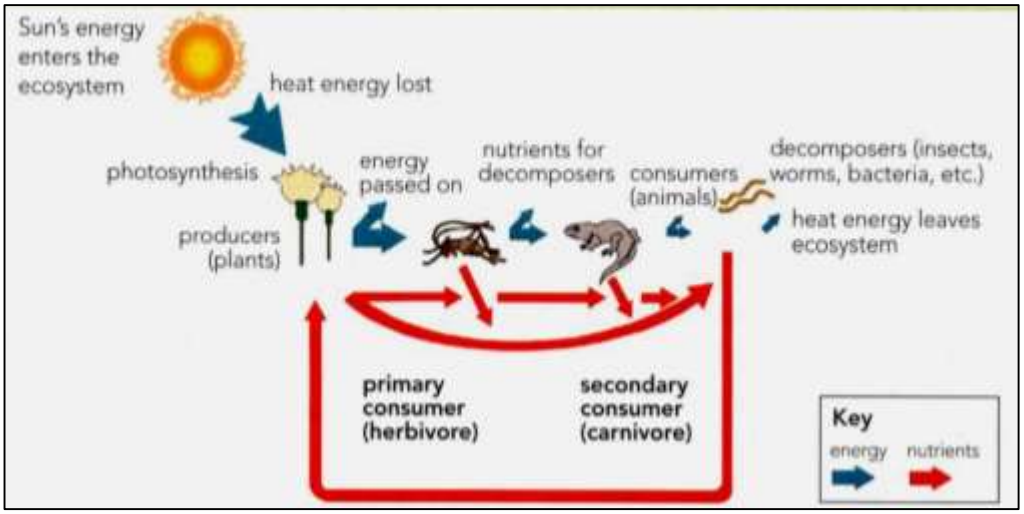
TOPIC 10

ECOSYSTEMS

Ecosystem

Is a self-contained system of interdependent organisms and their environment e. g a pond, grassland, garden, soil e.t.c. Organisms are dependent on each other and on the environment especially as a source of energy.

Features of an ecosystem



Terms used in ecology

1. Habitat - are places where animals and plant live. It has conditions such as light, temperature and water for organism to survive.
2. Community – composed of different plant and animal populations living and interacting in a particular place e.g. savannah community with elephants, zebra, acacia, trees and grasses.
3. Population – a group of individuals of the same species living in a particular habitat.
4. Niche – the role an organism play in its environment or position it takes within its community.

- **Components of an Ecosystem**

Abiotic and Biotic

Abiotic / Physical components

a) Soil-soils support plants .Soils provide plants with nutrients and water. However, not all ecosystems contain soil. Lakes and ponds contain water.

b) Air-oxygen and carbon dioxide are important for respiration and photosynthesis (define these terms).

c) Light-is the ultimate source of energy for all living organisms and vital for photosynthesis to take place.

d) Temperature- it varies from season to season and is related to sunlight and its changes is very important abiotic factor.

e) Water- the quantity and quality of water varies from one ecosystem to another. Water affects the type of plants and animals found in an ecosystem

f) Humidity- areas of low and high humidity has an influence on ecosystems. For example desrts and coastal areas with low and high humidity respectively.

g) Land- the topography can influence rainfall type, amount and sunlight and area receives.

Biological / living / biotic components

- Producers and consumers are two kinds of living things in any ecosystem.
- The plants that make their own food and the animals that feed on them. The plants are the producers which supply energy to the consumers in the system.
- Consumers are grouped into primary (leaf eater or herbivores) , secondary (carnivores & omnivores) and tertiary consumers (decomposers).
- When plants and animals die ,their bodies still contain energy and complex chemicals. These chemicals are broken down and decomposed by micro-organisms, mostly bacteria and fungi. These organisms are called decomposers.

NB: **1**. The distribution of living components in an ecosystem is influenced by physical components like shelter and food availability.

2. Energy from the sun flows into an ecosystem and is lost in various ways and stages.

Role of biological components in the soil

-Micro-organisms - Include bacteria and fungi. They improve soil fertility by decomposing plant and animal matter

-Earthworms-they improve drainage and aeration by making tunnels in soil hence water penetrates easily. They increase organic matter by pulling plants and grass into the soil. Recycling of nutrients and mixing topsoil and subsoil thereby increasing soil depth.

-Termites – help to stick soil particles together as they make fertile moulds. They secret an alkaline substance which reduces soil acidity.

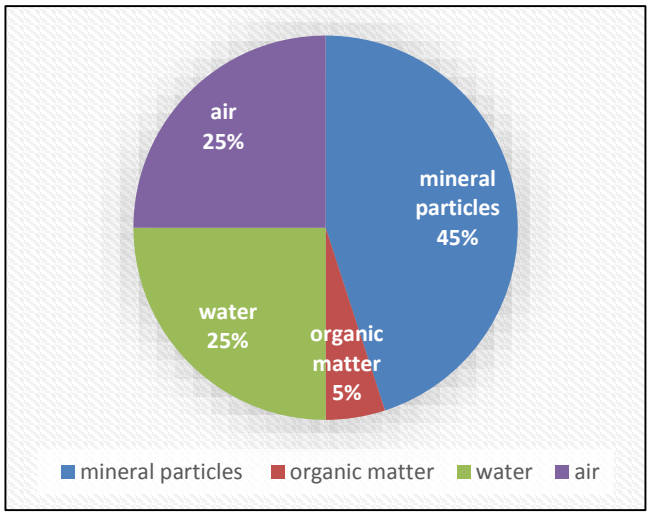
-Nematodes – they digest plant sticks, stems and grass helping in humus formation.

Feeding Relationships in a Natural Ecosystem

Plants are producers of food and animals are consumers. Organisms in an ecosystem depend on each other for living. The relationships amongst organisms are shown by food chains and food webs.

The Soil

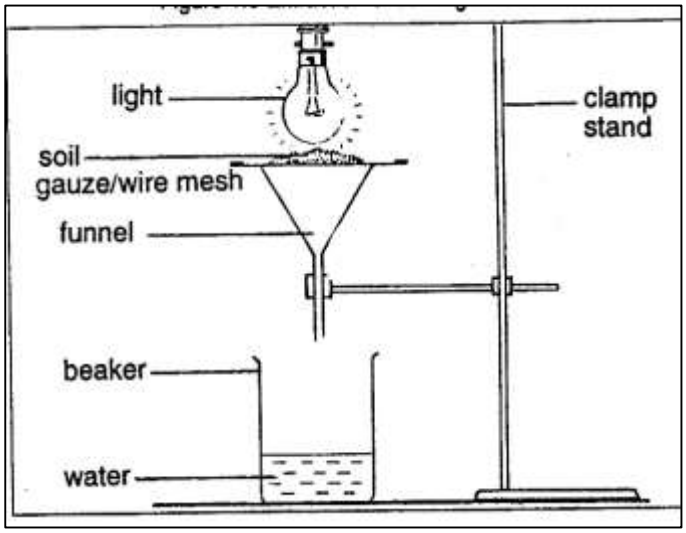
- Soil is a thin layer that covers the earth.
- Is made up of rocks break down to form small particles.
- Is important for plant growth as it provides water, air and minerals.
- Soil holds plants firmly in the ground.
- The type of soil in an area determines the kind of animal or plant found there.
- The soil composition is shown below:



Experiment 1

Extracting soil organisms

Materials: soil, funnel, light source, beaker, methylated spirit, or alcohol.



Method

i. Place some soil in a funnel which contains wire gauze; suspend the funnel over a beaker containing methylated spirit.
ii. Place a light above the funnel.
iii. Leave the set up for 36 hours.

Observations

Look at what has collected in the beaker (use a hand lens).

What caused the organisms to fall into the beaker?

Identify and describe the role of each organism. (8)(Do this as a home work).

Solution/answer

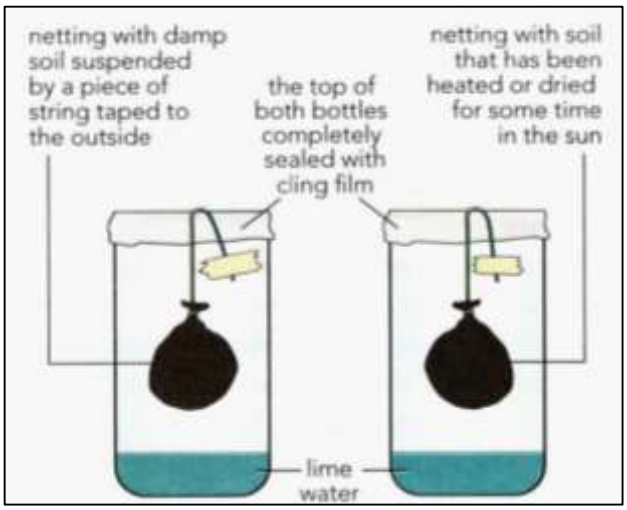
Soil organisms run away from light, enter into the soil and eventually fall in methylated spirit.

Micro-organisms prefer dark and damp environment.

Experiment 2

Aim: To investigate microorganisms in the soil

Materials: two 2 litre plastic cool drink bottles, lime water, or bicarbonate indicator, netting, plastic wrap, string, sticky tape, approx 2 cups of soil, burner



Method

i. Place lime water at the bottom of the two bottles (You can prepare lime water by boiling calcium hydroxide and water then filter the solution).
ii. Remove any visible plant or animal from the soil. Divide the soil in half. Dry the soil in the sun. and bake it at 100 ℃ in an oven. Make the other half soil damp.
iii. Cut 2 equal size squares of netting and place equal amounts of of soil. Seal the bottles with plastic.
iv. Label the bottles and leave them for few days.

Observations

What do you notice? Explain you observations.

Why was one soil sample dried and one dampened?

Solution/answer

- Lime water remained colourless in B. by heating the soil, organisms were killed. Since there was no life in the soil, there was no respiration and hence no carbon dioxide in the air.
- In A, limewater changed from clear to milky showing the presence of carbon dioxide and micro-organisms. They respired and produced carbon dioxide.

Types of soil

Soil consists of particles of different sizes. The size of the soil particle in a sample is called soil texture. Soil particles are broadly grouped as consisting mostly of sand, loam and clay soil.

Characteristics of sand, clay and loam soils

Soil group	Texture	Particle size	Other properties
Sand	• Particles are large and coarse • Feels coarse even when wet • Breaks up when moulded into an O – shaped.	• More than 0,022 mm in diameter.	• Large air spaces. • Good aeration. • Good drainage. • Little organic matter.
Loam	• Contains sand • Stick together when moist	• A mixture of sand and clay of particles between 0,02 and 0,0002 mm in diameter	• Moderate aeration • Moderate drainage • Large amounts of organic matter

clay	• Soft, smooth and sticky • Can be moulded into an O – shape without breaking	• Are less than 0,002 mm in diameter	• Small air spaces • Poor aeration • Poor drainage • Little organic matter

Soil pH

- Is the measure of how acid or alkaline the water in the soil is.
- The soil pH is measured on a scale of 1 to 14, where a pH of 7 is neutral, below 7 is acidic and above 7 is alkaline.
- A universal indicator and litmus paper or red cabbage indicator are used to test the pH of soils.
- Soil pH determines the types of crops grown. Most crops grow best in neutral pH.
- Acidic soil changes the indicator to red.

Role of biological components in the soil

-They improve soil fertility.

-They improve drainage.

-They improve aeration.

QN 6.a) What is soil? (2)

b) Draw and label the soil profile. (5)

c) What is its composition? (6)

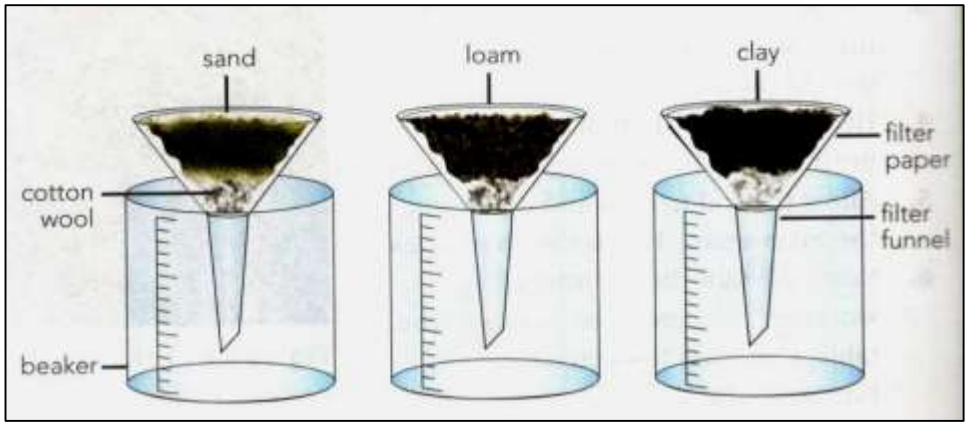
Experiment 3

Aim: To determine the water holding capacity

Materials: measuring cylinder, beaker, filter paper, cotton wool, water, equal volumes of sand, clay and loam,

Procedure

1. Set up apparatus as shown below.
2. Fold filter paper in half and and then in half. Open it and place it inside the funnel.
3. Use some damp cotton wool as plug.
4. Place in each funnel the same amounts of dry sand, clay and loam.
5. Write a prediction of this experiment.
6. Slowly pour 100ml of water onto each funnel with soil.
7. Record results in table.



Soil type	Clay soil	Loam soil	Sand soil
Volume of soil sample			
Volume of water added			
Volume of water collected			
Volume of water retained in the soil			
Time taken for water to drain			

Conclusion

- Sand soil drain water faster than clay so clay soil has good water holding capacity.

Experiment 4

To find the water content of soils

Materials: loam, sand and clay soil, evaporating dish, boiling tin, balance, stand and burner.

Method: Bio Today Bk 4 pg

Results and calculations

Mass of evaporating dish =20g

Mass of moist loam soil =50g

Mass of evaporating dish and moist loam soil =70g

Mass of dish and dry soil =60g

Mass of water evaporated =70g−60g=10g

Percentage of water content of loam soil =10⁄50 x100

= 20%

Experiment 5

Finding humus content of soils

Materials: different types of soils, a mass meter, a Bunsen burner, tripod, a porcelain dish,

Procedure

i. Place 30g of soil in a porcelain dish.
ii. Place the dish on the tripod and heat slowly with a burner until the soil is dry so as to remove any moisture.
iii. Allow the soil to cool and find the mass of soil again. This is the second mass.
iv. Heat the soil and intensify heat until soil is lighter in colour
v. All the soil to cool and mass the third mass.
vi. Record results in a table. Calculate the percentage of humus in the soil.

Results and calculations

Soil sample	First mass (g)	Second mass (g)	Third mass (g)	% humus
Clay				
Sand				
Loam				

Experiment 6

Aim: To find the air content of different soil types

Materials: sample of sand, loam and clay, measuring cylinder, three beakers,

Procedure

1. Place 200ml of each type of soil in different labelled beakers.
2. Add 250 ml of water to the measuring cylinder.
3. Add enough water to the beaker containing clay. The water will displace the air in the soil.
4. Take a reading of water left in the measuring cylinder. Calculate how much water was added to push out all the air in the soil (Subtract the final water reading from the initial water reading).
5. Repeat steps 2 to 4 for loam and sandy soil.

Results

- Water sinks into the soil and the volume of mixture is reduced.

- Sand soil has the largest air content, followed by loam and lastly clay due to the difference in particle sizes.

Natural ecosystem

Types of Ecosystems

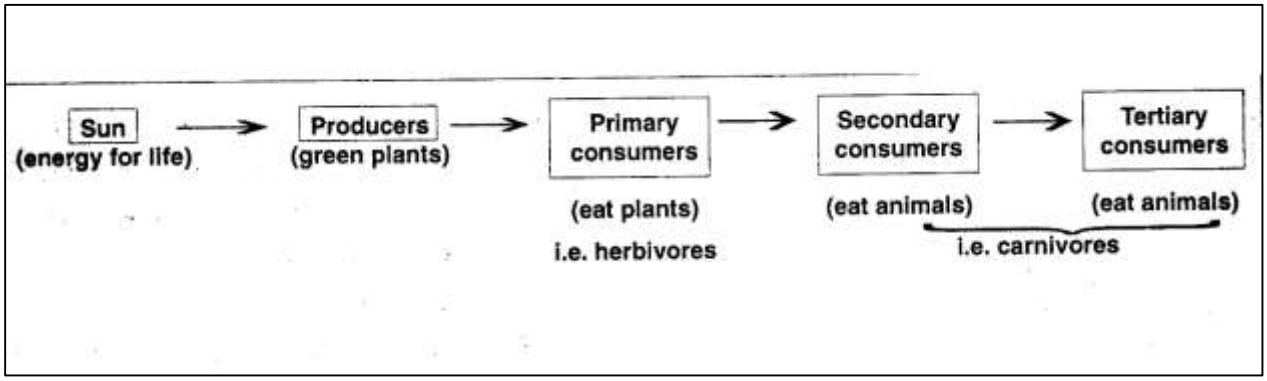
Two types are the natural and artificial ecosystem.

Natural Ecosystems

There are no human interferences. Pests and diseases are part of the ecosystem and no control measures taken. Animals graze freely and no fertilizer application. There is natural balance of nature. In Zimbabwe the three biome are savanna, grassland and forest ecosystems.

Food Chains

A food chain is a feeding relationship in which energy in producers is transferred to consumers at different trophic levels. Food chains start from the producer to consumers. e.g.



Each stage of the food chain is called a trophic level.

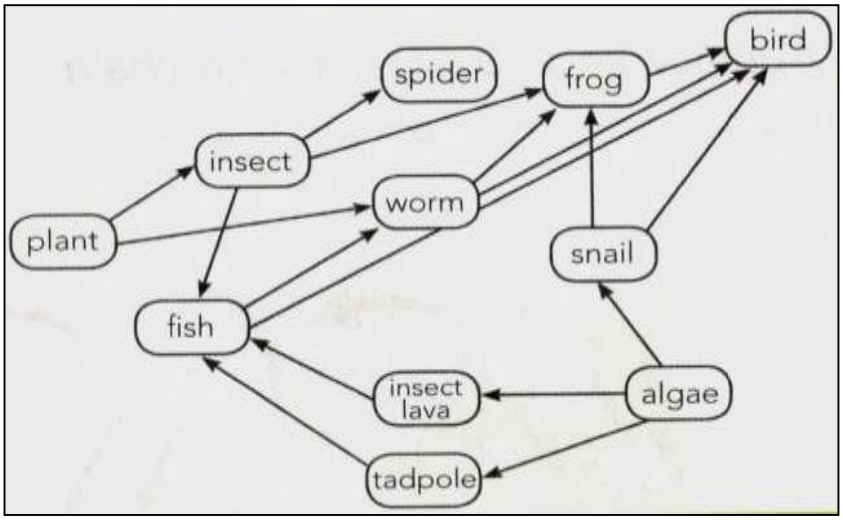
Trophic level is the position of an organism in the food chain. The four trophic levels are:

- Producers
- Primary consumers
- Secondary consumers and
- Tertiary consumers

At each trophic level, energy is lost due to respiration. Other processes include reproduction, movement and metabolism.

Food Webs

Food webs are interconnections of food chains or show a complex feeding relationship between organisms. An organism may feed on more than one organism and in turn it may be eaten by others. However, plants are the primary food source and the sun is the only energy input.



Exercise

QN3. Draw a food web and extract two food chains from the food web. (8)

Energy flow along food chains and food webs

- Energy flow in one direction through an ecosystem.
- The sun passes energy into green plants.
- Green plants trap sun `s energy and make sugars during photosynthesis.
- Some energy is passed on to consumers
- Secondly to carnivores that feed on herbivores.

Pyramid of Numbers

- A pyramid of numbers illustrates the number of organisms at each trophic level.
- A pyramid of numbers is a bar chart plotted horizontally with area of each bar proportional to the number of organisms at each trophic level.
- Here, organisms interact with each other through energy transfers and are linked by their feeding habits.
- On the higher levels of the pyramid of numbers can be a tertiary consumer or a decomposer for example hawk.
- The number of organisms decreases as you go up the pyramid.
- Again, energy is lost at each level. However, some pyramid of numbers may be inverted if one producer supports many consumers.
- One disadvantage with pyramid of numbers that it does not take into account the size of the organisms.

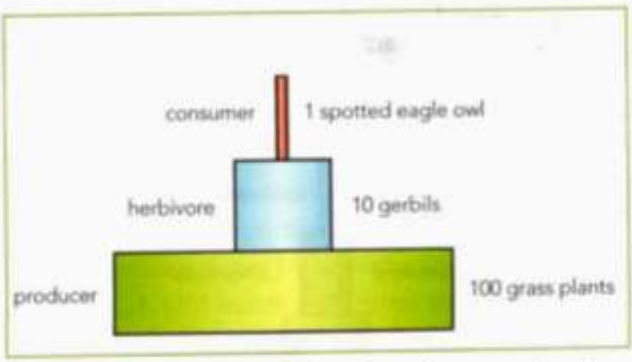


Figure 24.21a) Pyramid of numbers for a grassland community

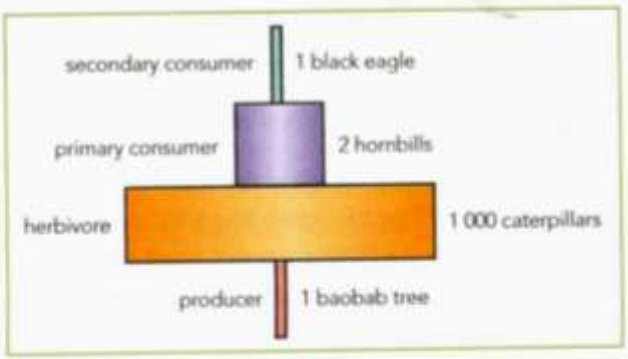
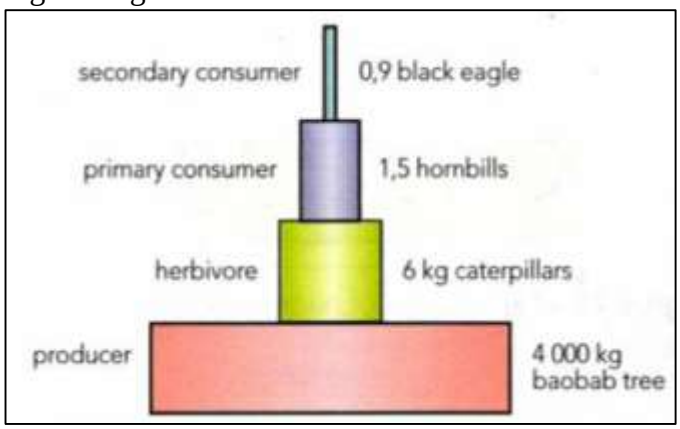


Figure 24.21b) Pyramid of numbers for a baobab tree community

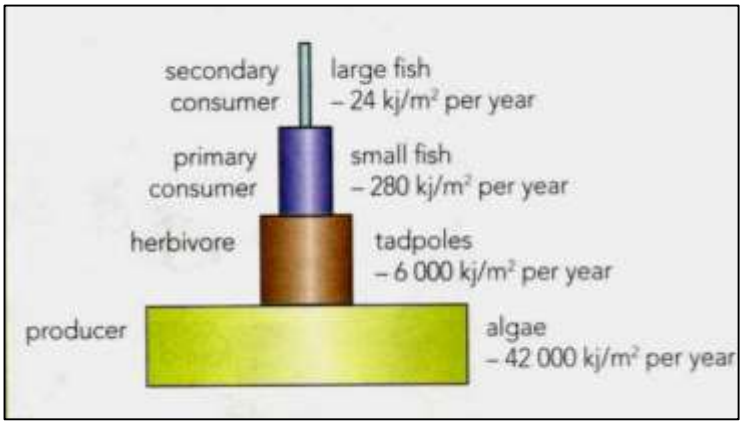
Pyramid of Biomass

- It shows the mass of living material at each trophic level.
- The total amount of living tissue at each trophic level is called biomass.
- A biomass pyramid of an ecosystem shows the amount of potential food available at each trophic level.
- Pyramid of biomass takes into account the size of organisms but cannot indicate the rate at which organism grow.



Pyramid of energy

- It shows the amount of energy transferred from one trophic to another.
- Only a part of energy that is stored in one trophic level is transferred to the next level.
- Example: producers transfer 42 000 kj/ m2 per year to the tadpoles. The tadpoles then transfer 6000 kj/m2 to small fish, and so on. If the tadpoles got 42000 kj/m2 and passes only 6000 kj/m2, what happened to the 36000 kj/ m2 per year?
- Some energy that organisms use for movement, reproduction and respiration is released to the environment as heat and some is lost through wastes.
- The only energy passed is used to make cells grow
- The more levels present in food chain the greater the loss of energy.
- Short chains are more efficient than long ones.
- Energy pyramids can never be inverted



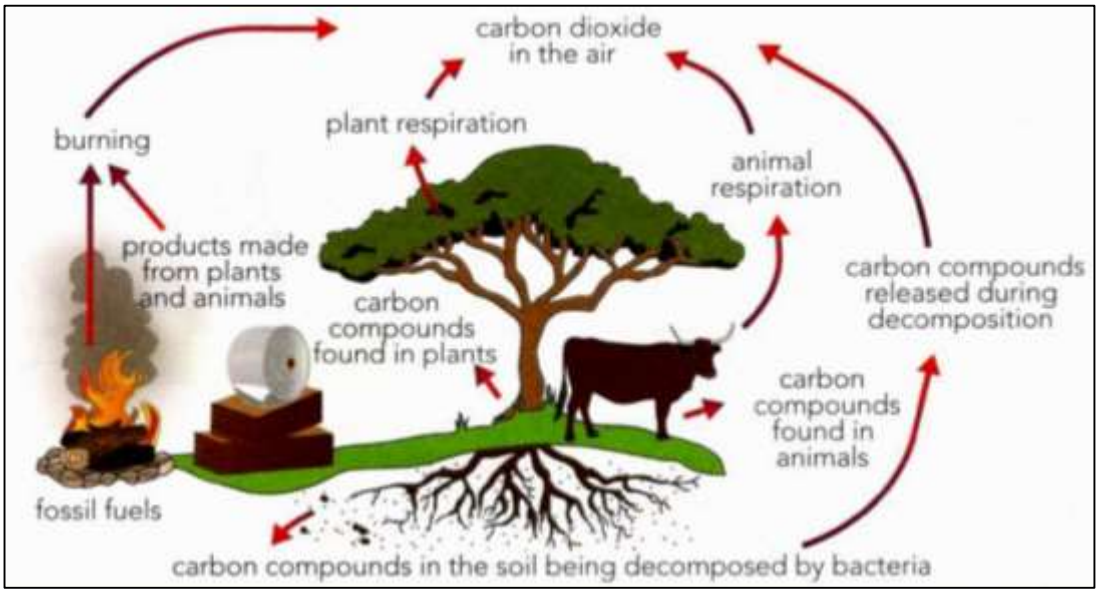
Question

5. What are the main causes of energy loss at each trophic level in pyramids of biomass? (3)

Nutrient Cycles in Ecosystems

- Materials such as carbon, nitrogen, oxygen and other nutrients are needed by organisms for growth and healthy.
- Nature recycles these materials.
- The carbon and nitrogen cycles are two vital cycling processes.

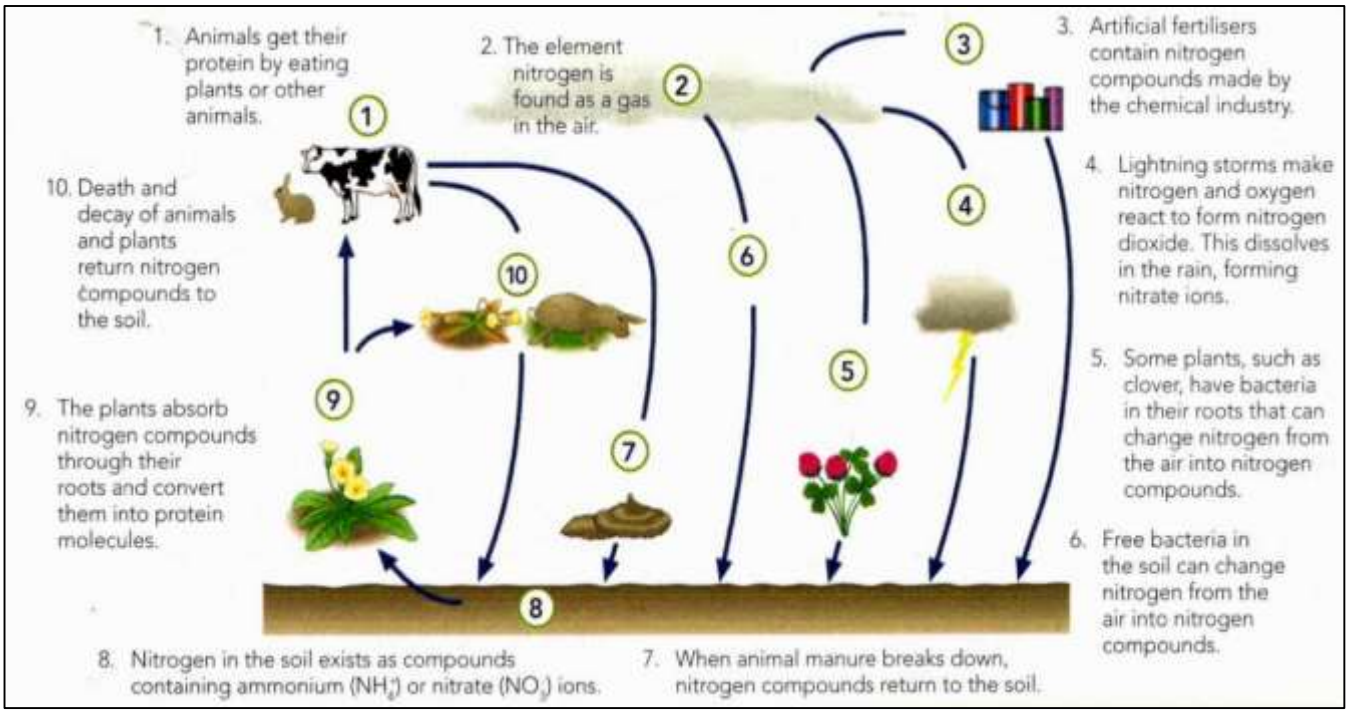
Carbon Cycle



- Carbon in ecosystems comes from carbon dioxide in the atmosphere.
- Plants remove carbon from the air during photosynthesis and build it into food compounds.
- Animals obtain carbon by eating plants and other animals. They use carbon to make carbohydrates, fats and proteins.

- During respiration, carbon is released in the atmosphere by micro-organisms, plants and animals.
- Carbon enters the atmosphere when fossils fuels such as coal are burnt (Combustion).

Nitrogen Cycle



- Nitrogen is need by organism so as to make proteins.
- Nitrogen is present in the atmosphere in a form not useable by organisms.
- It must be changed to nitrates which plants can use to make proteins.
- Animals get proteins from plants and other animals that they eat.
- Nitrogen – fixing bacteria converts nitrogen into nitrates which can dissolve in water so that plants use it to make proteins.
- Animals excrete nitrogen in form of ammonia and urea. Decomposers such as nitrifying bacteria converts nitrites into nitrates.
- Nitrogen in the atmosphere can be converted into a form that plants can use by lightning. However, the fixation is not efficient as by bacteria.
- Denitrifying bacteria converts nitrates into nitrites and ammonia.

Artificial ecosystem

- It is a natural ecosystem that has been interfered with and altered by people. It is one reflecting human interference and change e.g. fish pond, garden, orchard etc.
- Artificial ecosystems are usually characterized by low species diversity e.g. mono-culture.
- The natural balance that allows an ecosystem to be self-sustaining is disrupted in an artificial one. The system may be forced to produce more than it would naturally.
- Crops and animals produced are removed. To maintain self-sustaining artificial ecosystem energy, water and fertility must be supplied.

- Seeds which are supposed to be dispersed naturally are introduced from elsewhere, planted in prepared soil close together.
- Natural predators and control mechanisms are removed in an artificial system and where mono-cultivation is practiced; pest numbers build up alarmingly leading to the introduction of outside control.

Species Diversity

- Refers to the variety of life in an area, including plants, animals, fungi, protists and bacteria.
- Species are important and there are many species in Southern Africa.
- Thus, there is need to conserve enormous biodiversity of organisms.
- Biodiversity provides a number of natural functions that are beneficial to people (ecosystem, biological, recreational, educational functions).

Species Diversity in Ecosystems

Natural ecosystem : Veld area	Artificial ecosystem: grazing area
Has many plant species competing for space.	Limited number of plants growing. Plants may have been removed.
Many pests feeding on different plant species.	Few pests as sprays are used to control pests
A variety of animals.	Limited animals due to limited amount of food.

Problems caused by farming practices and limited species diversity in artificial ecosystem

- Soil erosion.
- Soil infertility.
- Need for the use of artificial fertilisers.
- Plants and animals pests and diseases built up.
- Much human and fuel energy and water is spent in maintaining an artificial productivity level which is intended to produce more biomass than a natural ecosystem would.

Home Work

QN 2. a. What are the advantages and disadvantages of artificial and natural ecosystems? (8).

Question

5. a) What is limited species diversity? (2)

   b) What are the problems caused by limited species diversity? (4)

TOPIC 11
HEALTH AND DISEASES

Health

- Refers to a state of physical, mental, and social well-being.
- Healthy refers to a lot more than just free of diseases.
- Good health depends on a balanced diet and varied diet, doing exercises, being mentally stimulated and getting proper shelter and enough sleep.

Levels of Hygiene

- Hygiene refers to activities that help to prevent diseases and maintain your healthparticularly through cleanliness.
- Hygiene can be personal /individual, domestic or community

Personal hygiene

- This is at an individual level.
- Includes good habits such as having meals regularly, eating a balanced diet, doing regular exercise each day, having enough sleep, washing your body and stress prevention.
- Washing of hands after using the toilet.
- Avoid smoking and consuming alcoholic substances.
- Covering your mouth while sneezing e.t.c

Domestic hygiene

- When the whole household takes part.
- Includes proper handling, storage and preparation of water and food to prevent contamination.

Community hygiene

- Is necessary to prevent epidemics such as typhoid and cholera.
- It might include:
  a) Proper water treatment.
  b) Proper sewage disposal.
  c) Proper ante and post natal care.
  d) Sanitation.
  e) Clean water for drinking.
  f) Immunising children.
  g) Building sufficient and adequate health facilities.

Waste disposal methods

- Modern waste management involves recycle or reuse, regular collection of wastes and sanitary disposal of wastes.
- Wastes needs to be taken to special site (waste dump sites). Wastes are dumped in a large hole and eventually covered by soil when they are full.

- If left open, there are high risk of diseases spreadal.
- Vectors can carry diseases to residential areas.

Providing clean drinking water

- Some sources of water do not provide clean water.
- People should be provided with clean safe drinking water.
- Water need to be treated by boiling, chlorination and other methods.

Waste water treatment

a) Large debris removed.
b) Sedimentation water is allowed to stand to allow large particles settle at the bottom.
c) Filtration through a layer of sand and gravel.
d) Chlorination to kill bacteria.
e) Water becomes clean.

Sanitation

- Means using safe method to collect, store and dispose human wastes.
- Poor sanitation allows spread of infectious diseases
- Discharge of effluents into stream and rivers puts people` health at risk due to pollution and contamination of food when water is used in homes.
- Blair latrines and septic tanks and water borne sewage are best methods of disposing human wastes.

Provision of clinics

- Public health system, mission hospitals and non – governmental organisation provide health care to the community.
- Hospitals and clinics should maintain very high standards of hygiene.
- All surgical instruments must be sterilised.
- Health worker should be clean, wear gloves and wash hands regularly after seeing a patient.
- Vaccines and medicines should be stored properly and used before expiry dates.
- Disposable needles must be used once, syringes and needles must be sterilised between injections.
- Waste must be disposed in a hygienic way.
- In Zimbabwe free services is offered to pregnant women and children below 5 years.
- Pregnant women are encouraged to visit the clinic regularly for identification of problems that may affect the baby`s health.
- Children must be vaccinated against diseases.

Diseases

✓ Can be defined as a disorder or malfunction of the body that leads to loss of good health.
✓ Diseases are classified into infectious and non – infectious diseases.

Infectious

✓ Are caused by pathogens.
✓ Can be passed on from one person to the next and this can be in following ways:
  - Direct contact with infected people for example skin infections and influenza.

- Droplets in the air through coughing without covering the mouth e.g. Tuberculosis and cold.
- Sexual contact e.g. HIV / AIDS and syphilis.
- Eating or drinking contaminated food or water, include cholera, typhoid.
- Through a break in the skin e.g. tetanus and gangrene.

✓ Non – infectious diseases

- Are not caused by pathogens.
- Include diseases caused by environmental factors poisons and pollutant. Poor diet, stress and drugs make a person susceptible to diseases.
- Non – infectious diseases include physical diseases like bone fracture, genetic diseases, mental diseases such as depression, deficiency and degenerative dizz e.g. sight defects, arthritis etc.

Causes of diseases

a. Infections - virus, protozoa and bacteria attack the body and cause diseases such as malaria (protozoa), TB and cholera (bacteria).
b. Genetic defects – see section on chromosome mutations.
c. Chemicals or food poisoning – tobacco smoke causes lung cancer, asbestos can cause asbestosis and pesticides lead to bone cancer.
d. Radiation – exposure to radiation can cause diseases such as skin cancer, birth defects and heart diseases.
e. Malnutrition – is a deficiency disease from not having a balanced diet for example kwashiorkor, rickets etc.

Cholera

- Is caused by bacterium known as vibrio cholerae.
- Is a water borne disease which spreads through food contaminated by human faeces, flies and rodents.

Symptoms of Cholera

i. Severe diarrhoea followed by collapse, shock and death.
ii. Passing loose of liquid stools
iii. Vomiting, abnormal pain and weakness.
iv. Loss of salts.

Prevention

i. Strict control of sanitation and water supplies.
ii. Boiling water before drinking.
iii. People should be vaccinated.
iv. Construction of blair toilets away from water sources.

Treatment

i. To replace the body fluids, Oral rehydration therapy is important (a solution of salt and glucose).
ii. Drugs such as tetracycline and chloramphenicol are used to treat the disease.

Malaria

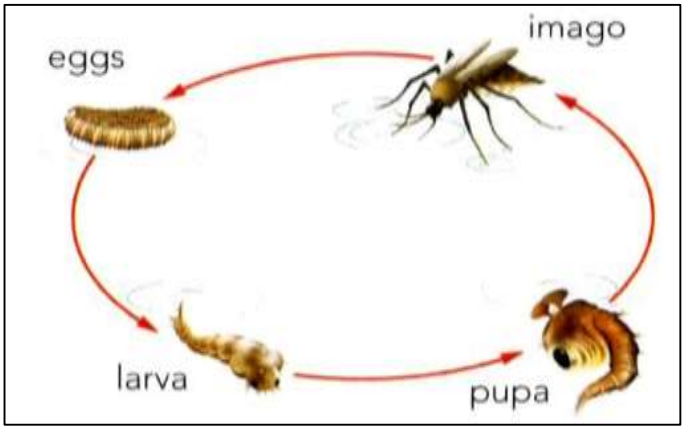
- Is a disease caused by a unicellular protozoan parasite called plasmodium.
- The parasite is transmitted from person to person by bites of infected female Anopheles mosquitoes.
- Mosquitoes have a special mouth parts called proboscis that can pierce the skin and injects the saliva into blood capillary.

Signs and symptoms

i. Chills and fever
ii. Headache
iii. Muscle ache
iv. Shivering
v. Sweating
vi. Enlarged spleen

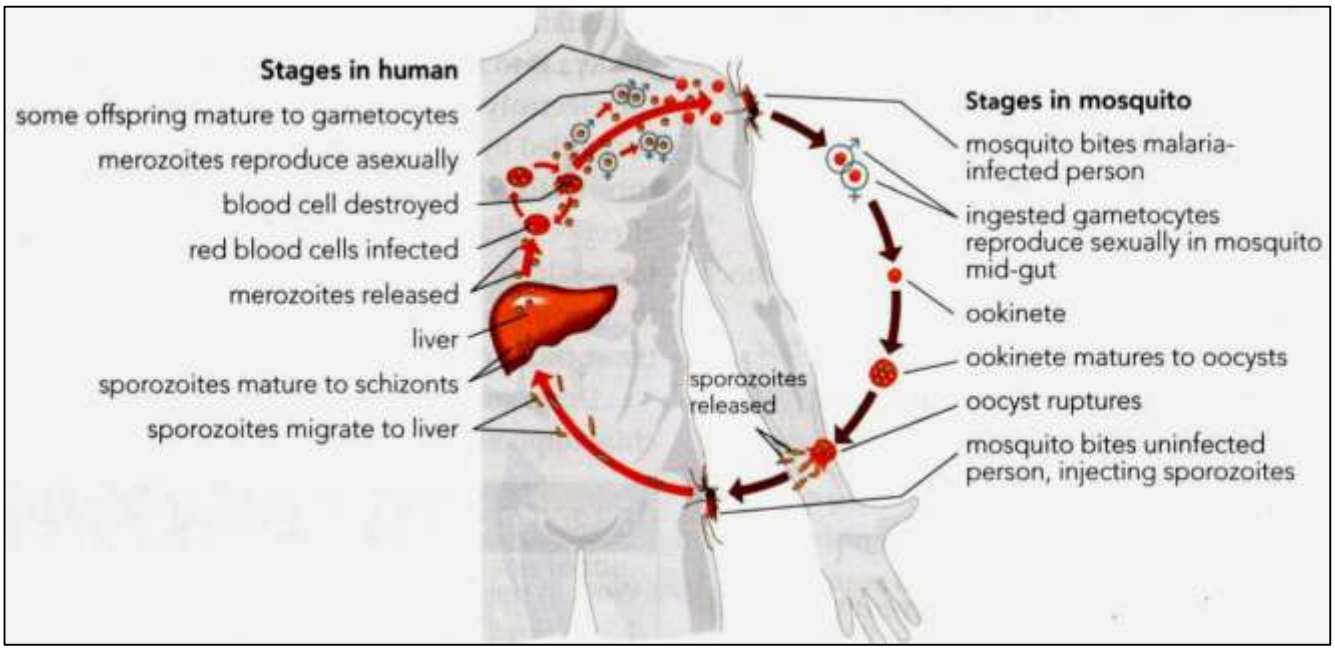
Mosquito Life Cycle

- The female lays eggs in stagnant water.
- The eggs hatch into tiny larvae, on the surface of water to breath air through a tube.
- The larva moults three times and change into pupa which swims in the water.
- The pupa undergoes changes and develops into an adult mosquito.
- Female feeds on blood for the eggs to develop after mating with its male.
- Two or three days after first blood meal, it lays eggs in water then seeks another host.



Life cycle of the Plasmodium

- When a mosquito feeds on an infected human host, they absorb the parasite`s gametes
- The gametes fuse and develop in the mosquito`s gut and then moves to the mosquito salivary glands.
- When the mosquito feeds again, they pass out into the blood together with an anticoagulant in the saliva.
- The parasite enters the person `s red blood cells where they multiply.



Ways of Preventing Malaria

+6Reduce the number of mosquitoes destroying breeding sites, killing using biological methods or chemicals but chemicals can poison other animals.

- Use of mosquito nets and repellents to avoid bites.
- Use prophylaxis drugs to prevent infection.
- Anti – malarial drugs include doxycycline, melfloquine, or atovaquone – proguanil.
- Quinine is used for treatment of malaria.

Typhoid

- Is caused by salmonella bacteria that live in the intestines and blood of humans.
- It is transmitted through contaminated water and food.
- The bacteria enters the mouth and lives for about one to three weeks in the intestines, then moves in the intestinal walls into the blood stream.

Signs and symptoms

- Fever lasting for a long time.
- Headache, sore throat.
- Dry cough.
- Vomiting, diarrhoea.
- Rash on the chest and abdomen.
- Stomach pain.

Treatment

- Use antibiotics.

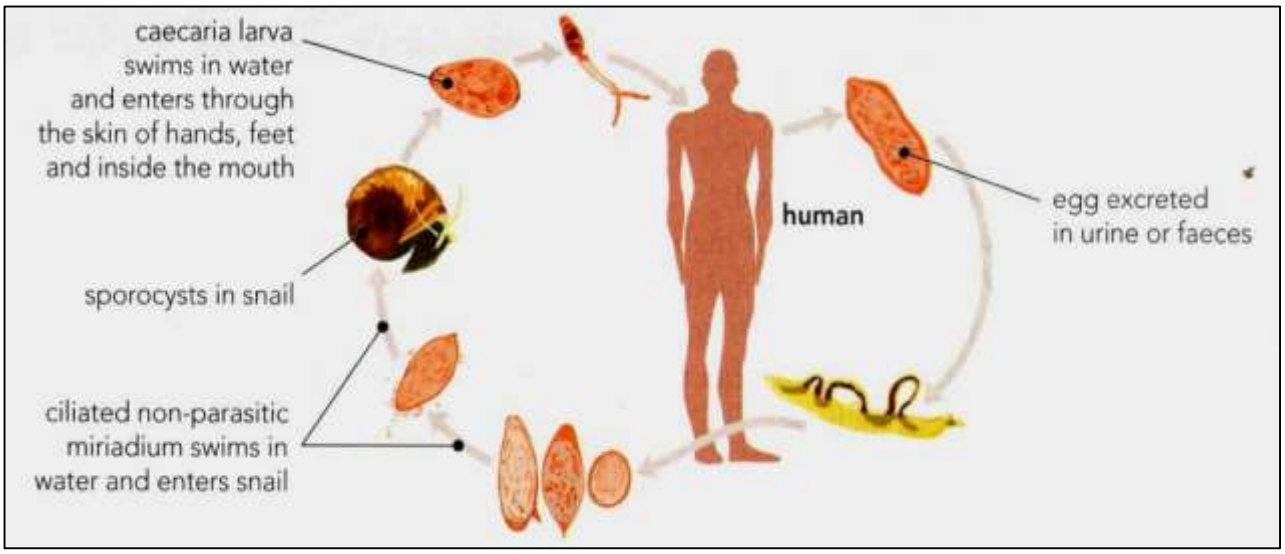
- Take plenty of clean water to drink.

Prevention

- Vaccination.
- Avoiding food that is raw, uncooked.
- Practice hygiene.

Bilharzia

- Schistosomiasis, also known as bilharzia or "snail fever.
- Is a parasitic disease carried by fresh water snails infected with five varieties of the parasite Schistosoma.



Symptoms

- Initial itching and rash at infection site.
- Frequent, painful or bloody urine.
- Abdominal pain and bloody diarrhoea.
- Fever, chills and muscle aches.
- Enlargement of the liver or spleen.
- Liver Cirrhosis.
- Blood disorders in cases of colon damage.
- Children with repeated infection can develop anaemia, malnutrition, poor growth and learning disabilities

Transmission

- The parasitic larvae live in fresh water and can penetrate human skin, placing people at risk through everyday activities such as washing, swimming or fetching water.

- The larvae migrate to the blood vessels where they mate and produce eggs. Some eggs travel to the bladder or intestines and are passed into the urine or stool. Others remain trapped in the body and cause damage to internal organs.

Prevention and Treatment

- Education campaigns about risks of infection by bathing in fresh water lakes and ponds.
- Praziquantel is the primary form of treatment.
- A single dose of praziquantel has been shown to reduce the severity of symptoms in cases of subsequent re-infection.
- Access to safe water.

Group Presentations

On diseases such as Tuberculosis, genetic diseases, cancer, and deficiency diseases.

Tuberculosis (TB)

- Is a bacterial disease common in developing countries and can be fatal if not treated.
- It spreads in overcrowded conditions and with poor sanitation.
- It spreads through airborne droplets when an infected person sneezes or coughs.
- Tb infects the pulmonary system. Causes inflammation and lesions of lung tissue.
- Symptoms can be seen on chest X-rays.
- People suffering from HIV/AIDS are more susceptible to TB.
- Treatment courses given should be properly followed and completed. If not, the bacteria becomes resistant to the drugs.

Signs and symptoms

i. Weight loss.
ii. Dry coughing and coughing up of blood.
iii. Chest pain and fever.
iv. Shortness of breath and tiredness.

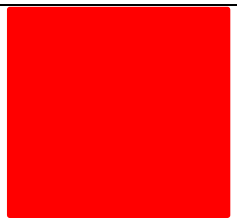
- TB can be treated. Treatment involves a six month course of tablets that the patient must take every day.
- Patients must follow the prescription given and the disease should be diagnosed as early as possible.
- Some types of TB have become resistant to drugs hence special medicines are expensive.

FORM 4 TERM 1
TOPIC 1
Safety, Careers And Branches In Biology

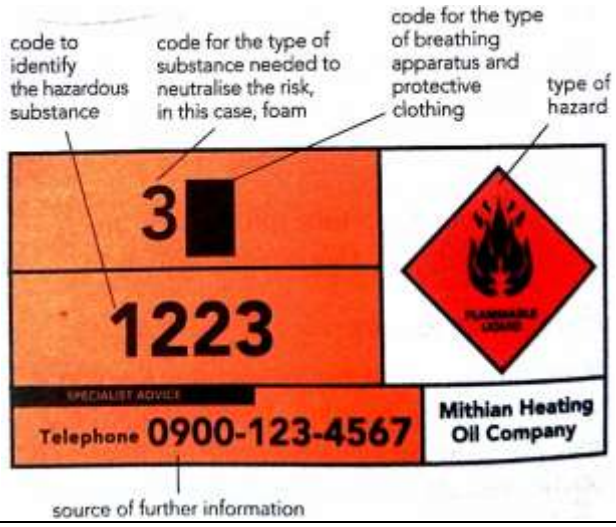
SAFETY LABELS AND SYMBOLS

Various safety lebals and symbols

- ✓ Warn us, keep us safe and help us find help quickly.
- ✓ Can be used on bottles or other containers. It is important to know the meanings of symbols in order for us to be safe from dangers of a substance.

Symbol	Substance / Area	Meaning	Safety measures
	**Chemical Hazard Warning Symbols**	Are used to alert us to potential danger of a substance. A red square or rectangle with a black symbol is used hence easy to see the symbol.	
	Toxic substances	-Substances are poisonous and can cause sickness and death if in contact with skin, enhaled or eaten.	-Wear glooves, goggles and a mask. -Handle the substance in a fume cupboard.
	Harmful substances	-Are less dangerous than toxic but may cause vomitng or irritation e.g. weak acids, dust, gases or fumes, liquids and powders that come into contact with eyes or skin.	-wear protective clothing. -if you spill harmful substances on the skin, wash them immediately with water.
	Corrosive substances	They destroy materials such as wood and living tissues such as skin and eyes	-Concentrated solutions of strong acids should be labelled with corrosive symbol -wear gloves, goggles and face shields.

	Irritant substances	-Are not as dangerous as corrosive but can cause blistering on the skin or an irritation in eyes hence need to be handled with care	-dilute solutions of acids and alkalis should be labelled with this irritant symbol - if you spill on skin, wash immediately with plenty of water.
	Highly flammable substances	-Can easily catch fire e.g. ethanol, propane and other fuels.	-Wear eye protection -Keep aaway from flames,sparks or oxidising substances that could burst into flames
	Oxidising substances	-They do not burn themselves but provide oxygen to causes other substance to burn e.g. ammonia perchlorate, hydrogen peroxide and bromine	-Keep away from flames and sparks when working with oxidising substances
	Radioactive substances	-they give out nuclear radiation which can be harmful e.g. radon and carbon 12	-You will not be allowed to handle radioactive substances at school but know the symbol
	Biohazards	Are used to warn people of danger of exposure to harmful biological substances e.g. viruses or medical waste could be harmful or could contaminate food products	-Never store food in the same refrigerator!
	Physical hazards	-Have a yellow triangle with a black border to indicate a hazard within a certain area	
	Hot surfaces	-If you touch hot surface, it will cause burns to the skin. They are found in science laboratories and industries	-Do not touch hot surfaces -Loose clothing should not touch hot surfaces

	High voltage	-Voltage refers to the potential to drive current. E.g. in power lines -Can kill if one gets into contact -However, is not likely to be found in Biology laboratory, hence know the symbol	-If you see the sign, keep away from the area
	Fire-fighting equipment	-Are shown by a red outlined square or ractangle that has a red symbol or white symbol on a red background e.g fire extinguisher	
	First aid and safe area	Has a green square with a white symbol	
	Hazardous Chemical Codes	Are found on vehicles transporting hazadous chemicals. They pose a risk if there is an accident.	

TOPIC 2

CHEMICALS OF LIFE

The four chemicals

Carbohydrates

Carbohydrates are the body's main source of energy. They come in two kinds:

1. Simple sugar (Monosaccharide)
2. Complex sugar (Disaccharide and Polysaccharide)

Simple sugar (Monosaccharide):

Simple sugars can provide a lot of energy for immediate usage. However, they contain no other useful nutrients. Example : Glucose,ribose and deoxyribose,xylose

Uses of monosaccharides

- Ribose and deoxyribose are building blocks of RNA and DNA respectively.
- Monoccharides are building blocks for more complex carbohydrates.
- Are soluble hence can be transported easily in the body of organisms and also affect the water balance in cells.

Complex sugar (Disaccharide and Polysaccharide):

They are good sources of energy. The body can easily store this form of energy for rapid use in future.

- Animal cells store complex sugars in the form of glycogen.
- Plant cells store complex sugars in the form of Starch.

Example

1. Disaccharide: Maltose, sucrose, lactose, maltose
2. Polysaccharide: Starch, Glycogen, cellulose

Uses of disaccharides

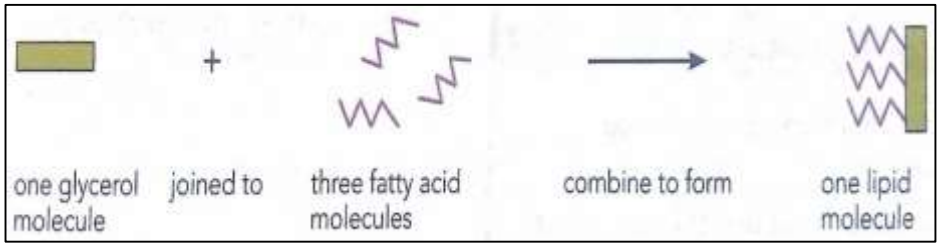
- To supply energy to body cells first by breaking down monoccharides such as sucrose into glucose and fructose.
- Lactose in milk is main source of energy to infants as it is broken into glucose and galactose.
- Maltose is energy source from grains as it is broken into two glucose molecules.
- Are also soluble and can affect the water balance in cells.

Uses of polysaccharides

- Cellulose is found in cells not animals with a structure similar to starch.
- Most cellulose fibres are obtained in wood pulp and cotton.

Lipids

- Are fats and oils. Used mainly to store energy in bodies of living things.
- Are made up of three fatty acids and a glycerol molecule (carbon, hydrogen and oxygen).
- Can be solids or liquids.



Functions

- Phospholipids form part of cell membranes.
- Are insoluble in water hence can be stored in plants seeds such as peanuts.
- Energy reserves
- When lipids (body fats) are broken, they release water for example in camels in dry conditions.
- Protection of parts such as heart and kidneys by a thick layer of fat.
- Insulation-fats under the skin avoid heat loss by the body.
- Waxes are lipids involved in waterproofing plants and animal cuticles.

Proteins

- They make 50% of dry mass of most cells .
- The proteins you eat are broken down into amino acids, and are used by the body to build and repair cells .
- Proteins transport substances such as haemoglobin, iron-containing protein of blood, oxygen from the lungs to other parts.
- Form enzymes and hormones that regulate body functions such as insulin to regulate blood sugar levels.
- Form antibodies that attack invading bacteria.
- Are also needed for blood clotting- that fibrin that holds platelets to clot when one is injuired.

Home work

Qn. 1 State and explain four functions of Nucleic acids in living organisms. [8]

2. Give the differences between DNA and RNA. [4]

TOPIC 3

ENZYMES

Enzymes

Enzymes are proteins that act as catalyst.

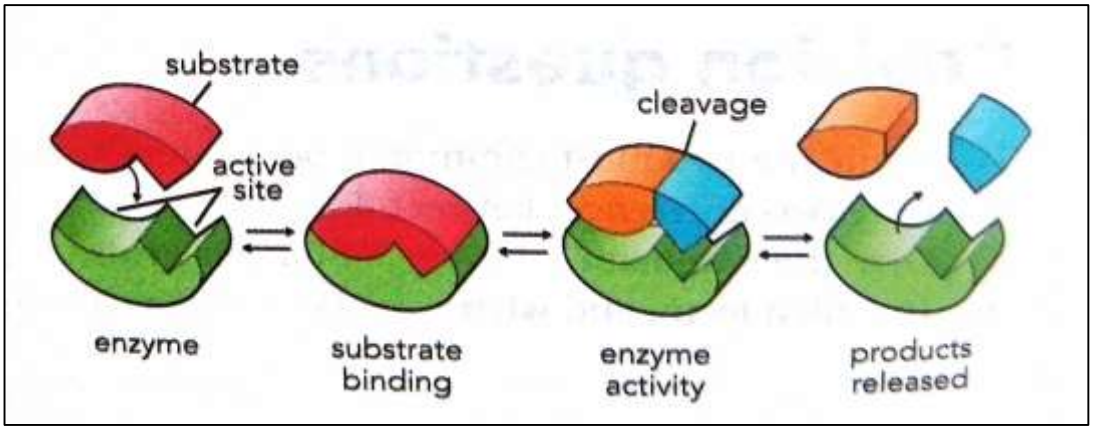
Using Enzymes

Uses in biological washing powders:

- In order to break down organic substances such as carbohydrates, proteins and fats (that chemical detergents fail to break), such biological catalysts are used
- Organic stains such as blood, oil, egg, butter etc. are broken down to simpler substances in the presence of proteinases.
- Enzymes need to have an optimum temperature and hence are extracted from thermophilic bacteria or bacteria living near hot springs to remove the other components of the dirt and so that other parts of the detergent work well as well.
- The enzymes found in these bacteria are majorly proteases and lipases.
- In order to keep these biological catalysts away from skin contact (as proteases can digest skin cells made up of protein!), they are packed in microscopic packets that only dissolve in the presence of water.

Enzyme action in washing powders

- The substrate consist of the substances in stain.
- They bind to specific enzyme in washing powder.
- The stain on clothing are broken down into soluble molecules that dissolve in washing powder and water.

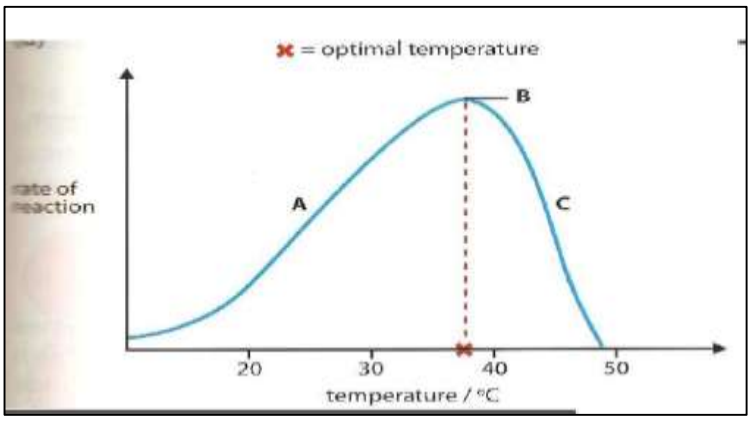


Uses in the food industry

- Fruits contain a substance known as pectin that is present within the primary and secondary cell walls of the fruit cell
- In industrial fruit juice extraction, an enzyme called as pectinase is used to break down the pectin present so that it is more easier to squeeze the juice out
- This relatively increases the volume of juice extracted and thus makes it economical for the company.
- Other than fruit juices, enzymes are also used in baby food production where the food is treated with proteases and carbohydrases to break it down to simpler substances.
- This helps the baby's body to easily absorb the food with indigestion prevented.
- Another use of enzymes is in sugar syrup production where amylase is used to break down starch to the sweet tasting disaccharide- Maltose.

Enzyme and temperature

- They work best within a certain temperature range.
- As temperature increases, reaction increases.
- However, if temperature continues to increase, the shape of the active sites changes
- The substrate can no longer fit into the active site hence we say they are denatured hence no function.
- Optimum temperatures are needed when washing using biological washing powders.
- They may not work in acidic or alkaline tap water.

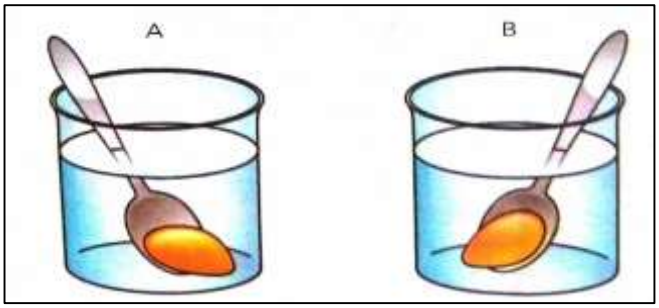


Experiment

Aim: To show the effect of enzymes on protein (egg york)

Materials: a soft boiled egg, cooking oil, two beakers, biological washing powder, ordinary washing powder, water, two teaspoons, measuring cylinder,

Procedure



1. a) Dissolve 5ml of ordinary powder in 100ml of cold water in one of the beaker.

   b) dissolve 5ml of biological washong powder in 100ml of cold water in the other beaker.

2. a) open the egg shell. Scoop out a small amount of york.

   b) place a teaspoon of york into the two beakers I,e. Beaker A and B.

Questions

1. Write a suitable hypothesis for this experiment.
2. Describe the observations in the experiment, and give reasons for what you observed.
3. Write a conclusion for the investigation.
4. What would you expect in your observations if you used warm water of about 30 ℃. Explain why.
5. What types of enzymes were present in the biological powder you used. Explain how you know this.

TOPIC 5
PLANT SCIENCE

Reproduction

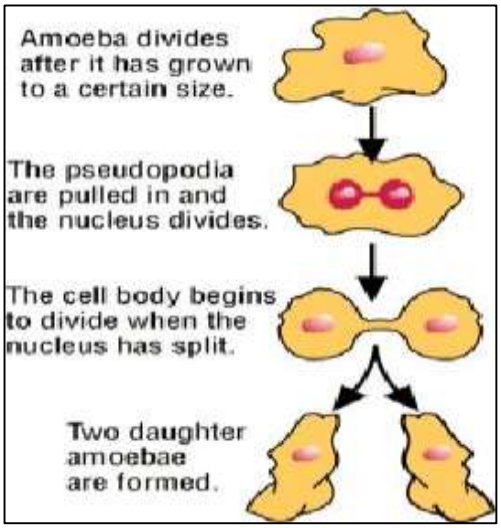
Two types are sexual and asexual

Asexual Reproduction involves:

- ✓ Only one parent to produce new individuals.
- ✓ No formation of gametes (sex cells).
- ✓ No production of seeds,
- ✓ Cell division called mitosis to produce cells that are identical to the parent.
- ✓ No parental care.

Binary fusion

- ✓ Happens in bacteria, amoeba, some algae.
- ✓ One parent cell splits into 2 identical daughter cells.



- ✓ When conditions are good, such as plenty of water, food, right temperatures, etc., binary fusion is a very effective way of producing many, many offspring.
- ✓ For example, the cell of a Paramecium can divide, grow, and divide again in the space of 8 hours.

Budding

- ✓ Happens in yeast, hydra, and corals.
- ✓ An offspring grows out of the body of the parent.
- ✓ When a yeast cell is mature it grows a copy of itself in the form of a bud.
- ✓ In yeasts the cell does not divide equally in two halves; instead, there is a large mother cell and a smaller daughter cell.

Spore Formation

- Happens in fungi, green algae, moulds and non-flowering plants (e.g. ferns) spores are produced and each spore develops into offspring which are identical to parent

Parthenogenesis is a form of asexual reproduction in which females produce eggs that develop without fertilisation. Parthenogenesis is seen to occur naturally in some invertebrates, along with several fish, amphibians, and reptiles as well as in many plants.

Sexual reproduction

- Involves specialized sex cells called gametes;
- The union of a male and female gamete results in the formation of a zygote that develops into a new individual.

Vegetative Reproduction

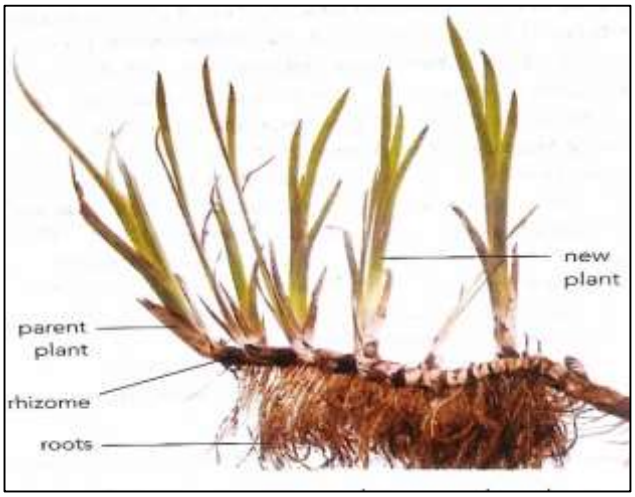
Natural Method

- ✓ Some plants develop specialized structures that can be used as organs of nature vegetative reproduction.
- ✓ Shoots develop from these structures and grow till they develop their own adventurous root system and later become independent parent plant.

Examples are:-

Rhizomes

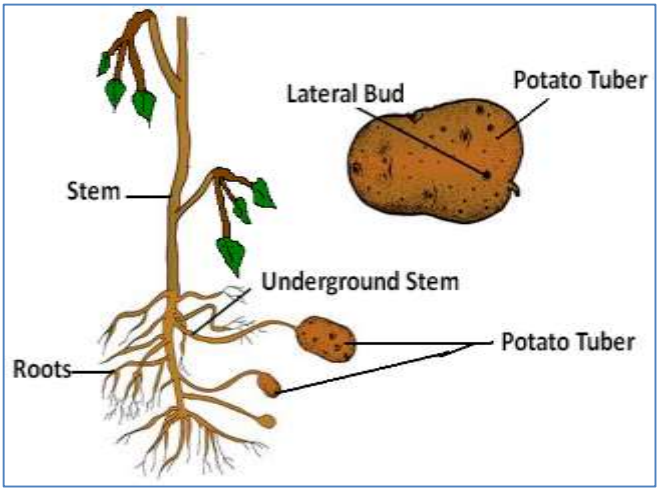
Are horizontal underground stems.they store food for the plant and are organs for vegetative reproduction. e.g. ginger, mangroves, grass etc.



Tubers

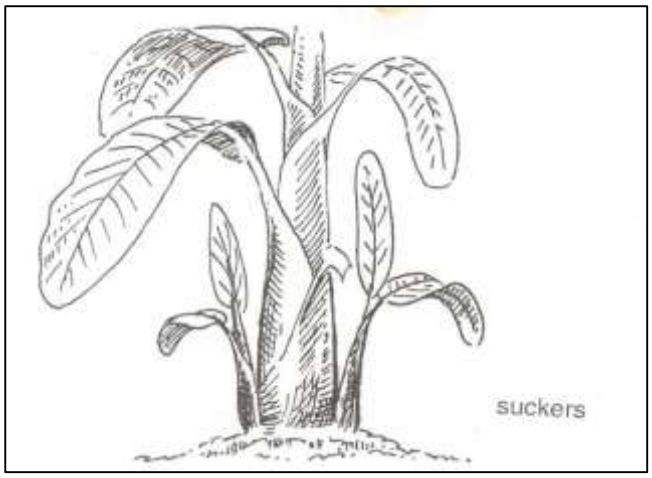
Are thickened underground part of a stem that store food for the plant e.g. sweet potatoes, yarms,

- ✓ Stem tubers – these have thickened rhizomes or stolons which are like underground stems growing below the soil. E.g sweet potatoes and yams.
- ✓ Root tubers – have elongated roots that grow deeper in the soil e.g sweet and cassava.



Suckers

These are outgrowth which grow from the stem below ground level. The terminal bud of a sucker grows upwards through the soil and form leaves above the surface. Roots form in the underground potion of the sucker and an independent plant is formed which losses its connection with the parent. E.g. bananas and covo, rasberries



Runners / stolons

These are long, thin stems that grow from the parent plant on the surface of the soil. These horizontal stems grow roots and shoots at every second node of the runner to form the new plant e.g. strewberry plant.

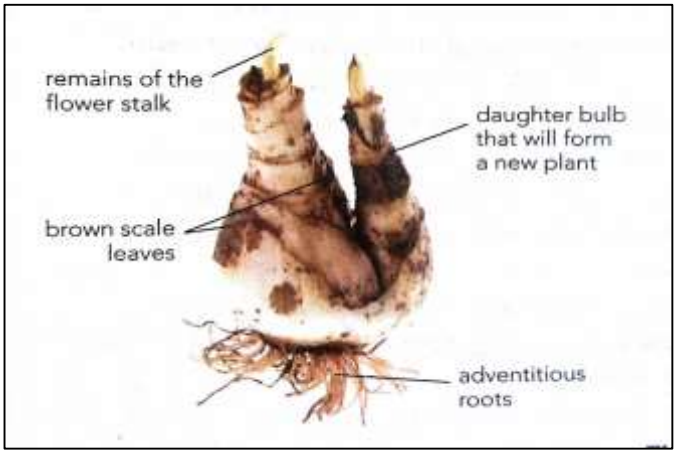
Leaves

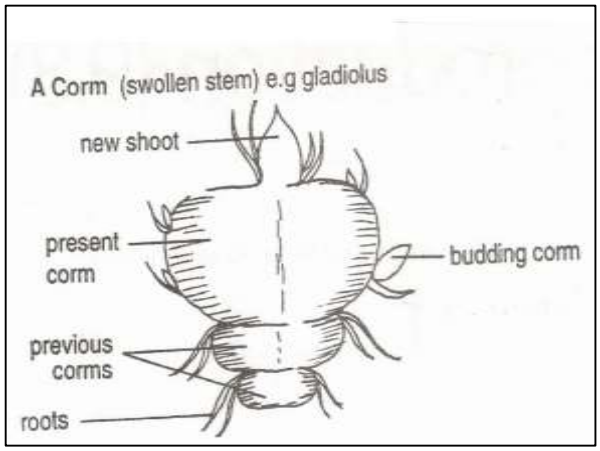
Some leaves grow new plants. Kalanchoe and Bryophyllum spp are succulent plants that can produce new plants in notches along the leaf margins.

Bulbs and corms

A bulb is an underground stem with scales and freshy leaves surrounding a central bulb e.g. onions and daffodils.

Corms are solid, similar to bulbs but they do not have scales and freshy leaves e.g. gladioli and freesias.





Artificial Methods

Cuttings

Are small parts of plants. These are cut off and used for producing other plants. e.g. sweet potatoes, sugarcane and mulberry.

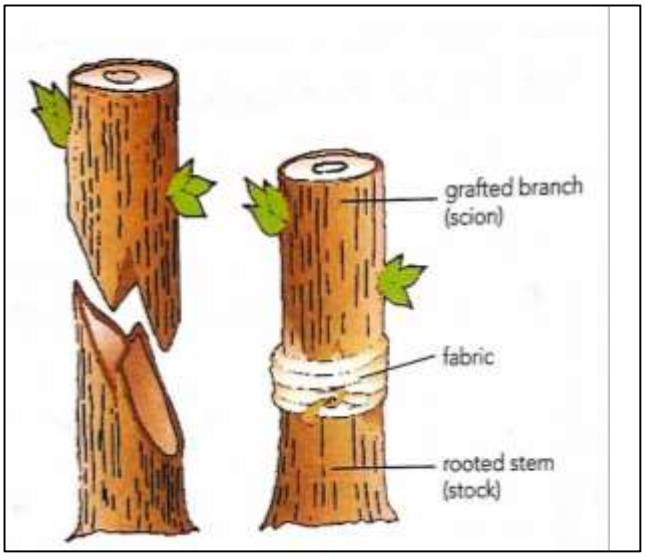
Are cheaper and faster method of reproduction.

Buds

Can be induced to produce new plants from cuttings by layering and bud grafting e.g. sugar cane, cassava etc.

Grafting

- ✓ Involves joining a part of a plant onto another. The plant that is selected for its roots is called rootstock and that selected for its flowers or fruits is called scion.
- ✓ The two parts are joined in such a way that the new section will receive food and water, and grow.
- ✓ With fruit trees it can take up to three year for the joint to be strong enough to carry the fruits.
- ✓ The advantage is that roots that are resistant to diseases are sellected.



Advantages of vegetative reproduction

- Plants are identical to the parent plant.
- Grow quickly as soon as conditions are favourable.
- Good chances of survival due to availability of stored food.
- Maturing more quickly than seed planted at the same time.
- Don't rely upon pollination, fertilisation and seed dispersal.

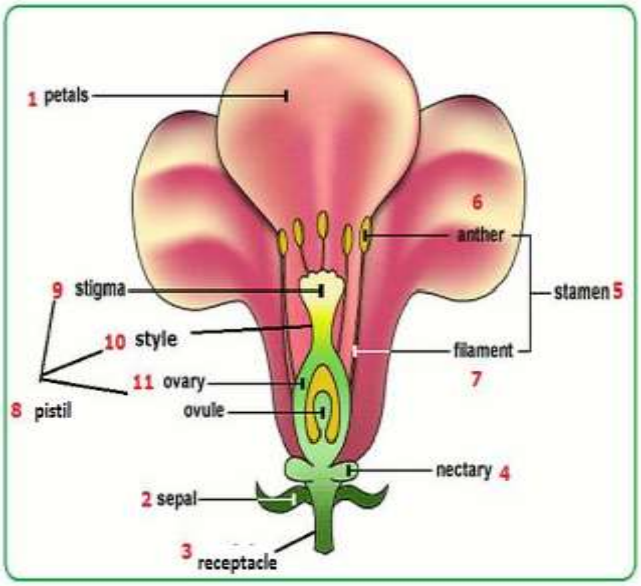
Disadvantages

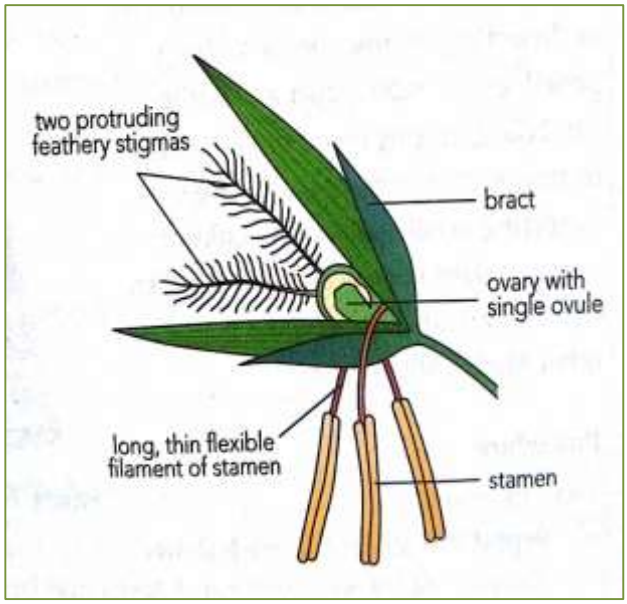
- No variety (not showing any genetic variation for parent plant).
- Vulnerable to the same pests and diseases as parent plant.
- Cannot reproduce in large numbers as in seeds.
- Cannot be dispersed away from the parent plant thereby causing overcrowding and competion for resources.

Sexual Reproduction in Plants

- The flower is the organ for sexual reproduction in plants.

Insect pollinated and wind pollinated flowers





Functions of Parts of a Flower

Stigma	The tip of the pistil that receives pollen.
Receptacle	The tip of the flower stalk that holds the flower.
Style	A hollow stalk connecting the stigma to the ovary, down which pollen must move to fertilise the ova in the ovary.
Ovary	Produces ovules and develops into fruit.
Ovule	Contains female sex cells and develops into seeds after fertilisation.
Petals	Attract insects for pollination and protect reproductive organs.
Sepals	Usually green and leaf-like which protect the petals while the flower is closed.
Anther	Male sex cells (produces pollen grains).
Filament	A stalk that supports the anther.

Features of Wind and Insect Pollinated Flower

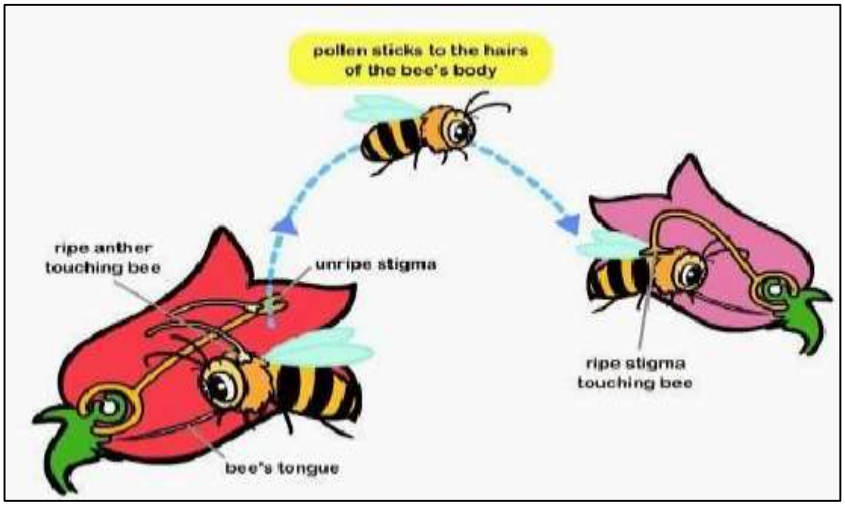
Wind pollinated flower	**Insect pollinated flower**
Not attractive to polinators	Attractive to pollinators
has no bright, colourful petals	large brightly coloured petals
do not produce nectaries	produce strong scent / nectar
have long stamens which hang out of the flower	have short stamens
produce plenty of light, smooth pollen	they do not produce much pollen
have small, smooth , light and dry pollen	have big, rough, sticky pollen
have hairy stigma hanging out of the flower to trap pollen easily	have short style with a sticky stigma

Pollination

It is the physical transfer of pollen grains from the anthers to the stigma. It involves self-pollination and cross-pollination.

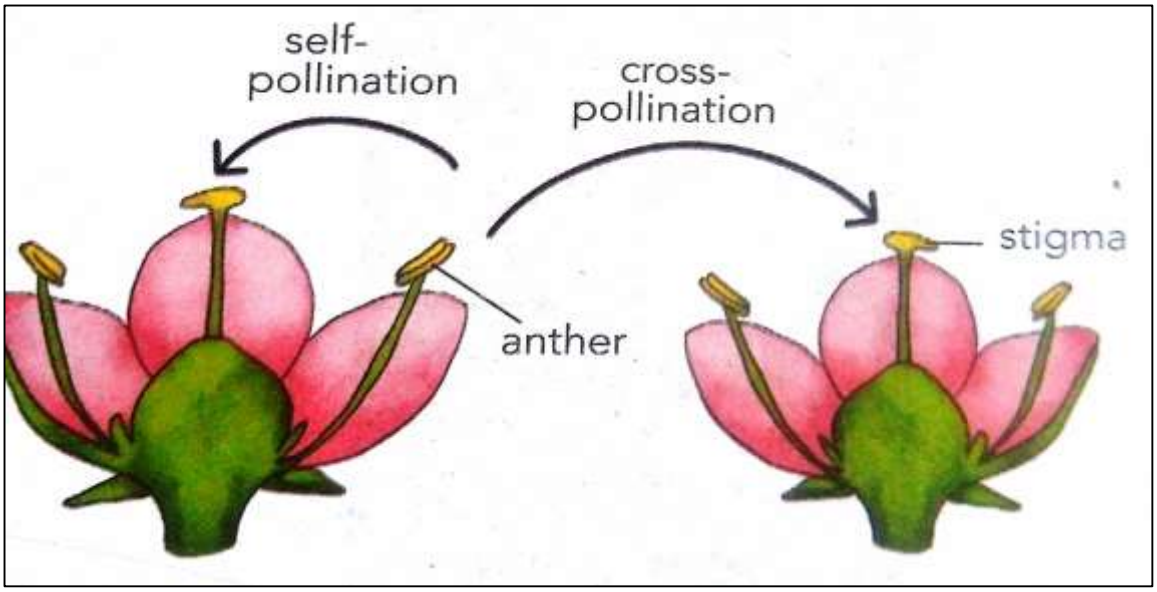
Agents of Pollination

- ✓ Wind.
- ✓ Insects.
- ✓ Animals such as birds.



Self-pollination occurs when pollen grains are transferred from the anther to the stigma of a flower on the same plant.

Cross-pollination is transfer of pollen grains from the anthers of a flower of one plant to the stigma of a flower on a different plant but of the same species.



Advantages of self- and cross pollination

Self -pollination-Plants can reproduce even if the is no pollinator.

Cross -pollination-More variation within a species hence high chances of survival in environmental changes.

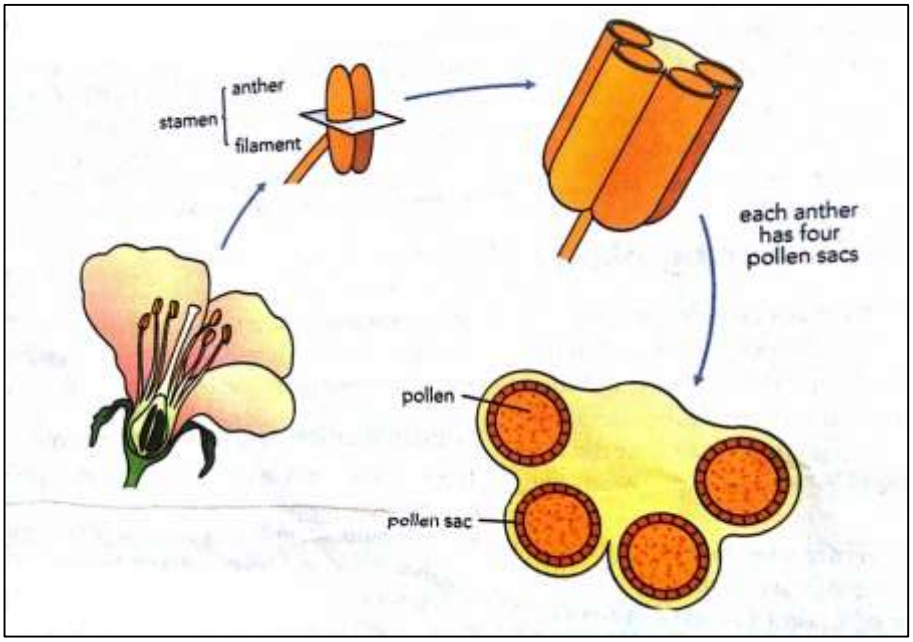
Disadvatages of self-and cross pollination

Self- pollination- results in decreased genetic diversity.

Cross -pollination-require a pollinator.

Stamens and pollen

- A stamen is made up of a thin thread-like filament with an anther on top of it. If the anther is cut in cross-section.
- You can see that it contains four pollen sacs.
- Pollen sac undergo meiosis to form four haploid microspores and each microspore develop into a pollen grain.
- Pollen grain contains the male gametes.

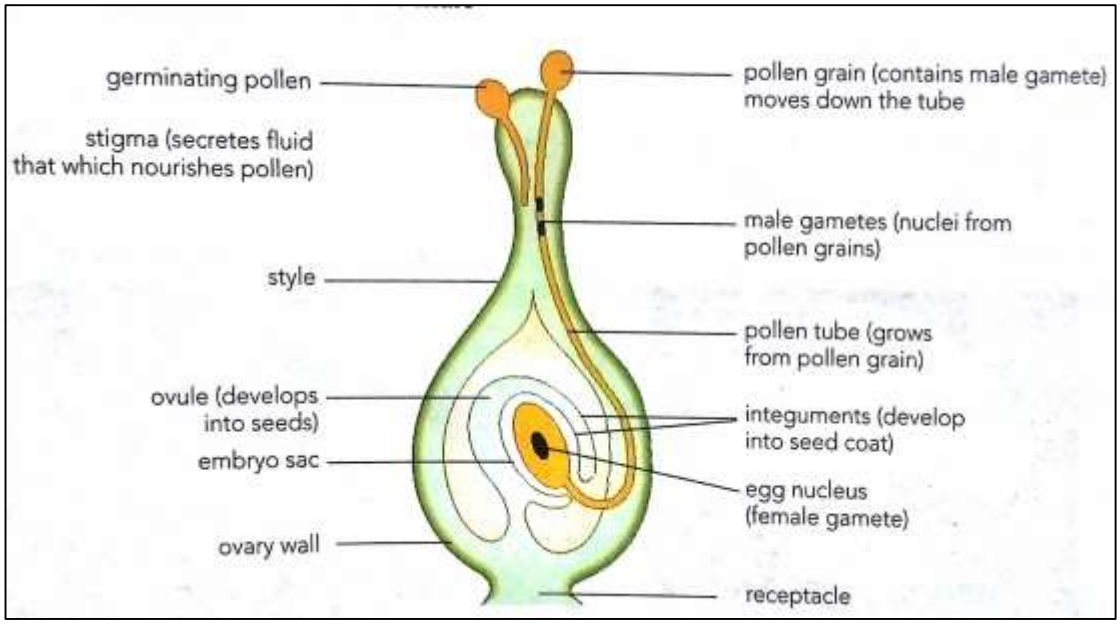


Fertilisation

Is the fusion or joining of male and female sex cells to form a zygote.

Occurrence

- Fertilisation occurs after pollination.
- When a pollen lands on the stigma of the same species, the stigma secrete a sugary substance, which is source of food for the pollen grain.
- A pollen tube(s) grow(s).
- The pollen tube grows down through the style facilitated by digestive enzymes towards the embryo sac.
- On reaching the ovary, the pollen tube grows towards one of the ovules and enters through a hole (micropyle).
- The male nucleus fuses with the female nucleus to form a zygote.



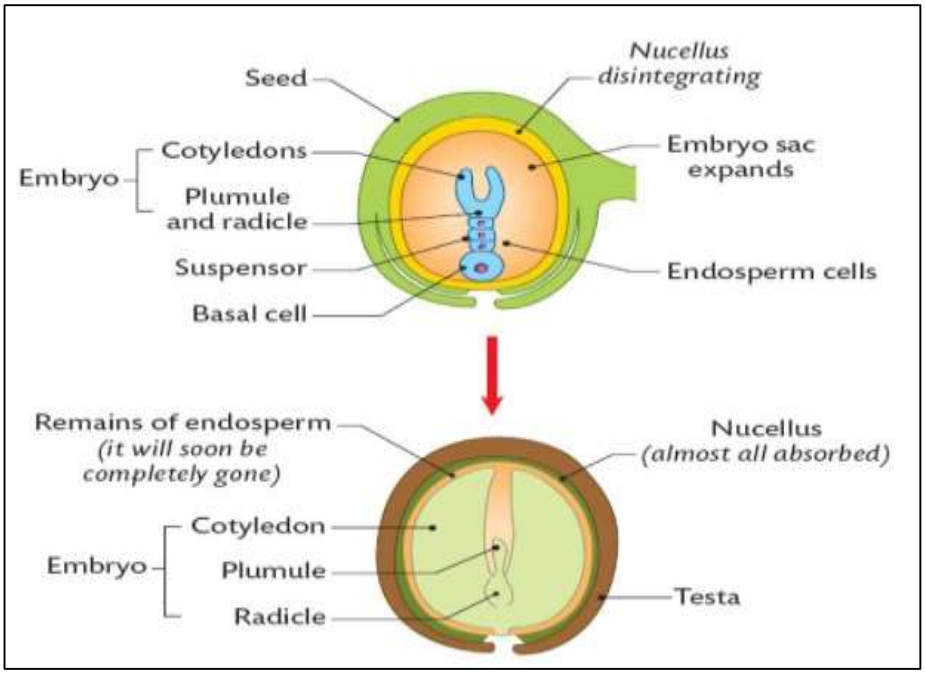
After Fertilisation

Seed Formation

- The fertilized ovule becomes the seed.
- The **integuments** become the wall of the seed called the **testa**.
- The **micropyle** becomes the seed micropyle/closes.
- The endosperm nucleus leads to the formation of **triploid endosperm**, a food tissue.
- The diploid zygote, by mitosis, develops into a **plant embryo**.
- The developing embryo draws **nourishment** from the endosperm.
- The embryo ceases development becomes dormant.
- The ovule becomes a **seed**, which contains a dormant plant embryo, food reserve, and the protective coat called the testa.

The Embryo

- The embryo is made up of the **radicle** or future root and the **plumule** or future shoot.
- The **endosperm cells** divide many times and absorb the nucellus. This is the nutrition (mainly fats, oils and starch) for the embryo.
- There are 2 types of seeds. Some are **endospermic** while others are **non-endospermic.**
- In endospermic seeds the food reserve is the endosperm, which is outside the plant embryo. Examples of this type of seed are maize and wheat (monocotyledons).
- Non-endospermic / **cotyledonous** seeds have food reserve within the cotyledon(s) of the plant embryo. This occurs in dicotyledons e.g. broad beans.



Fruit Formation

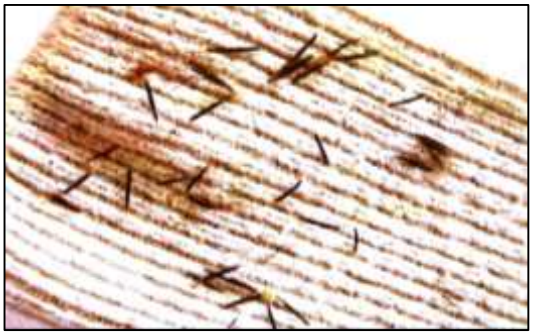
- The fruit forms by the expansion of the ovary as the seed develops from the ovule.
- The ovary wall becomes the pericarp or fruit wall.
- Fruits differ in size, shape and number of they seeds they bear.
- Fruits can have one or more seeds and may be edible or not.

Fruit and seed dispersal

Refers to the spreading of seeds.

Ways of fruit and seed dispersal

1. Animals – fruit may be fresh and juice and can be eaten by animals and seeds passed out in animal faeces e. g guavas . Some stuck to clothes or cling on animals due to hooked seeds e.g black jack etc.



2. Wind dispersal- the fruit may develop wings or parachute of hairs so that it can be carried by wind e.g. dandelion and seed cotton, combretum has wings , poppy e.t.c.


3. Explosive / self dispersal - some fruits fall, roll and or may break open e.g peaches and fruits granadillas. Some may become dry , twist and explode therefore casting their seeds some distances from the parent plant e.g. acasia, musasa pods, beans and soya beans.

4. Water- seeds have fibrous coat around that trap air making it able to float e.g coconuts. The water lily forms a fruit that floats in the water for a while and then drops down to the bottom of the lake where it germinates.

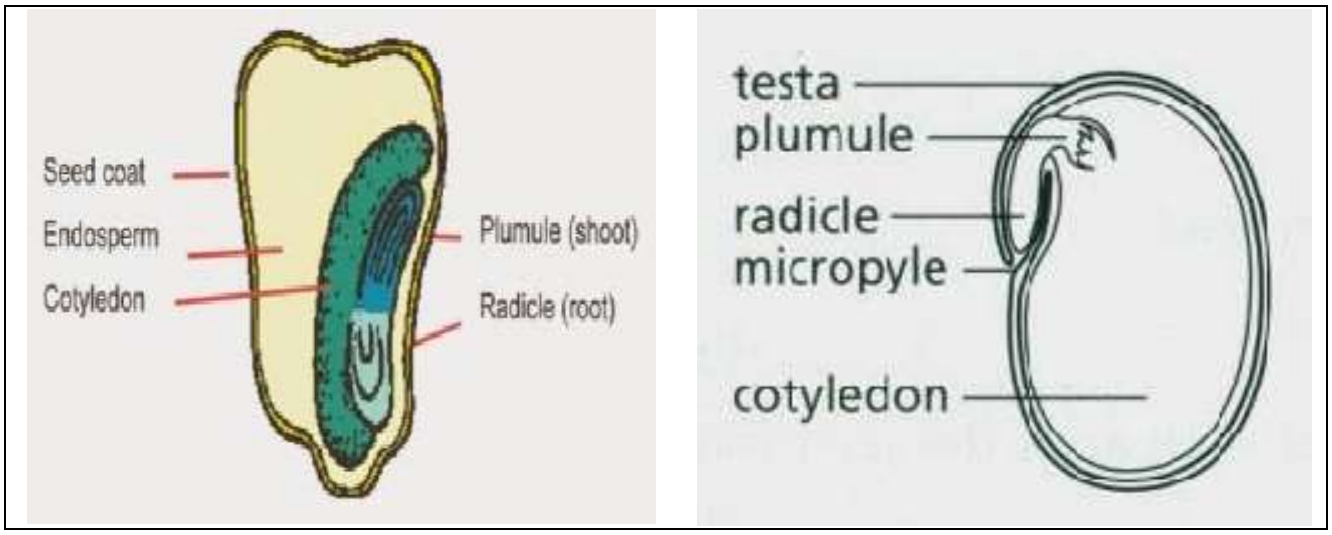

Importance of seed dispersal

- It ensures that seeds are spread as far away from the parent .
- This reduces competition for light, water and nutrients.
- Overcrowding is reduced.
- Survival is increased.
- Spreading of diseases is reduced from the parent to the seedlings.

Monocotyledonous and dicotyledonous seeds

Monocotyledonous means one seed leaf and dicotyledonous means two seed leasves. Other difference include leaf venation, root system and number of flower parts.

Structure of Seeds: Maize and Bean Seed



Function of Seed Parts

Part	Function
Testa	Seed coat (protects seed from fungi, bacteria and insects.
Micropyle	Small poening in seed coat that allows water and oxygen into the seed.
Radicle	Embryonic roots. Develops first when the seed coat has ruptured and grows downwards into the soil to form primary root of the plant.
plumule	Embryonic shoot with one or more leaves. It form the shoot of the plant that photosythesise once the shoot is out of the soil.
Hilium	Scar showing place where seed was attached to the ovary wall.
Cotyledon	Source of food for germination.
Endosperm	Provides food for the developing embryo.

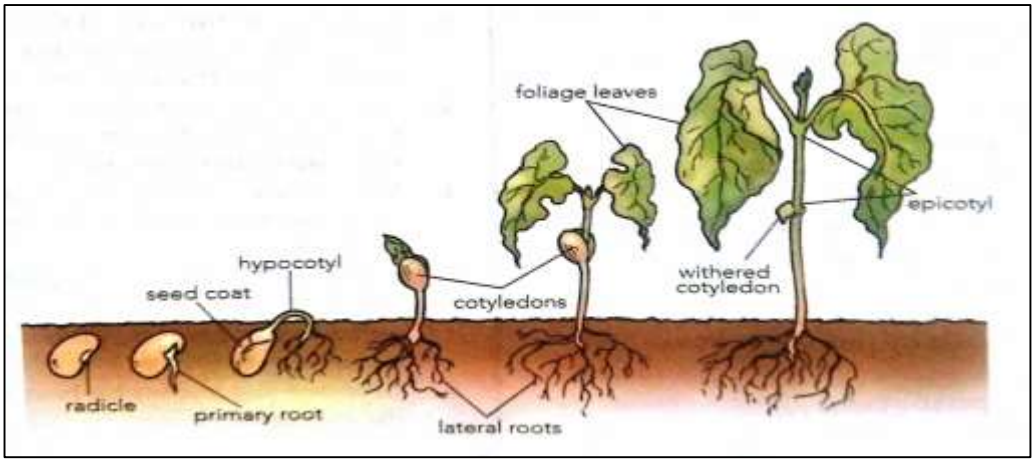
Germination

Germination : Step Ahead Biology Bk 4 page 49-53.

It is the beginning of growth in a plant or a process by which a seed becomes a seedling/ new plant.

Process

- Dry and hard seeds absords waer.
- The seed coat and testa splits.
- Radicle grows downwards into the soil.
- The shoot straghtens and pushs above the soil.
- First leaves emerg and start to photosynthesise.
- New roots and leaves are formed hence an established plant.

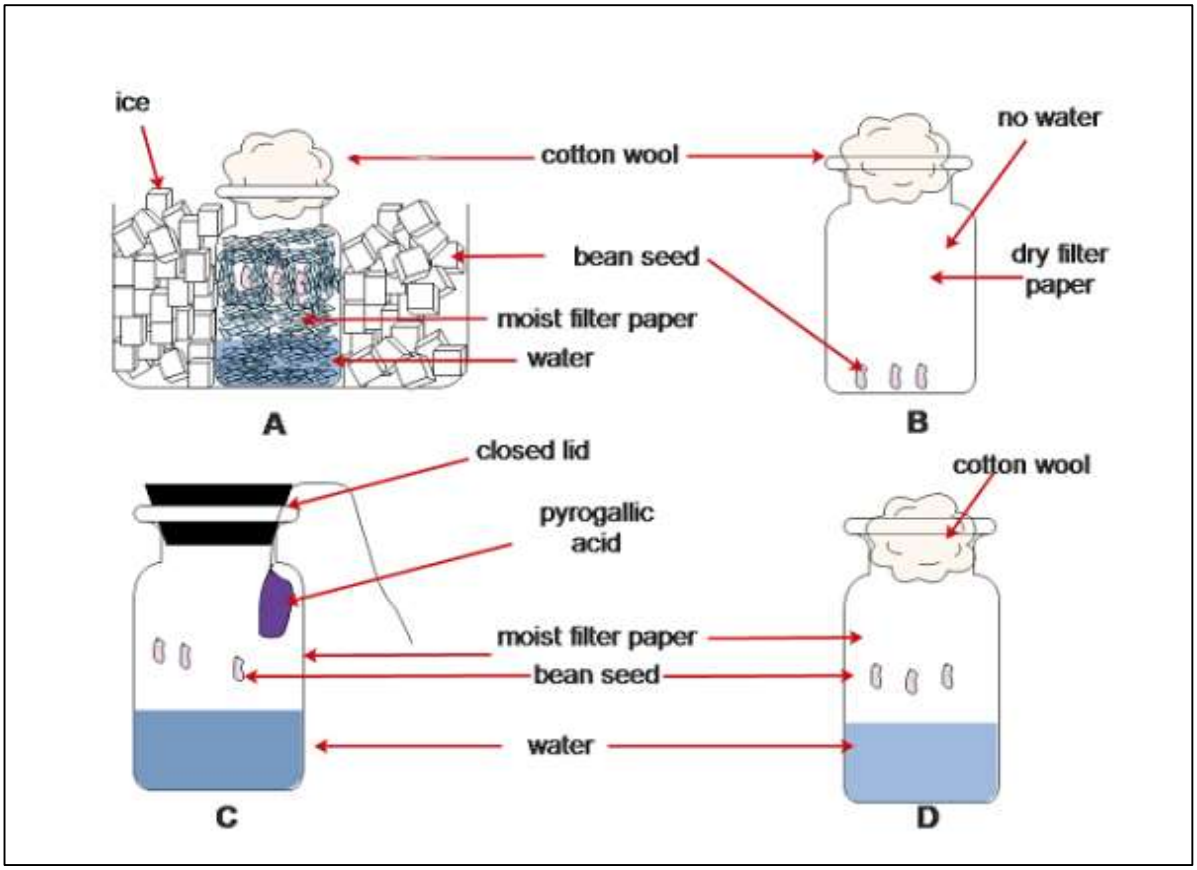


Experiment 1

Investigating conditions necessary for Germination

Materials: maize seeds, containers, cotton wool, filter paper, pyrogallic acid.

Method



- Take four batches with ten seeds in each.
- Put them into containers as shown above.
- Container A has water, oxygen, low temperature.
- Container B has oxygen, suitable temperature but no water.
- Container C has water, suitable temperature but no oxygen(pyrogallic acid absorbs oxygen).
- Container D is the control.

Results

- ✓ Very few seeds in container A germinated.
- ✓ The dry seeds in container B did not germinate.
- ✓ Seeds in container C did not germinate at all.
- ✓ Most of seeds in D germinated.

Conclusion

- Temperature, moisture and oxygen at optimum are necessary for germination.
- Light is not necessary for germination.

Question1: Explain the main functions of temperature, moisture and oxygen during germination. (6)

Answer:

Condition	Purpose for seed germination
Suitable temperature	Increases enzymes activity which speeds up biological reactions and development of the seed.
Moisture (water)	To cause the testa to split and to activate enzymes.
Oxygen	Needed for respiration. Oxygen is used to burn the endosperm and /cotyledon (food sources) so that energy is released for the plumule to shoot out of the soil and the radicle to develop into the root system.

Percentage Germination

Percentage germination=$\frac{\text{Number of seeds that germinated}}{\text{Number of seeds that were planted}}$ x100%

Role of Enzymes in Seeds Germination

- Seeds grow into plants by germinating. Seed germination involves enzymes breaking the materials stored in the seed down to be used in growth, energy and building cells. The seed contains stored substances such as:

*Starch: Starch is broken down by amylase enzyme into maltose, maltose is then broken down by maltase enzyme into glucose which is used in respiration.

*Proteins: Proteins are broken down into amino acids by Protease enzyme, amino acids are used in building up cells and growth.

*Fats: Fats are broken down into fatty acids by lipase enzyme, they are used in making cell membranes.

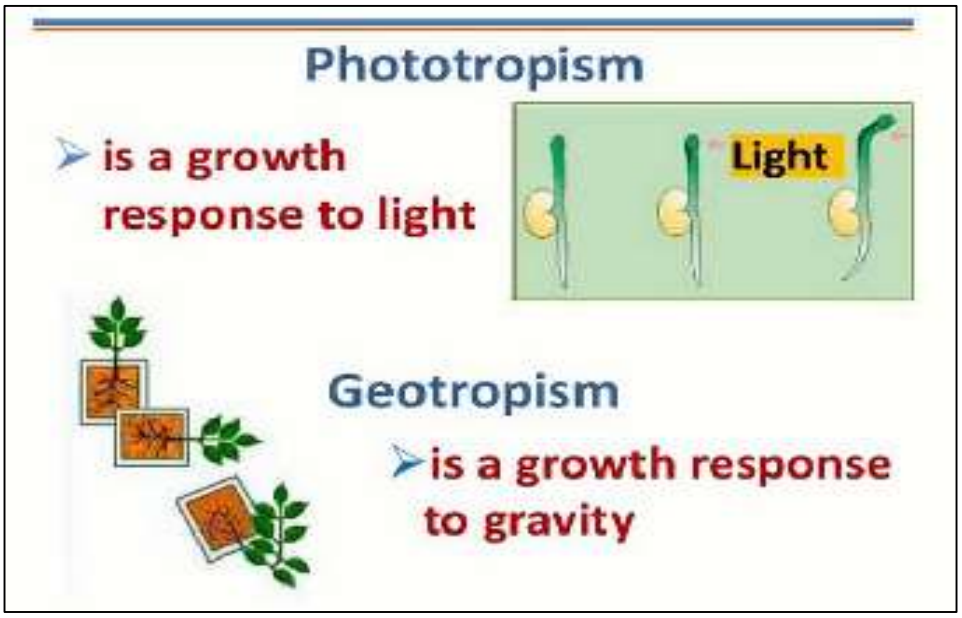
Coordination and Response in Plants

Tropisms

- Tropisms are growth movements related to directional stimuli, e.g. a shoot will grow towards a source of light but away from the direction of gravity.
- Important stimuli for plants are light, gravity, water and chemicals.

Stimulus	**Name of Tropism**	**Positive response of plant part**	**Negative response of plant part**
Light	Phototropism	Moves towards light	Moves away from light
Gravity	Geotropism	Moves vertically downwards	Moves vertically upwards
Water	Hydrotropism	Moves towards water	Moves away from water
Chemicals	Chemotropism	Moves towards chemicals	Moves away from a chemical

Gravitropism / Geotropism is a response in which a plant grows towards or away from gravity (earth). Phototropism is a response in which a plant grows towards or away from the direction from which light is coming.



Experiments on tropisms

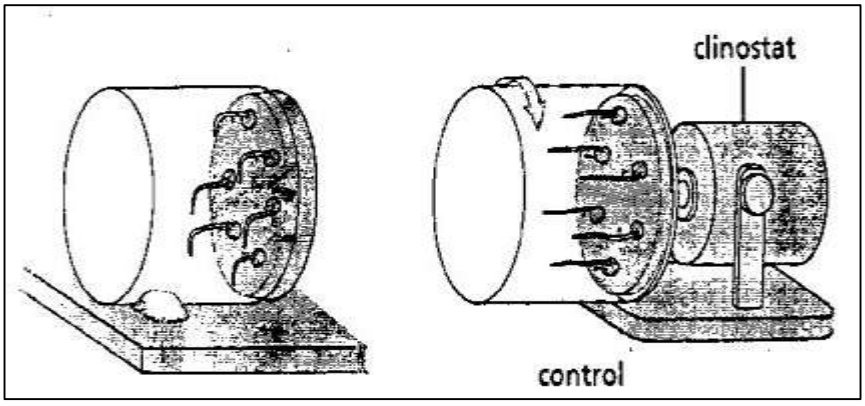
Gravitropism / Geotropism in pea radicles

Method

- Soak about 20 peas in water for a day and then let them germinate in a vertical roll of moist blotting-paper.
- After 3 days, choose 12 seedlings with straight radicles and pin six of these to the turntable of a clinostat so that the radicles are horizontal.
- Pin another six seedlings to a cork that will fit in a wide mouthed jar. Leave the jar on its side.
- A clinostat is a clockwork or electric turntable, which rotates the seedlings slowly about four times an hour. Although gravity is pulling sideways on their roots, it will pull equally on all sides as they rotate.
- Place the jar and the clinostat in the same conditions of lighting or leave them in darkness for 2 days.

Result

- The radicles in the clinostat will continue to grow horizontally but those in the jar will have changed their direction of growth, to grow vertically downwards.



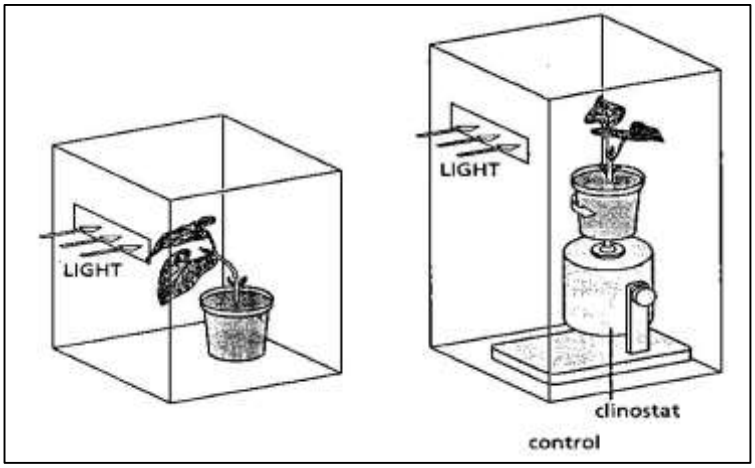
Interpretation

- The stationary radicles have responded to the stimulus of one sided gravity by growing towards it. The radicles are positively gravitropic.
- The radicles in the clinostat are the controls. Rotation of the clinostat has allowed gravity to act on all sides equally and there is no one-sided stimulus, even though the radicles were horizontal.

Phototropism in shoots

Method

- Select two potted seedlings, e.g. sunflower or runner bean, of similar size and water them both.
- Place one of them under a cardboard box with a window cut in one side so that light reaches the shoot from one direction only.
- Place the other plant in an identical situation but on a clinostat. This will rotate the plant about four times per hour and expose each side of the shoot equally to the source of light. This is the control.



Results

- After 1 or 2 days, the two plants are removed from the boxes and compared.

- The stem of the plant with one-sided illumination has changed its direction of growth and is growing towards the light.
- The control shoot has continued to grow vertically.

Interpretation

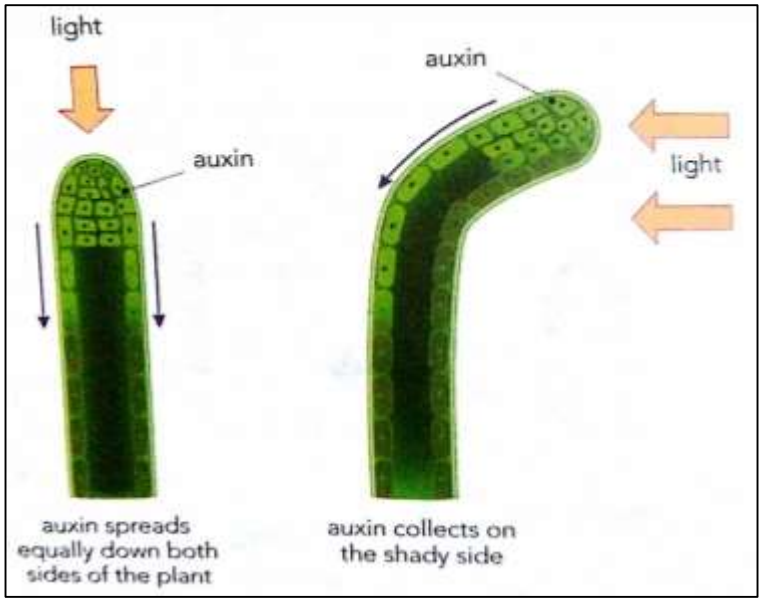
- The results suggest that the young shoot has responded to one sided lighting by growing towards the light. The shoot is said to be positively phototropic because it grows towards the direction of the stimulus.
- However, the results of an experiment with a single plant cannot be used to draw conclusions that apply to green plants as a whole.

Plant Hormones

- Hormones are chemical messengers found in plants and animal to control the internal environment of the body so that it respond to the extrnal environment.
- Control plant growth, plant structures such as flowers and fruits.
- Are made in cells and transported through the xylem to areas of the plant where they have an effect.
- Their productionis controlled by genetic information.

Auxins:

- Auxin is a plant hormone. It is produced by cells at the tip of roots and shoots of plants.
- At the tip of a shoot, there is an area in which cells are being produced by dividing so that the shoot grows. Old cells do not divide, but they grow longer instead.
- The growth of these cells longer is controlled by auxins.
- Control direction of plant growth.
- Promote fruit development since they delay abscission.
- Auxins is what makes the plant grows this is why a plant doesn't grow if you cut its tip off.



Auxin in phototropism

*1. If a **shoot** is exposed to light from one side*

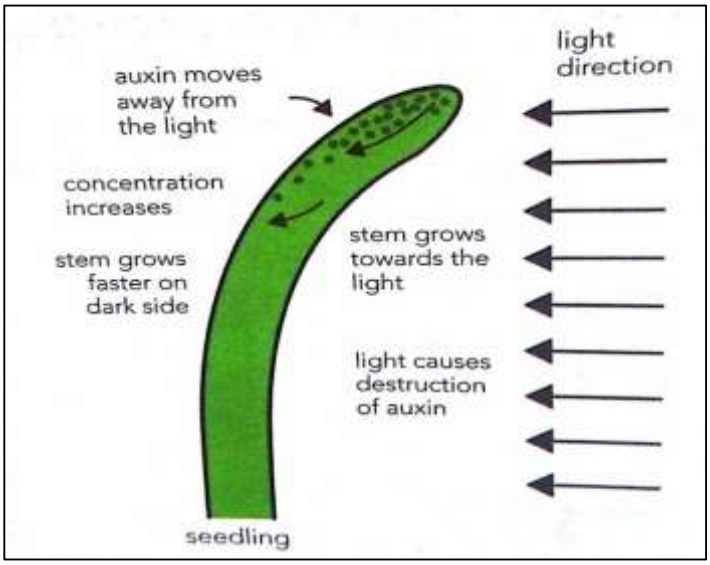
- More auxins are moving in the **shaded** side (from the tip of the shoot)
- On this side, cells are stimulated to absorb **more** water, plant grows more.
- Shoot bends **toward** the light.

This is called **positive phototropism.**

*2. If a **root** is exposed to light in the absence of gravity*

- More auxins are moving in the **shaded** side (from the tip of the root) →
- On this side, cells are stimulated to absorb **less** water, plant grows less.
- Root bends **away** from the light.

This is called **negative phototropism:**



Auxin in geotropism

1. If a shoot is placed horizontally in the absence of light:

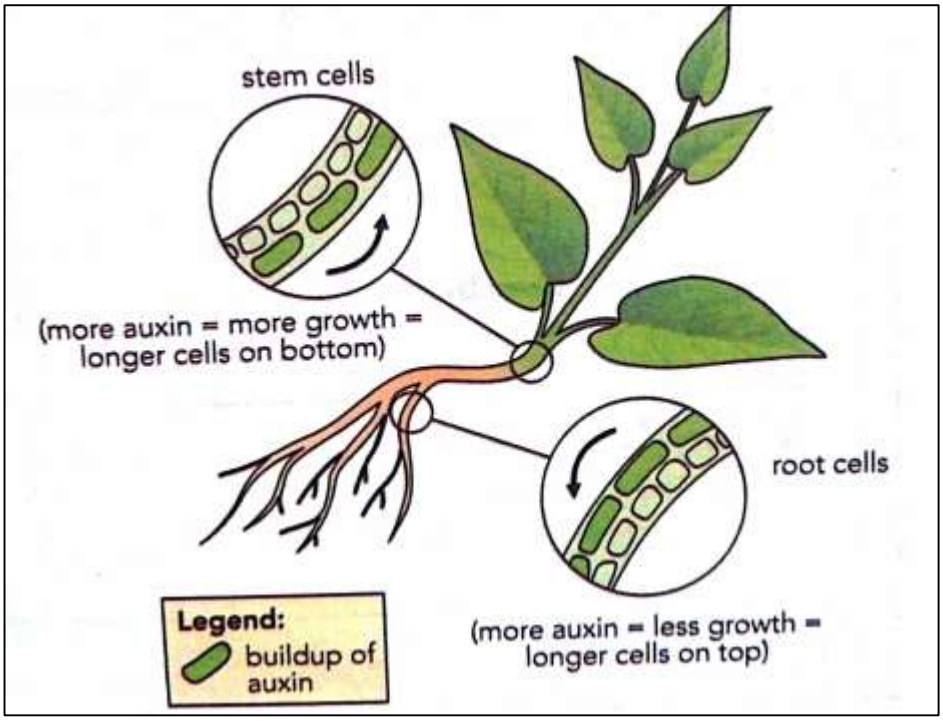
- Auxins accumulate on the lower side of the shoot, due to gravity.
- Cells on the lower side grow more **quickly**
- The shoot bends **upwards**.

This is called **negative geotropism.**

2. If a root is placed horizontally in the absence of light:

- Auxins accumulate on the lower side of the shoot, due to gravity.
- Cells on the lower side grow more **slowly.**
- The shoot bends **downwards**.

This is called **positive geotropism.**



Weed Killers

- Auxins can be used to kill weeds that grow over grass or cereal crops.
- If weed grows on crops, auxins are sprayed everywhere.
- Weeds absorb auxins faster than crops or grass. Auxins accumulate in the weeds making them grow very rapidly.
- Fast growth of weed kills it leaving the crops or grass alive.
- Auxins are used as selective weed killers.

Commercial uses of plant hormones

How plant hormones may be used in commercial contexts

Auxins

- ✓ are responsible for some cell elongation, and are involved in responsive processes, such as positive and negative phototropism.
- ✓ Under a commercial context, artificial auxins can be used to prevent leaf and fruit abscission ('drop') and to promote flowering in plants which flower.
- ✓ Other uses may also include:
  a) Taking cuttings – dipping the end of a cutting in rooting powder before planting it encourages root growth, and this rooting powder contains auxins, among other ingredients.
  b) Growing seedless fruit – treating un pollinated flowers with auxins can promote seedlessness in fruit growth.
  c) Herbicides – artificial auxins can be used for herbicides to help kill unwanted weeds, as it enters the phloem and flows around the entire plant and elongates the shoots so much that the stem cannot support the plant any further that it buckles over and dies

Cytokinins

- ✓ Cytokinins prevent senescence of leaves and fruit (the removal of nutrients due to ageing).
- ✓ these hormones can be used in our favour for example to prevent the yellowing of lettuce leaves after they have been picked. It is when levels of cytokinin decrease (which happens after being picked) that senescence occurs, and this results in the yellowing of leaves – senescence is what gives leaves their autumn colour.
- ✓ Are also used in tissue culture to help with the mass production of plants. They also promote bud and shoot growth from small pieces of tissue taken from a parent plant. This produces a short shoot with a lot of side branches, which can be split into lots of smaller plants, and all grown separately.

Ethylene

- ✓ The gas ethene is inhibited by the hormone auxin, so as auxin levels drop, ethene is produced which stimulates the production of cellulose in the abscission zone of a leaf.
- ✓ Whilst ethene is a gas, and therefore cannot be sprayed directly, a liquid spray has been developed which releases ethene inside the target plants.
- ✓ Commercial uses include:
  a) speeding up ripening of fruit (in apples, tomatoes and citrus fruits).
  b) promoting fruit drop in cotton, cherry and walnut plants.
  c) promoting lateral growth in some plants, yielding compact flowering stems

Gibberellins

- ✓ In plants, gibberellins are involved in both cell elongation and cell division.
- ✓ Under a commercial context, gibberellins may be involved in:
  a) Fruit production – gibberellins delay senescence in fruit, extending the time they can be left unpicked or in the shops.
  b) Also, gibberellins acting with cytokinins can promote elongation in apples, improving their shape.
  c) brewing – adding gibberellins to the process of producing malt (in a malt house at the brewery) speeds up production.

TOPIC 5

ANIMAL SCIENCE

Productivity

- Refers to the rate of generation of biomass in an ecosystem or agricultural system
- Farm animals that are reared for economic reasons. High productivity means profit from the farming enterprise and low means financial loss.
- Productivity can be affected by so many factors include pests ans diseases hence farmer dealing with livestock should increase productivity inorder to farm more effeciently.
- If the animals can be measured to find out their increase in mass, it should be possible to determine the amount of food that is fed to animal before it gains a unit mass. The animal converts the food into its own flesh or product. This is called **conversion efficiency.**

Conversion efficiency of live animals can be obtained from growth curves made by plotting graphs of live weight against time. The graph curves are used for other things such as determining the most opportune time when animals kept for meat should be slaughtered.

NB: Conversion Efficiency = $\frac{\text{mass gained by animal per month}}{\text{mass of food fed to animal per month}}$ X 100 %

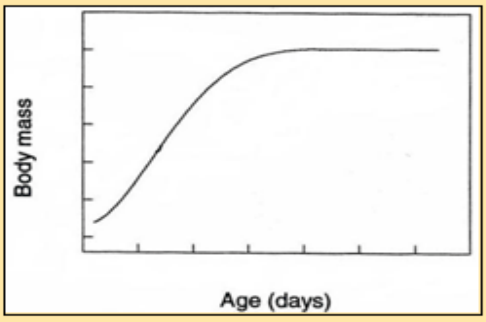
Example 1 mass of food given =15kg; mass gained in one month =4.5kg – 2.5kg =2.0kg. Therefore, F.C.E =2/15 multiplied by 100%.

Generally animal growth curves are S – shaped, that is they are sigmoid in shape, as shown in the diagram below:

TYPICAL GROWTH CURVES FOR BROILERS

As is typical of all animals, broilers experience a period a rapid growth early in their development (see Figure 6.1). This is then followed by a slow rate of growth as more feed is used in maintaining the already existing body structure. As a result, feed efficiency is much better in the first weeks of broiler production and then declines with increased target market weight.

Figure 6.1 - Generic growth curve for broilers



Growth is slow soon after birth and it quickly speeds up. This period of rapid growth is called "grand period" of growth .The graph then slows down as the animal reaches maturity. It is most convenient to slaughter your animal for meat just before maturity age but after the start of breeding period.

Calculating and interpreting feed energy flow

- The total feed requirement can be expressed in terms of energy value because the feed is primarily used for production of energy.
- Animals at different stages have a specific energy requirement.
- The nutritive ratio indicates the protein content of a feed.
- The nutritive ratio is the ratio between the digestible protein compounds and the digestible non – protein compounds (carbohydrates and fats) in a ration or feed.
- Nutritive ratio = 1: $\frac{\%\text{ digestible non-protein}}{\%\text{ digestible protein}}$

So a feed with a highly digestible protein content will have a narrow nutritive ratio (NR<1:6) and a feed with low digestible protein content will have a wide nutritive ratio (NR>1:6).

Nutritive Requirements of Animals

For maintainance	For growth	For milk production	For fattening	For reproduction
- NR not wider than 1:8 - Protein only for the replacement of worn out tissues - Carbohydrates, fats and vitamins only for maintenance - Minerals only for the replacement of losses	- NR must be 1:5 or less - Lots of protein of biological value - Sufficient carbohydrates and fats for maintenance and production - Sufficient minearls and vitamins	- NR must be wide 1:10 - Protein for maintenance - Carbohydrates and fats in large quantities - Minerals and vitamins for maintenance	- NR must be 1:5 or less - Lots of protein of biological value - Carbohydrates and fats only for maintenance - Sufficient minerals and vitamins for growth	- NR must be narrow and less than 1:5 - Lots of protein with high biological value - Carbohydrates and fats for maintenance; increasd to support pregnancy - Sufficient minerals and vitamins

Animal pests and diseases

- In any situation where large numbers of the same kind of animals are kept , diseases can spread very quickly.
- In livestock, diseases are caused by another organism living in or on the host animal. This organism is called pathogen. Pathogens include parasites and micro-organisms like viruses and bacteria. Pathogens destroy the tissues of the host animal and use its food.
- Some diseases are spread or carried by another animal called a vector e.g. ticks spread red water. Tsetse flies are vectors that spread nagana in cattle.

- Animals are affected by internal and external parasites.

QN: How do external and internal pests affect animals? (12)

Parasites and Diseases in Southern Africa

Disease	Cause	Spread	Symptoms	Control
Liver fluke	Fluke	-Have two hosts: water snail and mammals	-Slow growth. -Weight loss. -Decreased milk production -Poor quality meat	-Not allowing animals to graze in swampy and wet areas. -Rotational grazing. -Dosing using appropriate drugs.
Redwater/ babesiosis	Protozoa Babesia spp	-Is a tick-borne disease hence spread by ticks e.g blue tick.	-Fever. -Loss of appetite. -Red urine. -pale, yellow gums and eyes. -Difficulty walking.	-Practising tick control. -Vaccination.
Anthrax	-Bacteria called bacillus anthracis	-Enter the body throug mouth and cut wounds -Eating conatminated meat.	-Fever, -Swollen head, neck and chest, -Difficulty breathing.	-Vaccination, -Treat with pencillin. –Isolate infected animals. -Burn carcases to prevent spread of disease.
Foot and mouth (FMD)	-Virus	-Movement and of the animal products	-Fever, -Loss of appetite –Difficulty walking. –Blisters and ulcers on feet, in mouth and skin. -Excessive saliva production .	-Vaccination. -There is no tratment. -Kill affected animals and burn their carcases. -Isolate/quarantine, no mvt of animals

How parasites and diseases are controlled? Explain the points below:

- Dipping
- Dosing
- Quarantine
- Destruction of infected animals
- Notifying the authorities.

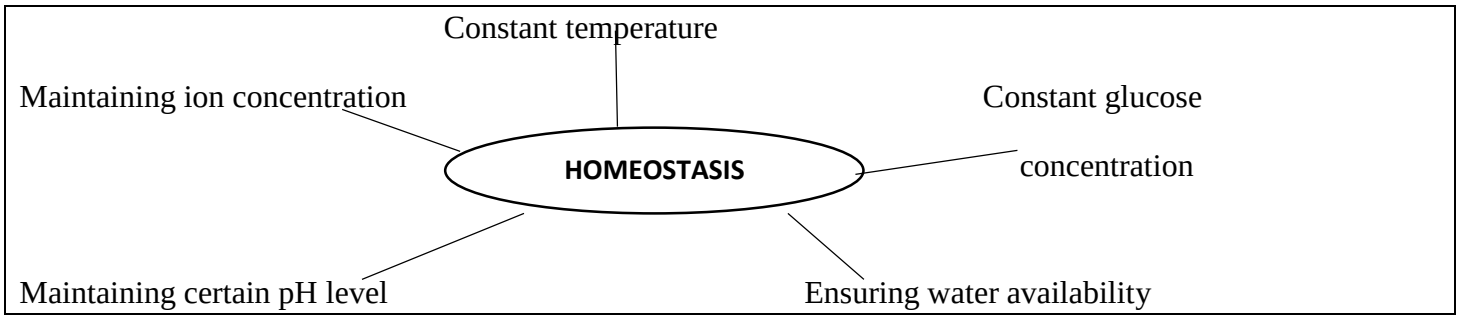
HOMEOSTASIS

Homeostasis

- Is the maintenance of a constant internal environment.
- Homeostasis literally means 'staying similar'. It refers to the fact that the composition of the tissue fluid in the body is kept within narrow limits.
- The maintenance of internal condition or environment is done by the hypothalamus in the brain

Importance of Homeostasis

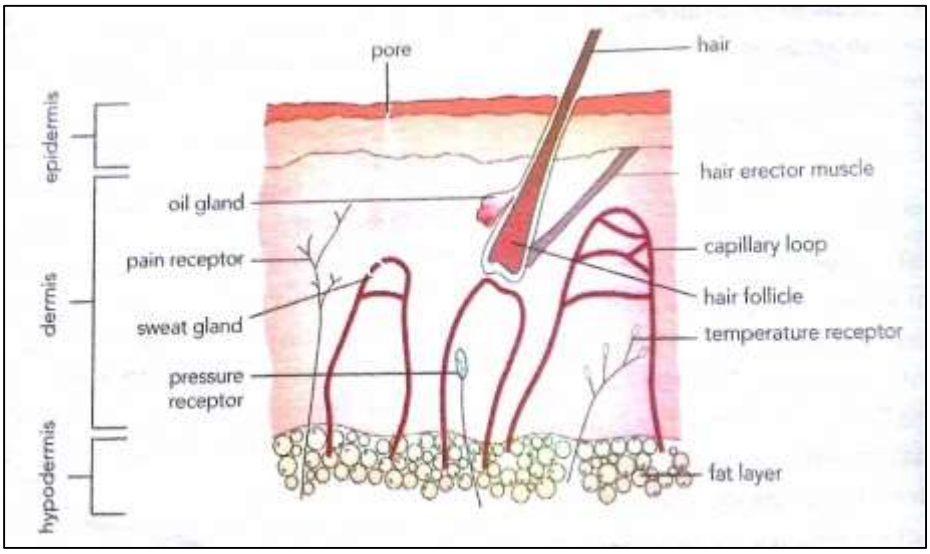
- Helps your cells work at optimum rate
- Ensures that enzymes work most efficiently
- Ensures that the cells aren't damaged by absorbing or losing too much water by osmosis
- Ensures that there is enough fuel in reserve for respiration



The skin and functions

- Contains sense organs such as touch, temperature, pain which make us aware of changes in our bodies and world around us.
- Form a waterproof layer to pretect water loss from body tissues by evaporationand prrevent osmosis every time youhave a bath.
- Protects entry of bacteria and pathogen.
- Protects the body from damage by UV light from the sun.
- It sectetes wastes such as awter and urea through sweating.
- Controls body temperature.

Structure of the skin



The Upper (Outer layer) / Epidermis

- Epidermis forms a waterproof and protective wrap.
- The outermost layer of epidermis is made up of flat dead cells or dying cells, which are continuously worn away by friction and are called the cornified layer.
- This has a layer which is always forming new cells through cell division.
- The new cells gradually move towards the surface, become flat, and develop keratin.
- Epidermis also contains a pigment called melanin, which gives a black colour to the skin and absorbs harmful UV radiation

Middle layer / Dermis

- The dermis contains blood vessels, sweat glands, sensory receptors and hair follicles.
- It has blood capillaries to supply food and oxygen and help to regulate the temperature.
- There are sense organs to respond to touch, pressure and temperature.
- Sweat is produced by sweat glands, travels through the sweat duct and evaporates to regulate the internal body temperature.
- Hair follicle produce hairthat sick out of the skin. Hair is made of a protein called keratin.
- Assosiated with hair follicles are sebaceous glands or oil glands that keep hair supple and helps to keep the skin waterproof.
- Attached to the hair is hair eractor muscle. When it contracts, hair is raised and whenir relaxes, hair is lowered down close to the skinhence regulating temperature.

Lower layer / Hypodermis

- A layer of fatty tissue acts as an insulator and energy store.
- It contains blood vessels which feed the capillaries in dermis.
- The fat deposits are called adipose layer.

Role of Skin in temperature regulation

- The skin helps to keep the body temperature more or less constant. This is done by adjusting the flow of blood near the skin surface and by sweating.
- Normal human body temperature varies between 35.8 °C and 37.7 °C. Temperatures below 34 °C or above 40 °C, if maintained for long, are considered dangerous. Different body regions, e.g. the hands, feet, head or internal organs, will be at different temperatures, but the **core** temperature, as measured with a thermometer under the tongue, will vary by only 1 or 2 degrees.
- Heat is lost from the body surface by conduction, convection, radiation and evaporation.

The part of the skin that regulate temperature are blood vessels, sweat glands and hairs and work in the following ways:

1. **Sweating** – the sweat glands secrete sweat onto the skin surface. When this layer of liquid evaporates, it takes heat (latent heat) from the body and cools it down.
2. **Vasodilation** – the widening of the arterioles in the dermis allows more warm blood to flow through blood capillaries near the skin surface and so lose more heat. (Figure 14 a)
3. **Vasoconstriction** – narrowing (constriction) of the arterioles in the skin reduces the amount of warm blood flowing through blood capillaries near the surface (Figure 14 b).
4. **Shivering** – uncontrollable bursts of rapid muscular contraction in the limbs release heat as a result of respiration in the muscles.

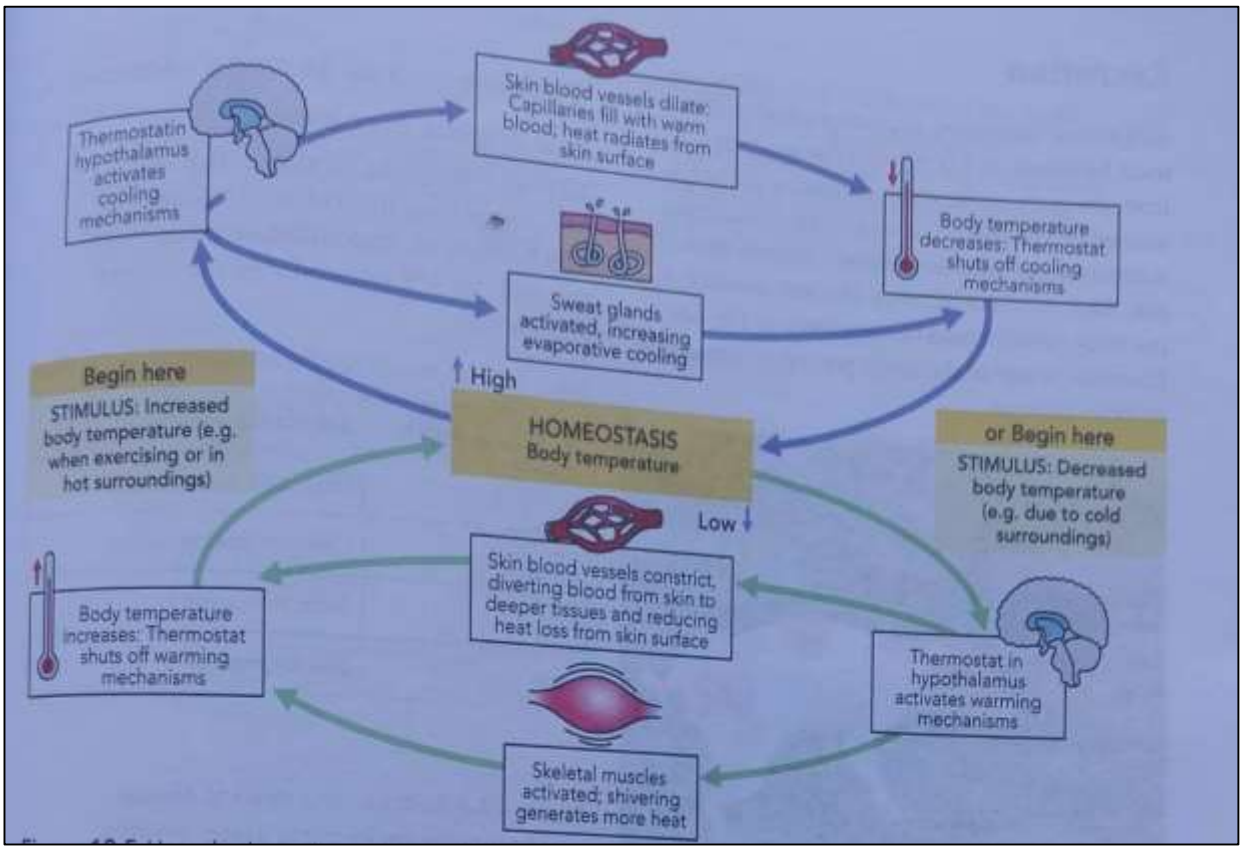
In these ways, the body temperature remains at about 37 °C. We also control our temperature by adding or removing clothing or deliberately taking exercise.

The Hypothalamus

- It contains a thermoregulatory centre in which temperature receptors detect temperature changes in the blood and co-ordinate a response to them.
- Temperature receptors are also present in the skin. They send information to the brain about temperature changes.
- When it senses that you are too cold, it sends signals to muscles to make you shiver.
- When you are too hot, it sends signals to sweat glands to make you sweat.

Negative feedback

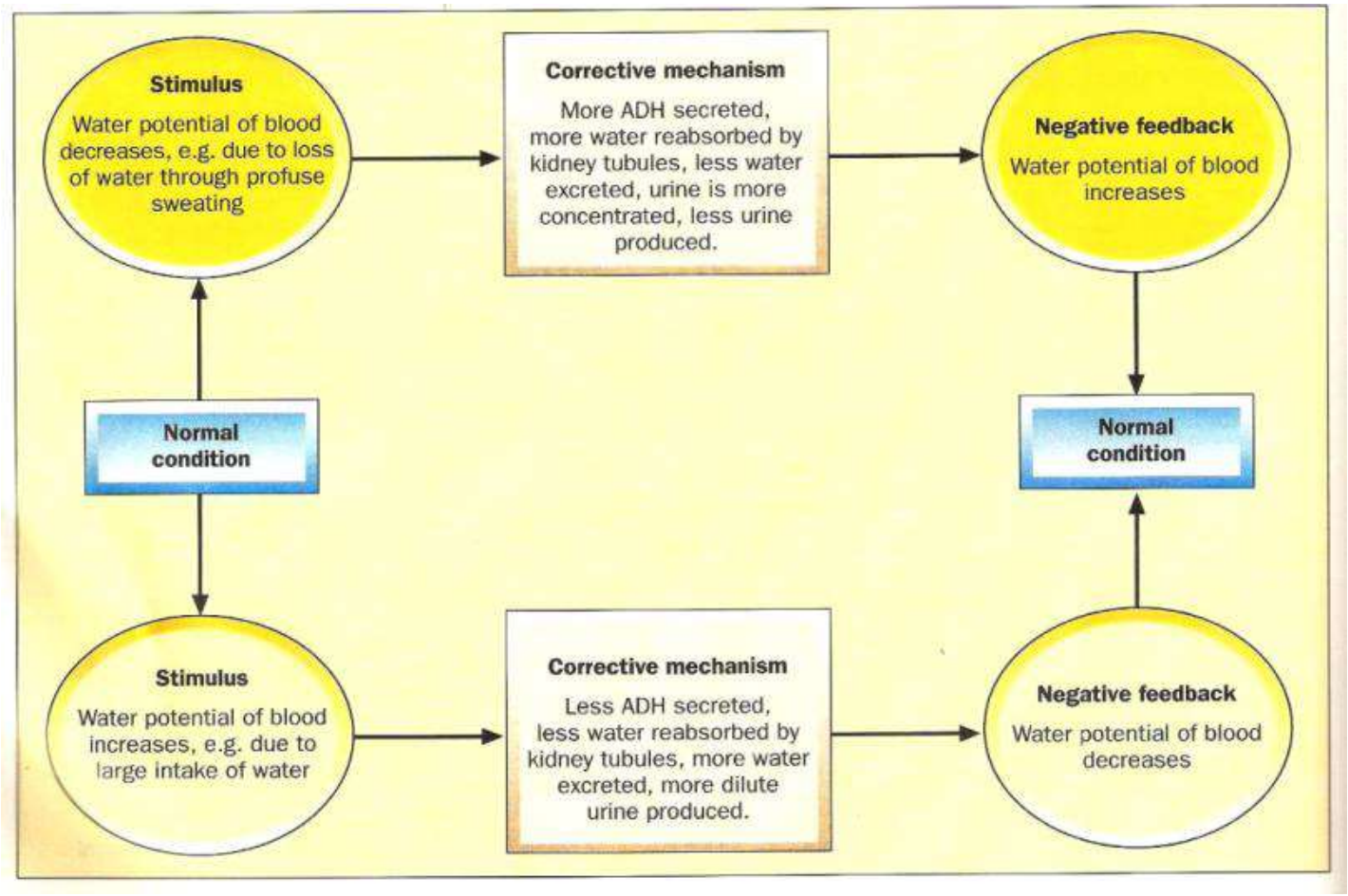
- A mechanism used in homeostasis, in which a change in a parameter brings about actions that push it back towards normal.
- For example, when the body temperature rises, information about the temperature change is sent to the hypothalamus which in turn sends signals to the effectors to decrease this change.
- It is termed ‘feedback’ as the information about the effects of cooling the body are fed ‘back’ to it and ‘negative’ as it is compelled to ‘stop’ doing these changes in order to stop overcooling.



Regulation of water

- ✓ Regulation of water is done by the kidney and salt balance.
- ✓ As blood flows from the heart, it enters the kidney in renal arteries.
- ✓ Here the blood is filtered and returns to the blood stream in renal veins.
- ✓ 98% of the filtered fluid is reabsorbed. Most variable constituent of urine is water content.
- ✓ Thus, concentration of urine varies depending on the state of blood with respect to water and salts.
- ✓ Osmoregulation is the regulation of water and salts by the kidney.
- ✓ The hormone which regulates water and salts is adrenaline.

Feedback Diagram on Osmoregulation in Man (Water Regulation)



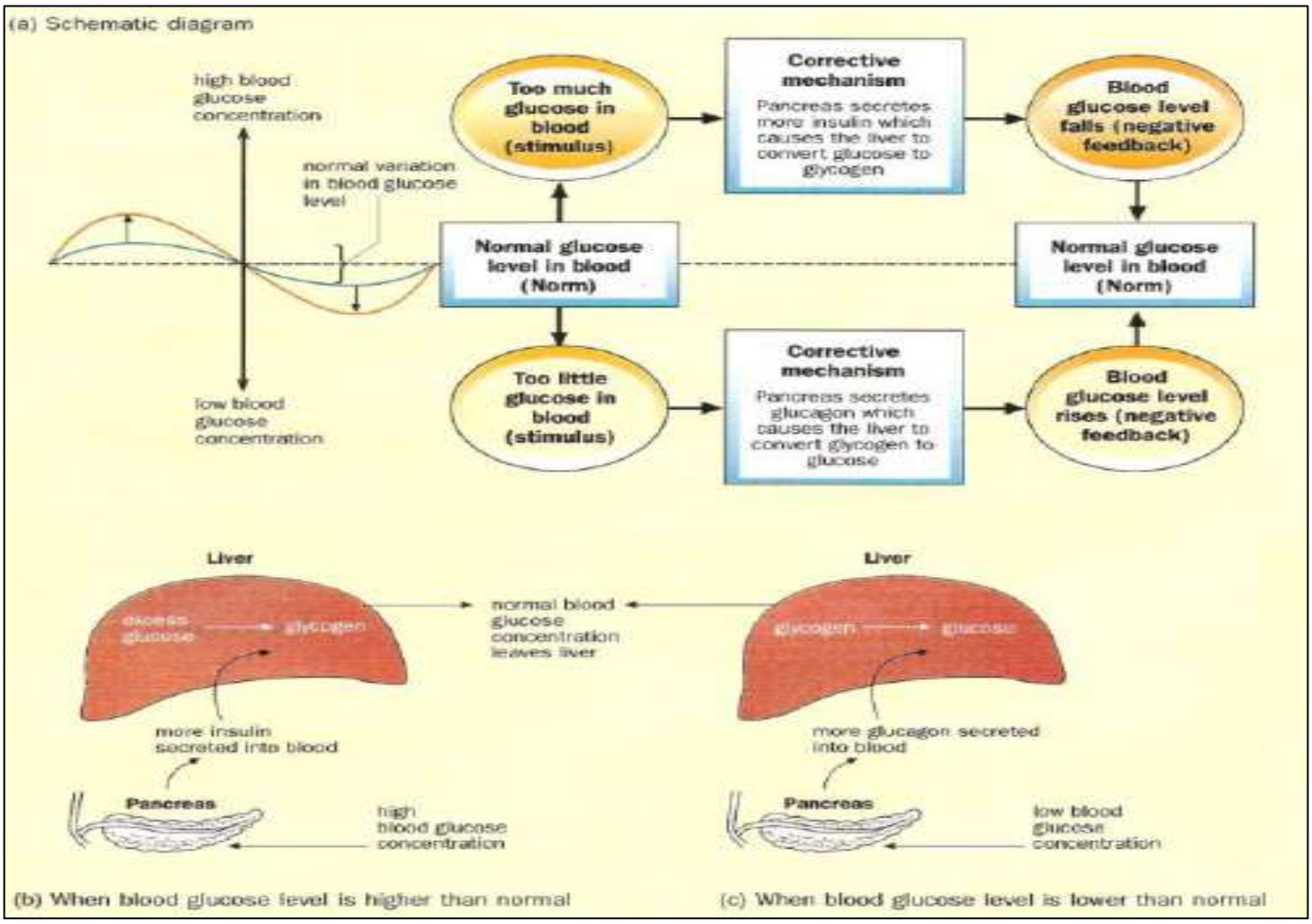
Regulation of glucose by the liver

- ✓ Blood of glucose level is supposed to be maintained at 90mg / 100cm^3 or at 0,01%.
- ✓ Liver maintains the level of blood glucose at a constant.
- ✓ It prevents the fluctuations of glucose according to the feeding patterns.
- ✓ Fructose, lactose - (Hexos sugars) are converted to glycogen which is insoluble.
- ✓ The conversion of glucose to glycogen is called glycogenesis and is stimulated by a hormone called insulin.

Glucose $\xrightleftharpoons[\text{phosphorylation}]{\text{insulin}}$ glucose – 6 – phosphate → glycogen

- ✓ Glycogen is broken down to glucose to prevent blood glucose level below 60mg /100cm^3 blood.
- ✓ This reaction is activated by a hormone called glycagen .

Diagram of regulation of glucose



Excretion

- Is the removal of toxic waste materials which are produced by metabolism of body cells.
- It is necessary to maintain homeostasis, if not the will be a build of wastes in the body hence become toxic to the body.
- Is once of the seven processes that define living organisms.

Exctretory organs and substances excreted

Excretory organs	Substances excreted
Kidneys	urea, water, salts, toxins, urine
Lungs	carbon dioxide, water
Skin	salts, water, sweat

Types of metabolic wastes

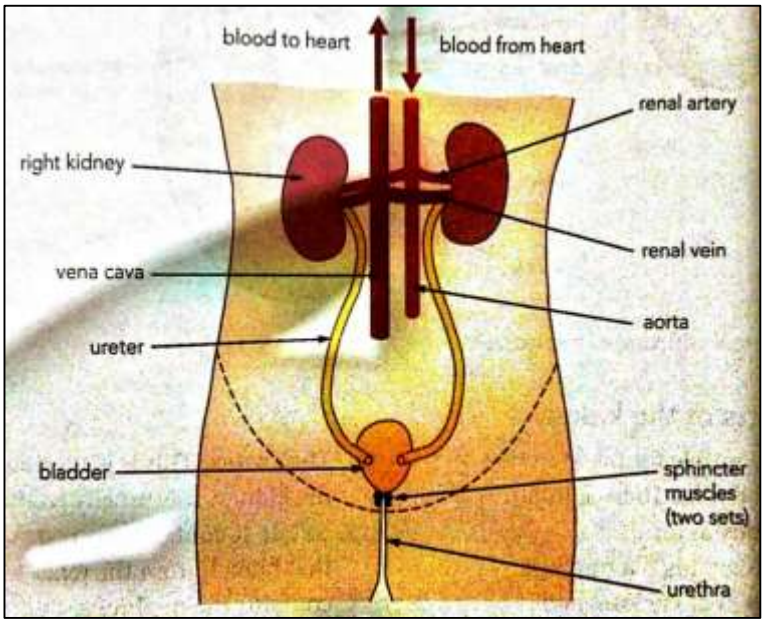
Waste	Produced from
Carbon dioxide	Aerobic respiration
Water	Aerobic respiration
Salts	Metabolic activities
Nitrogenous wastes	Breakdown of excess amino acids

Types of nitrogenous wastes

Waste	Produced from	Toxicity
Ammonia	Breakdown of excess amino acids	Highly toxic
Urea	Breakdown of excess amino acids	Moderately toxic
Uric acid crystals	Breakdown of DNA and RNA	Minimally toxic
Creatinine	Waste product of muscle action	Minimally toxic

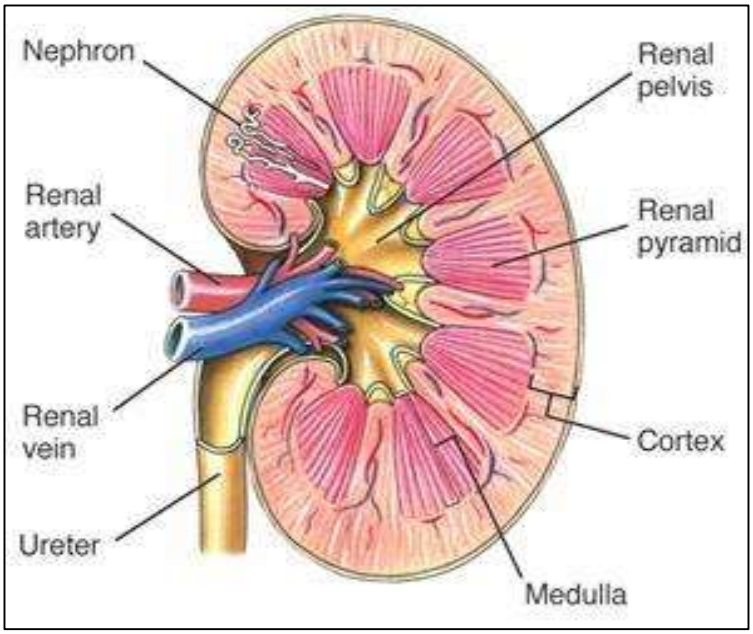
- Substances excreted are those that are toxic and those which are in excess to the requirements of the body.
- Examples of substances which can be in excess and toxic are water, salts and bile pigments and urea, alcohol and products from the breakdown of drugs respectively.

The Structure of the urinary system



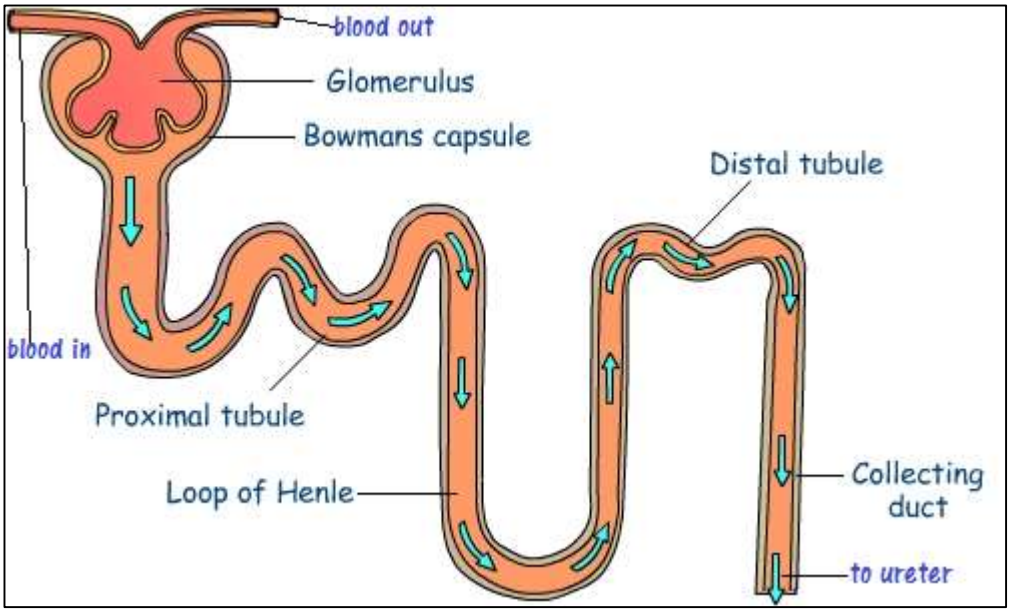
1. Kidneys- are two bean shaped organs that filters wastes from blood to form urine.
2. Ureter- are two thin tubes that link the kidney to the bladder.
3. Bladder- a hollow muscular organ situated at the base of the pelvis that stores urine.
4. Urethra- a thin tube that leads from the bladder to the opening through which urine is excreted.
5. Sphincter muscles- contract to close the urethra and hold back urine. The lower sphincter muscle is voluntary or controlled and the upper sphincter is involuntary, so it automatically relaxes when the bladder is full.

The Structure of the kidney



i. Renal capsule-a thin tough membrane that encloses and protects the kidney **(Label it on the diagram**)
ii. Renal artery – brings oxygenated blood to the kidney. Blood contains cells and plasma with wastes (urea), glucose, amino acids, proteins, fats, hormones, etc, in solution.
iii. Renal vein –takes deoxygenated blood away from the kidney to the vena cava. Contains all materials except wastes.
iv. Ureter – runs from each kidney to the base of the bladder carrying urine.
v. Cortex – outer part of the kidney where blood is filtered by thousands of microscopic tubules.
vi. Medulla – this is the middle layer of the kidney. It is slightly light than the cortex. The nephrons run through the medulla.
vii. Pelvis – This is funnel-shaped cavity that connects with the ureter.where the ureter leaves the kidney.
viii. Nephrons- are microscopic tubes in the cortex . they act as filtering units. They regulate the concentration of water and soluble substances by filtering the blood, reabsorbing what is needed and excreting the rest as urine. At the atart of the nephron is hollow cup of celles called Bowman`s capsule. It surrounds a ball of blood capillaries called glomerulus where blood is filtered.

Structure of the Nephron



Functions of the Kidney

- Kidneys are responsible for filtering wastes from blood. The wastes are excreted in form of urine (a dilute solution of urea, salts, water and other waste compounds).
- Keeps acid and base balance in the body.
- Osmoregulation – Keeps a proper balance between water and mineral salts in the body fluids.
- Make material that controls blood pressure and makes red blood cells.

NB: Urine production on a cold day is high due to less or no sweating and vice versa.

Effects of high and low blood pressure to the kidneys

- Blood pressure is the force of blood moving through your arteries. Arteries carry blood from your heart to the rest of the body.
- Blood pressure lower than or equal to 120/80 is ideal. For people with diabetes or kidney disease, blood pressure lower than 130/80 is good. Lower than 120/80 is ideal.
- High blood pressure (hypertension) is when your blood pressure is usually higher than it should be. It means that your heart is working harder to pump your blood.
- High blood pressure can cause kidney disease and kidney failure. High blood pressure is due to many things, including kidney disease.
- Diabetes is the leading cause of kidney failure. The filters in your kidneys are made up of tiny bunches of blood vessels (called glomeruli). High blood pressure can harm these tiny blood vessels. When this happens, it is called kidney disease.
- A heart-healthy diet [low salt (sodium) and fat], exercise and medicines can help one keep a healthy blood pressure.

Dialysis

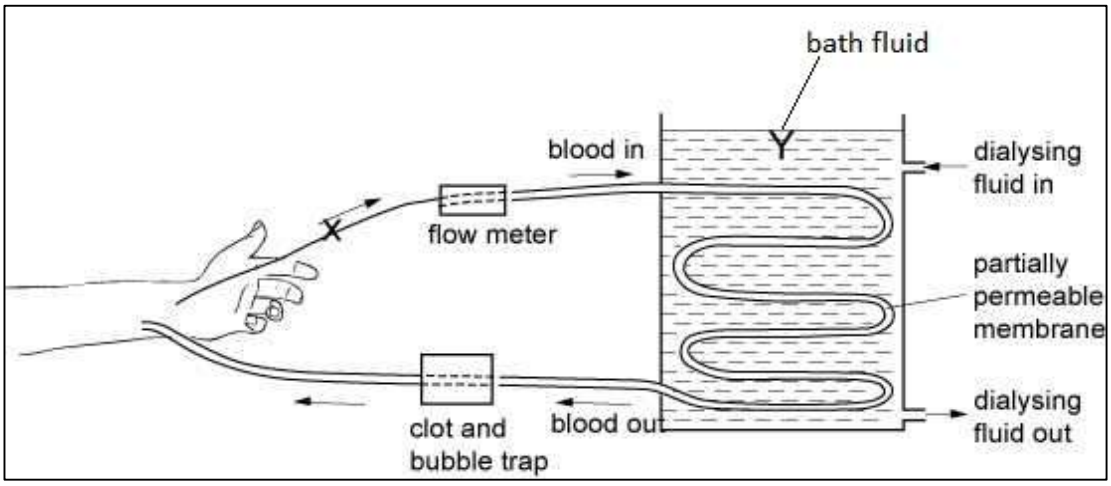
Is a way to clean the blood of wastes; extra salt and water after the kidneys have failed. It is the most common treatment for end-stage renal disease (ESRD). The only option to dialysis after chronic kidney failure is a kidney transplant.

Two main forms of dialysis are hemodialysis and peritoneal dialysis.

- ✓ Hemodialysis is the most common treatment for chronic kidney failure (end-stage renal disease), whose major cause is diabetes.
- ✓ Peritoneal dialysis (PD) uses the body's own stomach membrane (peritoneum) as the filter. A permanent tube is placed in the stomach. Dialysis solution is poured through the tube and fills the space between the stomach wall and organs. The solution draws wastes and extra fluid from the bloodstream. After several hours, the used solution is drained from the stomach.

Kidney dialysis machine

- ➢ It consists of a long coiled cellulose tube coiled up in a water bath.
- ➢ The patient`s blood is led from a tube in the renal artery and pumped through the cellulose tubing.
- ➢ The microscopic pores in the dialysis tubing allows small molecules such as salts, ammonia, uric acid , and other wastes leak out into the water bath.
- ➢ Blood cells and proteins do not leave the blood.
- ➢ Filtration in the kidney works in the same way with the machine.
- ➢ To prevent loss of glucose and salts from blood, the liquid in the water bath has a solution of salts and sugars of correct composition so that only substances above this concentration can diffuse out of the blood into the bath solution.
- ➢ Bathing fluid is kept at body temperature and constantly changed as unwanted blood solutes accumulates in it.
- ➢ The blood is then returned to the patient through a vein in the arm.
- ➢ The tubing is coiled to increase the surface area for the exchange of materials.



Kidney Transplants

- ✓ Most people under treatment using a dialysis machine would rather prefer treatment using kidney transplants as, the patient would suffer much less pain and it would enhance their quality of life.
- ✓ Moreover, surgeons are even quite efficient at successfully conducting kidney transplants.
- ✓ In a kidney transplant operation, the person donating the kidney is called the donor and the person receiving the kidney is the recipient.

- ✓ However, the problem arises when the patient's immune system recognizes the donor's organ as foreign as the DNA in the donor's organ and the patient's cells do not match.
- ✓ This leads to the patient's WBCs attacking the 'foreign' organ and destroying it. This is known as immune rejection.
- ✓ Hence it is crucial that the donor's DNA is a close match with the patient's cells.
- ✓ To avoid immune rejection, the patient is prescribed immuno-suppressants in order to stop the immune system do its usual task. This makes the patient vulnerable to all kinds of diseases and the worst part is that the immuno-suppressant needs to be taken for life!

Coordination and Response

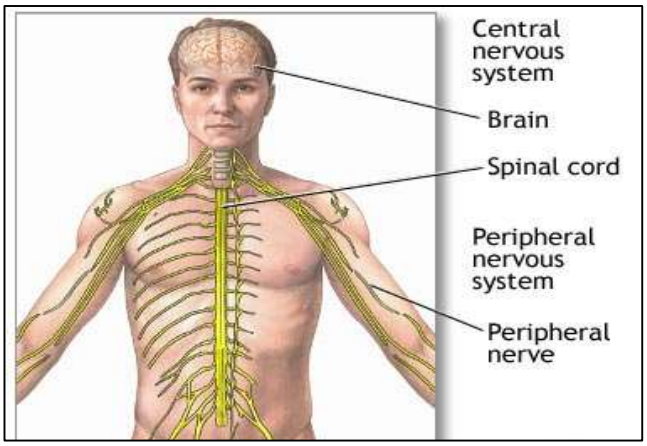
- Living organism are sensitive to their environment. Sensitivity refers to the ability to detect a change in the outer environment and respond to it.
- A change in the environment is also called a stimulus (plural stimuli).
- Actions taken by the body in order to co-operate with a stimuli are called responses.
- The body detects a stimulus by parts in the body called receptors and is able to respond to it through other parts called effectors.
- Two organ systems are continuously working to detect and respond to stimuli, these organ system are called the nervous system and the endocrine system.

The Nervous System

- The nervous system is a system of organs working together to detect and respond to stimuli.
- The nervous system is made up of two systems, the central nervous system (C.N.S) and the peripheral nervous system (P.N.S).
- The peripheral nervous system connects the central nervous system to the other parts of the body.

Central Nervous System (CNS)

- The central nervous system is made up of the brain and the spinal cord.
- The spinal cord is basically a big bundle of nerve cells running through a tunnel inside the backbone which protects it while the brain is protected by the skull.
- The central nervous system is what gives out orders to other parts of the body to perform certain jobs.



The Peripheral Nervous System PNS:

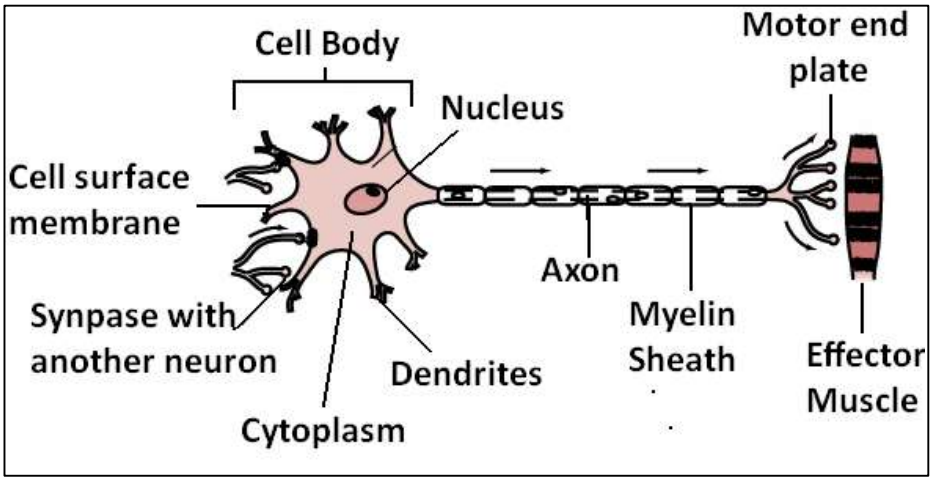
- The peripheral nervous system is the other part of the nervous system. The main job of the PNS is to detect stimuli and send impulses to the CNS according to the stimuli.
- The PNS is made of receptors and nerves that carry the impulses.
- Receptor cells are ones which's function is to detect something about its environment.
- There are many receptors in the body that are able to detect many changes like temperature, touch, light, sound and chemicals.
- There are some organs in the body that are there to detect just one stimulus, like the eye for example. These are called sensory organs and they can be defined as a group of receptor cells responding to specific stimuli.
- Effectors are the opposite of receptors. Receptors are two detect the stimuli while effectors are two respond to it. Effectors are usually muscles and glands.

Neurons (Nerve Cells):

- Neurones are important structures of the nervous systems.
- Neurones act as a wire that transmits electrical impulses all over the body.
- A bundle of neurones is called a nerve. There are 3 types of neurones are described below:

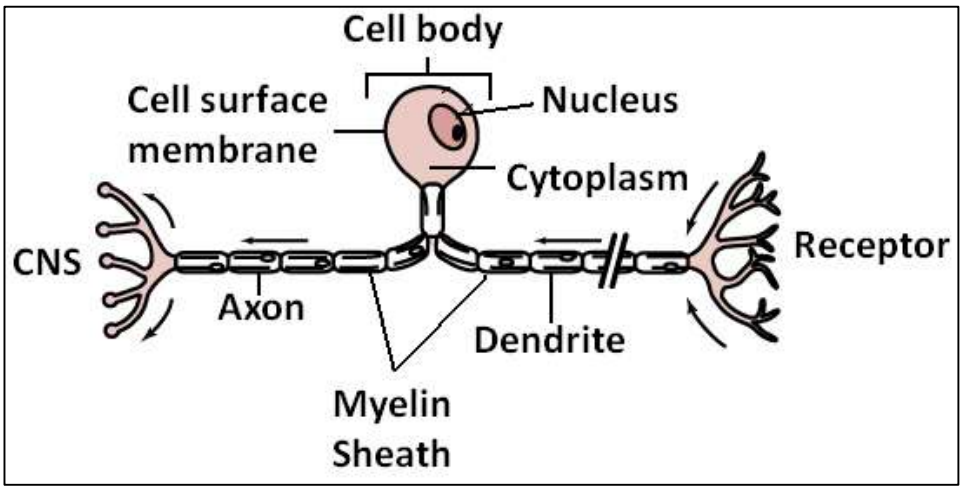
1. Sensory Neurone

- Transmits impulses from the sense organ such as the eye, nose and touch receptors.
- The sensory neuron have two long fibres (i) the Dendrone – which conducts impulses from a sense organ to the cell body of neuron (ii) Axon – conducts impulses from cell body to the central nervous system.



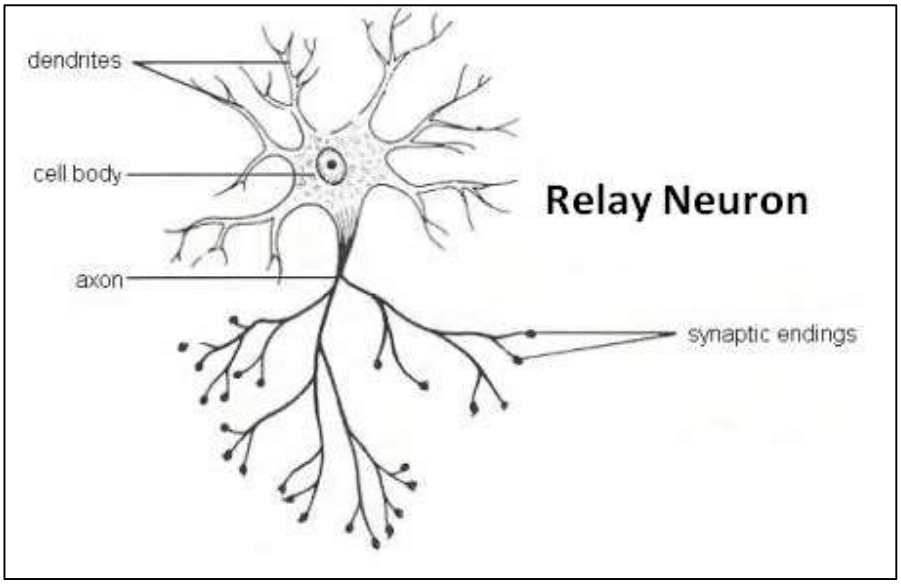
2. Motor Neurone

- Conducts impulses from the cental nervous system to effector organ such as muscles and glands.
- The cell body of the motor neurone is embedded in the central nervous system.
- The cell conducts impulses from other neurones to dendrites.
- A long single axon carries impulses from cell body to muscle fibre or gland.



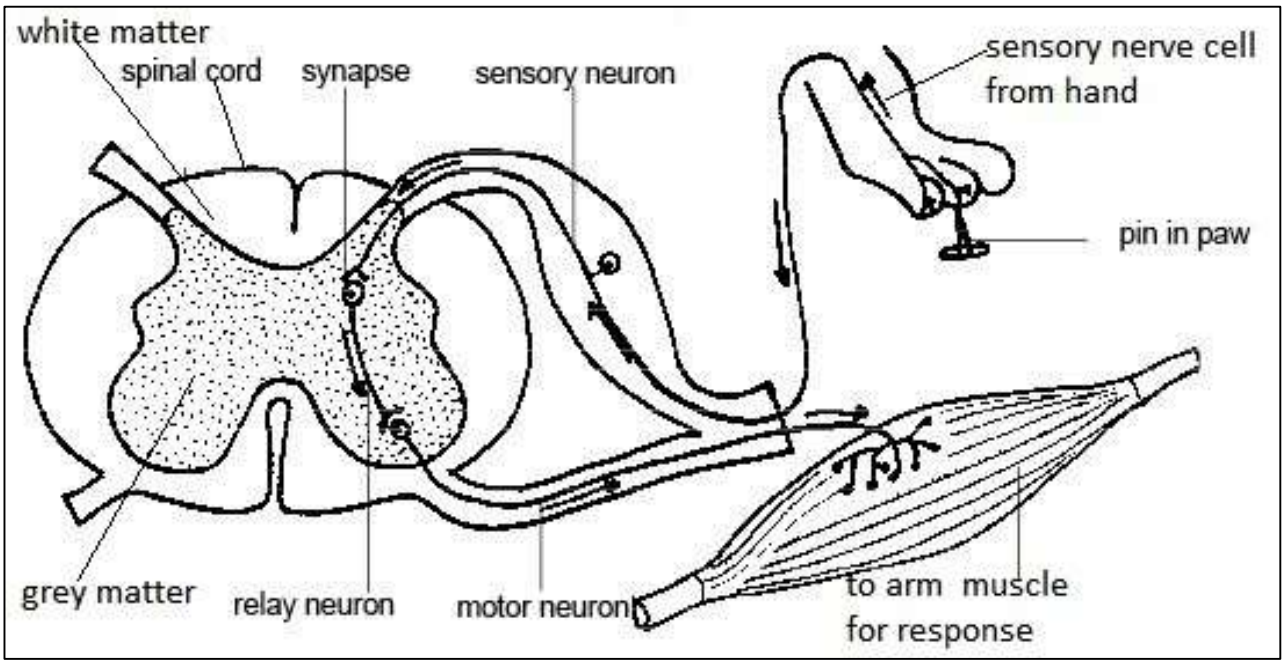
3. Relay neurone

- Is found in the brain.
- It makes contact with other neurones in the brain and it passes on impulses to the motor neurones.



Spinal Cord and Reflex Action

- The spinal cord transmits sensory and motor impulses to and from receptors and effectors.
- It relays sensory and motor to and from the brain.
- Is also concerned with spinal reflexes that is automatic actions.



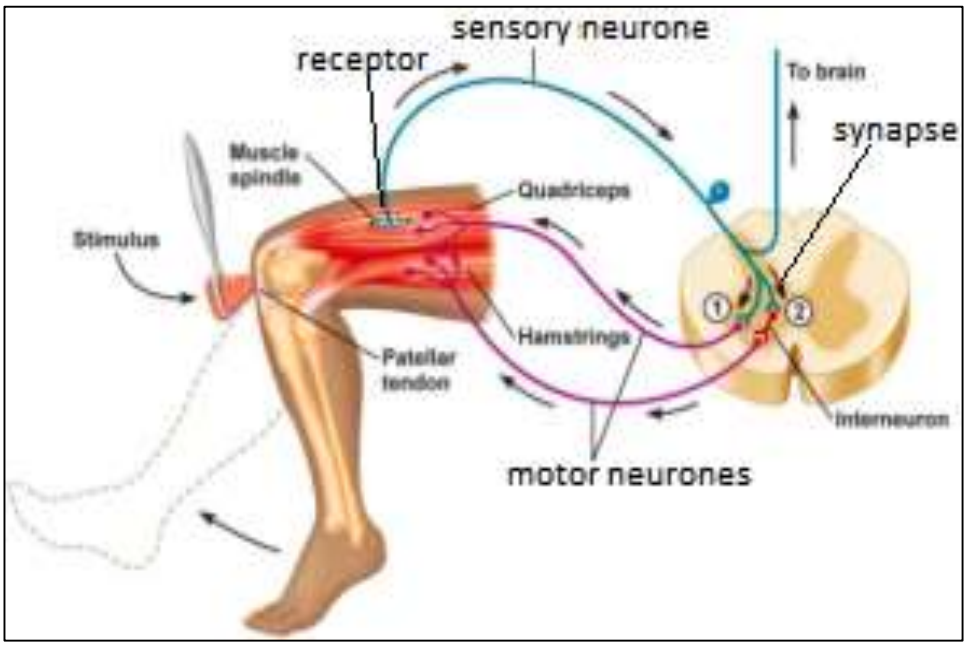
Parts and Functions

1. Grey matter – mainly motor and relay nerve cell bodies.
2. Synapses – are gaps between two neurons (motor and relay neurons).
3. White matter – is the outer layer which contains the cell body of the sensory neurons and nerve fibres.
4. Dorsal route – passage for incoming impulses. Sensory fibres enter through this route.
5. Ventral route – passage for outgoing impulses. Motor fibres leave through this route.
6. Receptors – receive impulses.
7. Effectors – produce an effect (response to the stimuli).

Reflex Action

Knee Jerk Reflex

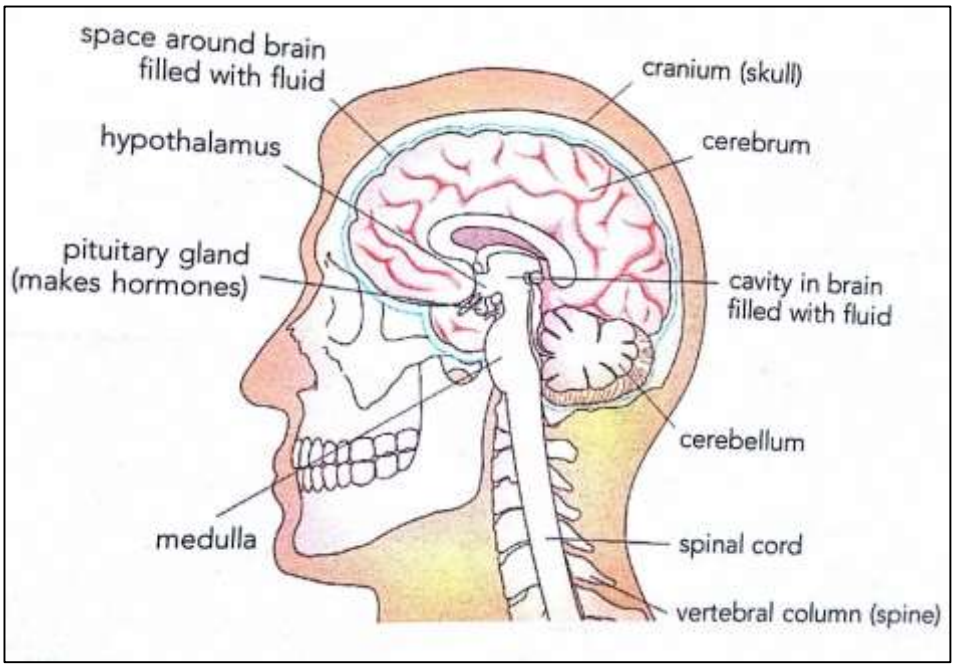
- When the hammer hits the tendon. The muscle contracts, causing the foot to jerk upward.
- Stimulus is detected by receptor at the end of a sensory neurone in the leg.
- An electrical impulse travels along the sensory neurone into the spinal cord until it reaches end of the cell.
- The impulse jumps across to a motor neurone and travel down to the muscle of the leg.
- The muscles are called effectors because they produce an effect.
- Where the impulse jumps across between two neurone is a microscopic gap called synapses.
- The route taken by impulses is called a reflex arc and there is a curved shape.



The Brain

- This is the body`s computer, every minute it will be receiving information from parts of the body.
- It makes links between each new piece of information and what is already stored inside the brain cells.
- This linking of new to old is the bases of the learning process.

The Brain and Its Functions



1. Cranium – protects the brain. Draw and label it on diagram above.
2. Hypothalamus – is the control centre for homeostasis. That is regulates thirst, hunger, body temperature, heart rate, blood pressure, breathing, sleep cycles and secretion of hormones. Controls and regulates eating and helps keep the body internal steady.
3. Cerebellum - influences memory and learning. Coordinates voluntary movement and balance. It extends from the rear of the brain stem.
4. Medulla oblongata / brain stem – it connects the spinal cord with the rest of the brain.it is an automatic control centre for heartbeat, breathing, swallowing and coughing. Controls sleep and loss of consciousness and cerebrum activity is done by a tissue within the medulla.
5. Cerebrum - for memory, learning, coordination and senses. It has (i) sensory areas which receives impulses from receptors in the skin. (ii) motor areas which transmit impulses to the effectors in the skeletal muscles. (iii) association – sort out, interpret and decide action. This area is concerned with learning memory, enabling increased adaptability.
6. Pituitary gland – is the master endocrine gland. It controls / influences hormones and even those produced by other glands.

When a person touches something hot, the immediate response is to remove the hand without thinking. This rapid response to a stimulus is referred to as reflex action. Other examples include blinking, the pupil in dim or bright light and the knee jerk reflex.

The Eye

Front View

- The human eyeball is a slightly battened sphere about 25 mm (I inch) in diameter.
- The eyes are protected from behind by the cone-shaped `bony eye sockets (orbits) which are padded by layers of fatty cushions.
- The eyebrow stops sweat running down into the eye.
- Eyelashes help to stop dust blowing on to the eye.
- Eyelids can close automatically (blinking is a reflex) to prevent dust and other particles getting ton to the surface of the cornea.
- Blinking also helps to keep the surface moist by moving liquid secretions (tears) over the exposed surface.
- Tears also contain enzymes that have an antibacterial function.

Internal Structure of the Eye

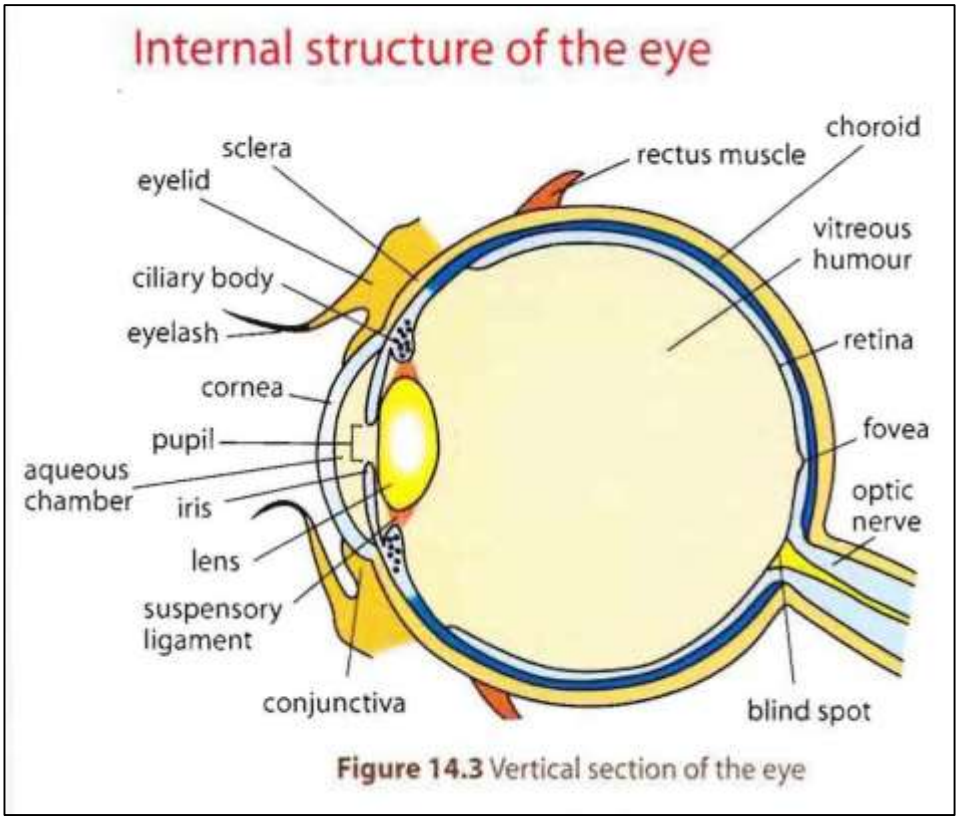


Figure 14.3 Vertical section of the eye

Functions of the parts

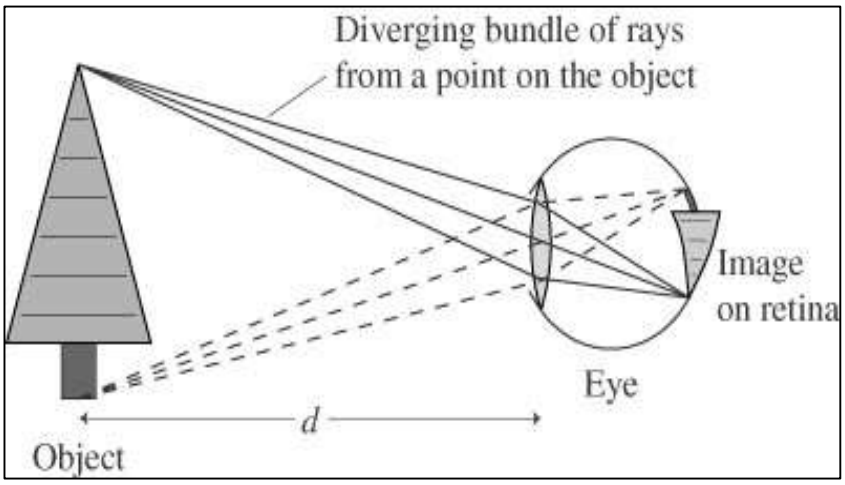
1. Sclera – is a tough outer layer which is in the front, visible and white in colour. It protects the retina.
2. Vitreous humour – is a jelly like substance which maintains the shape of the eye ball and is found at the back of the eye.
3. Aqueous humour – is a watery substance which is found in the front of chamber of the eye and is a watery transparent substance which transmit light.
4. Lens – is a transparent structure behind the pupil, flexible and can change its shape in order to focus images on the retina.
5. Suspensory ligaments – hold the lens into position.
6. Iris – is a ring of tissues which controls the size of the pupil and it gives colour to the image. The iris may be blue, brown, green, gray, or black depending on the amount of pigment (melanin) contained in its tissue. If no pigment is present, the iris appears to be blue. Small amounts of pigment cause the eye to have a gray or green color and, as the amount of pigment increases, the depth of color approaches black. Eye color is a hereditary trait, meaning that the distribution of melanin pigment in the eye is controlled by genes.
7. Pupil – is a hole in the centre of the iris which admits light. The diameter of the pupil varies and is regulated by the amount of contraction of the two sets of iris muscles. Thus, the amount of light allowed to enter the eye is determined by the size of the pupil. If a bright light is flashed into the eye, the circular muscles contract very rapidly and the pupil becomes smaller. In dim light the other set of iris muscles contracts and the pupil becomes larger.

8. Choroid – a darker layer which contains many blood vessels that bring oxygen and nourishment to the cells of this structure e.g. the retina. Many pigment granules are found in the choroid layer causing it to have a deep reddish-purple color. This prevents refraction of light inside the eye in much the same way as a coating of black paint inside a camera eliminates stray rays of light that might otherwise ruin the film.
9. Retina – it contains light sensitive cells where images are formed. Rays of light entering the eye are bent by the lens so they focus on the retina. The retina, is the innermost layer of the eye and extends along the inner surface of the eyeball to the ciliary body. Within the retina, are nerve cells that are the receptors for light. Because of their sensitivity appearance these photo receptors are called rods and cones. The rods are primarily responsible for black and white vision and the cones are for colour vision
10. Optical nerve – it carries impulses to the brain and so gives rise to the sensession of light.

Light Rays

- Light travels through a transparent medium in straight lines, called light rays, at speed v □ c/n, where n is the index of refraction of the medium.
- Light rays do not meet / interact with each other.
- A light ray continues forever unless it has an interaction with matter that causes the ray to change direction or to be absorbed.
- Between two media, light can be reflected or refracted. Within a medium, light can be scattered or absorbed.

An object is a source of light rays. We have self-luminous and reflective objects.
Rays originate from every point on the object, and each point sends rays in all directions.



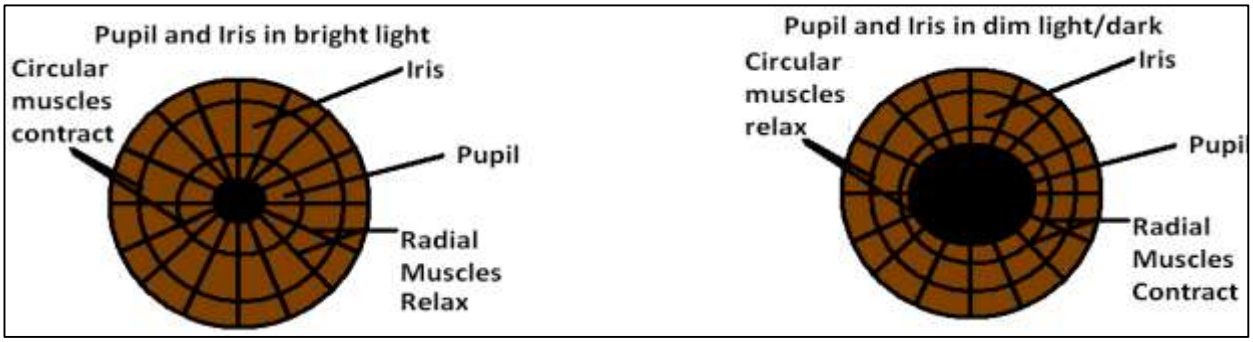
Formation of images

- When the light hits an object, it is reflected in all directions.
- When a light ray reflected from the object hits your eye you see that object. At the back of your eye, there is a spot on the retina called the fovea (blind spot).
- This spot is full of light sensitive cells. When the light ray falls on the fovea, the light sensitive cells generate electrical impulses that travel through the optic nerve to brain.
- When the electrical impulses reach the brain, the brain generates the image you see. This all happens in less than a fraction of a second.
- But this is the general idea only. Light rays enter the eye from every direction.
- If they are not focused on the fovea, they will most probably not hit it and we won't see.

- Here comes the role of the front part of the eye. When the light ray hits the eye at an angle, it first has to penetrate the cornea which refracts (bends) the light ray inwards.
- The cornea acts as a converging (convex) lens. Then the light penetrates the lens which refracts the ray a little more inwards focusing the light ray on the fovea.
- Thus, the light ray is focused on the retina. When the ray hits the retina, the closer to the fovea the sharper the image is.

Dilation and constriction of the pupil in bright light and dark

- In bright light the pupil becomes small or constricts because the circular muscles contract and the radial musclesrelax.
- On dim light, the pupil becomes wider or dilates because radial muscles contract and circular muscles relax.



Accommodation

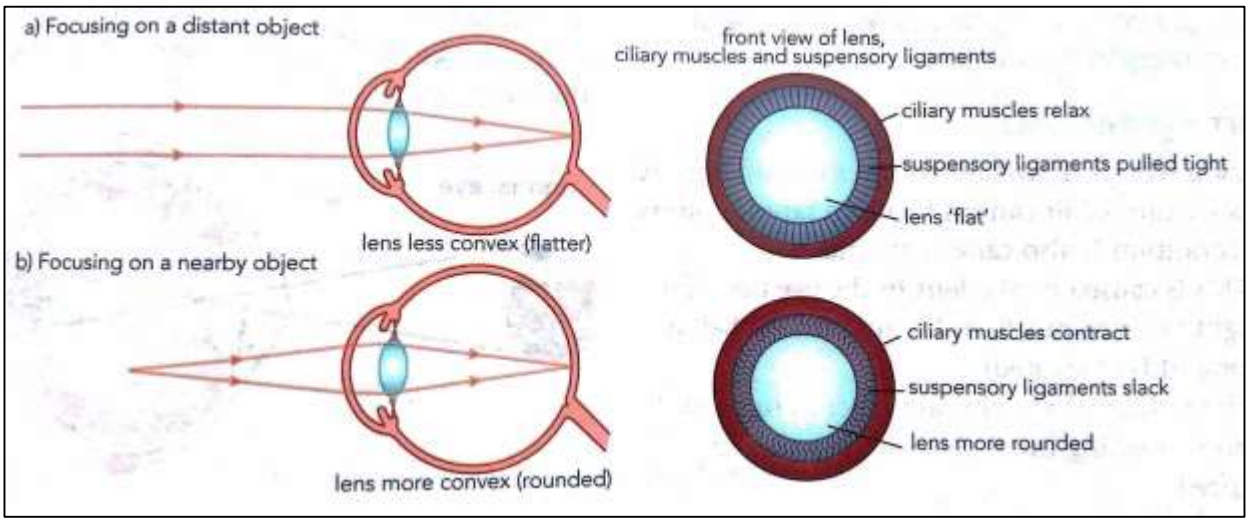
- ✓ This is the adjustment of the lens shape to focus near and distant objects.
- ✓ The light sensitive cells in the retina are stimulated to relay impulses through the optical nerve to the visual centre of the brain where images are formed.
- ✓ Images will be upside down and is corrected in visual centre of the brain.

Light from a distant object

- ciliary muscle relaxes.
- Lens become thin.
- suspensory ligaments become taut / stretched.

Light from a near object

- Ciliary muscle contract.
- Lens allowed to thicken.
- Suspensory ligaments relaxes.



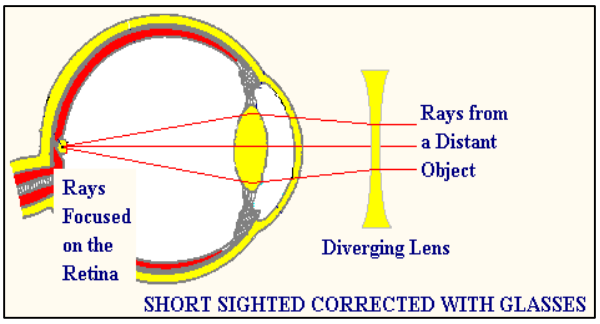
Eye Defects

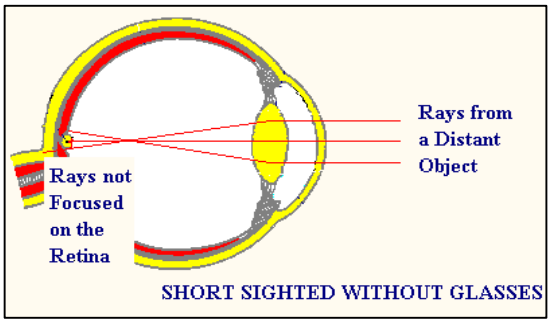
Myopia / short sightedness

- A person can see nearby objects but cannot focus far-off objects.
- Is caused by lens in the eyes bending light rays too much or due to large or elongated eyeballs.
- Light from distant object is focused in front of the retina.

Correction

It can be corrected by the use of concave lens which diverge light so that it is focused on the retina as shown below:



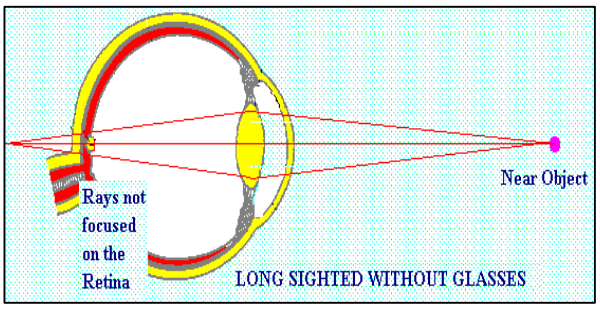


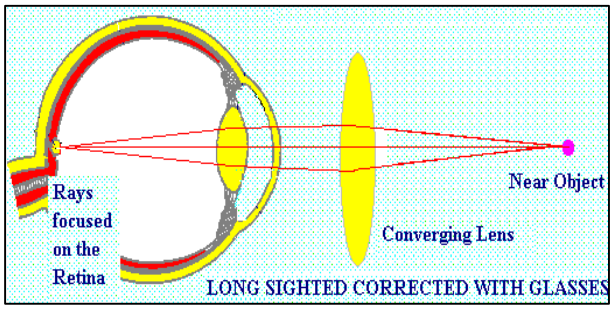
Hypermetropia / Long-sightedness

- A person cannot see nearby objects but far-off objects.
- It may be due to the eyeball being too small or lens too thin, that is not bending the light rays enough.
- Long sightedness results in the rays of light to converge behind the retina.
- A long sightedness person can see distant objects quite clearly but cannot see near objects clearly.

Correction

To correct this defect, convex lenses are used to converge the light rays further so that they will meet on the retina.



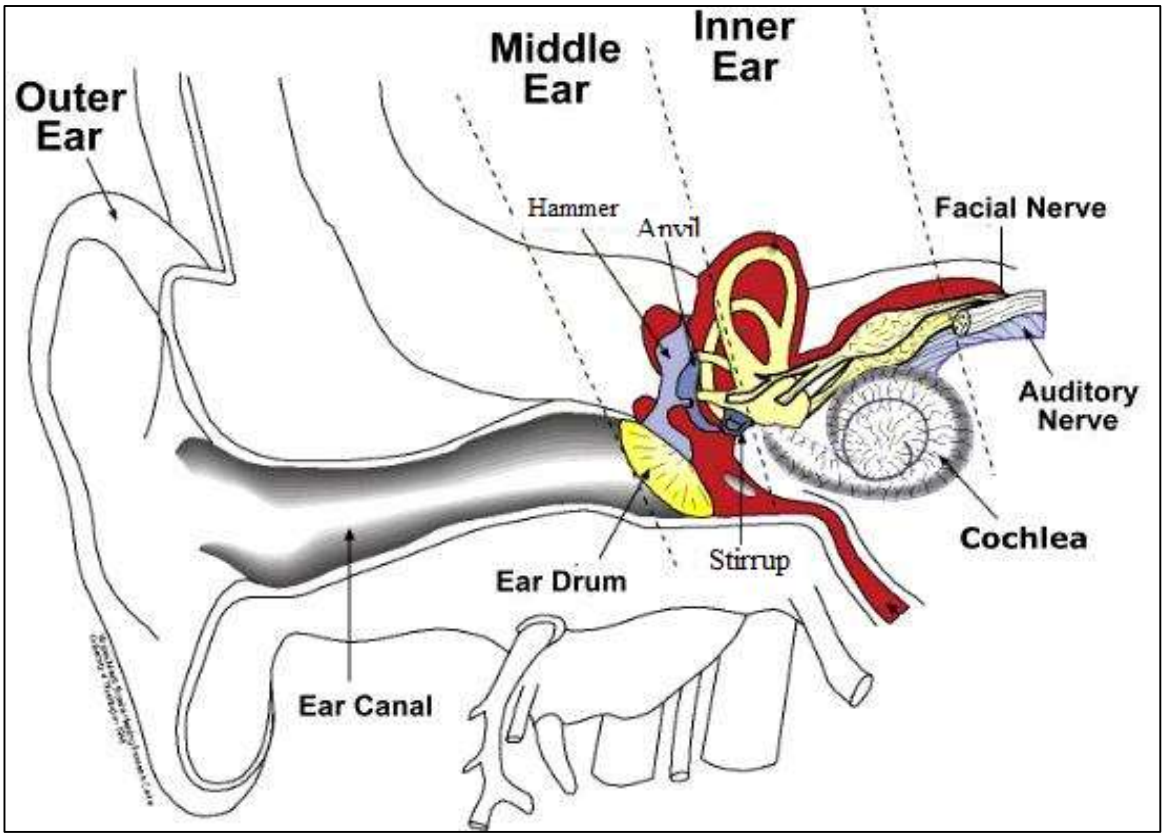


Cataracts

- Are caused when the lens of the eye becomes cloudy (Shanga).
- When cataracts interferes with a person`s ability to seee, a doctor can do an operation to replace the cloudy lens with an artificial lens.

Structure of the Ear

- The organ humans use to detect sound.
- The ear is divided into three parts – outer ear, middle ear and inner ear.
- Each part of the ear serves a specific purpose in the task of detecting and interpreting sound.



Outer ear

- The curved formation on the outside (the pinna) helps funnel sound down the **ear canal** to the eardrum (Like a satellite dish).

Middle ear (air filled)

- When sound waves reach the middle ear, they cause the eardrum to vibrate.
- This vibration then causes the three bones to vibrate.
- These vibrations are transformed into longitudinal/pressure waves in the middle ear.

Inner ear (fluid filled)

- Two main parts are the Cochlea and Auditory Nerve.
- The Cochlea is coiled like a snail shell
  a. Contains many hair cells
  b. Is filled with fluid, through which sound can travel easily.
- Auditory Nerve.
  a. The tiny hair cells of the cochlea are set in motion by vibrations
  b. The vibrations stimulate tiny nerve cells.
  c. The nerve cells then send signals along the auditory nerve to the brain.
  d. The brain interprets it as sound.

Other function is **balance**

- It helps us keep balance due to semicircular canals that are near the cochlea.
- The canals are filled with fluid and they contain receptors.
- The receptors are stimulated when they are moved for example when you move your head, the fluid pulls on the receptors and a message is send to the brain hence a reflex is induced and keep you balance and do not fall over.

Exercise

Put the following steps in order: [8]

A. The stirrup moves back and forth, creating pressure waves in the cochlea.

B. The bones of the middle ear (hammer, anvil, & stirrup) vibrate.

C. Hair cells send an electrical impulse through the auditory nerve.

D. The outer part of the ear (the pinna) "catches" the sound waves.

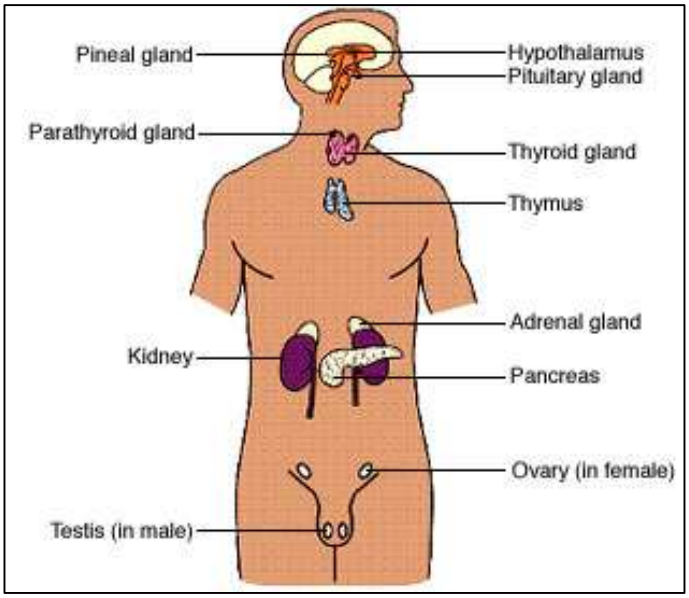
E. Sound waves vibrate the eardrum

F. The brain receives an electrical impulse and interprets it as sound.

G. Tiny hair cells in the cochlea move as the waves pass.

H. The sound waves travel into the ear canal.

Endocrine System



- The endocrine system is a system which uses chemicals for communication hence it is known as the hormone system.
- A hormone is a chemical substance produced by a gland and carried by blood which affect the activities of a target organ.
- Each hormone has its own target organ for example, the hormone which controls urine production only acts in the kidneys even though it travels in the blood stream.
- Most hormones are protein in nature. However, sex hormones are not protein in nature but steroids – substances which are similar to lipids.

Gland	Hormone	Function
Pituitary (master gland - controls other glands directly or indirectly)	Growth hormone	Growth and repair (bone elongation)
Hypothalamus (Links nervous and endocrine systems). Located - Base of brain, above pituitary	Anti-diuretic hormone (ADH) (stored in pituitary)	Causes nephron to reabsorb water and so produce less urine.
Parathyroids (4) Behind thyroid	Parathyroid hormone	Stimulates release of calcium from bones into blood.
Thyroid On trachea beside larynx (H-shaped)	Thyroxine	Controls metabolism.
Adrenals (2) On top of kidneys	Adrenaline (from adrenal medulla) - flight or fight hormone	It activates the body during stress – causes emergency responses.
Pancreas (islets of Langerhans) In abdomen, below stomach	Insulin Glucagon	Reduces blood sugar levels. Causes cells, especially muscle and fat cells to absorb glucose from the blood. Glucose is used in respiration or stored as glycogen – mostly in liver and muscles. Raises blood sugar levels (converts glycogen to glucose)

Sex glands a) Ovaries	Oestrogen (secreted by developing follicle) Progesterone (secreted by corpus luteum (after ovulation)	Repairs lining of uterus. Development of secondary sexual characteristics. Inhibits Follicle stimulating hormone (FSH). Stimulates pituitary to produce Luteinising hormone (LH). Causes proliferation of uterus wall. Prevents contraction of muscles in wall of uterus. Inhibits both FSH and LH.
b) Testes	Testosterone	Development of sex organs. Enlargement of larynx - deepening of voice. Growth of body hair, Production of sperm, Increased muscle. Reduction of fat (fat converted to muscle).

Adrenaline (The Crisis hormone)

- Is produced in the small adrenal glands above the kidneys.
- Is the hormone which is poured into the blood stream when the body is under stress or danger/ in crisis.
- Is sometimes called the "F" hormone because it is produced in a flight or fight situation.
- In a flight or fight situation, the adrenaline prepares the body to function on its best in other situations.
- It does this by targeting several organs and tissues.

The Adrenaline Action

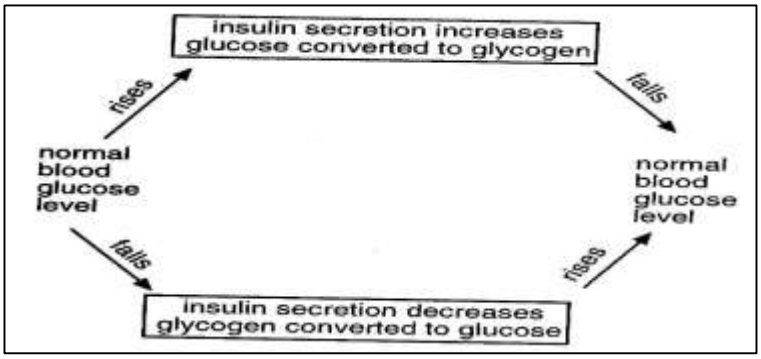
What adrenaline does	**How it helps the body**
Makes your heart beat faster (supplying more oxygen to brain and muscles)	Gives more energy for fighting or running away
Increases your breathing rate	More oxygen enters the lungs; improved blood circulation
Gives you butterflies in your stomach (by contracting blood vessels in the skin and digestive system)	It ensures that maximum volume of blood is transported to your muscles and brain, and you can think faster
Causes the pupils in the eye to widen	Helps you to see danger more clearly
Causes the liver to release glucose into the blood	It again gives the muscles extra energy to fight or run

Insulin and glucagon

- Insulin and glucagon are produced in the pancreas and their target organs are the liver and musles.
- Insulin converts glucose to insoluble carbohydrate storage compound known as glycogen.
- Glycogen is stored in the liver and musles.
- The normal blood glucose level is +/- 100mg / $100cm^3$.
- After a meal reach in carbohydrates, the blood glucose level will rise dramatically.
- The amount of insulin secretion increases in a situation and excess glucose is converted to glycogen or fat in the liver.

- Most of the body cells absorbs glucose, the level return to normal hence insulin release stops (Negative feedback).
- If blood glucose level are too low, glucagon is secreted to convert glycogen to glucose.

This is an example of a negative feedback in the body:



Diabetes Mellitus

- Is a set of symptoms caused by the malfunction of the pancreas.
- Absence of insufficient production of insulin by the pancreas results in diabetes.
- Low levels of insulin result in high blood suger levels.
- It is of two types: Type 1 and Type 2.
- Type 1 is caused by the immune system destroying the **beta cells** in younger people- are cells in the pancreas that produce insulin.
- Type 2 affects people over 35 years. This can be aggravated by a family history, obesity, stress and lack of exercises.

Signs and symptoms

- Increased blood glucose level, presence of glucose in urine, high production of urine, fatigue – feeling very weak all the time, a strong thirst, increased appetite, weight loss, blurred vision, nausea – feel like vomiting, bladder, skin and vaginal infections and tingling or numbness on feets and fingers.
- If diabetes is not treated for long time, it results in kidney failure, blindness and nerve damage.
- Extreme cases of insulin malfunction can cause "diabetic coma".

Ways of Controlling the Disease

✓ It can be controlled in various ways for example:

i) Mild Diabetes

- May be able to regulate their blood glucose by controlling their diet for example eating small regular meals with specific carbohydrates content.
- Monitor your blood sugar level.
- Lose weight.
- Regular exercising.
- See a doctor for medication to regulate your blood glucose levels.

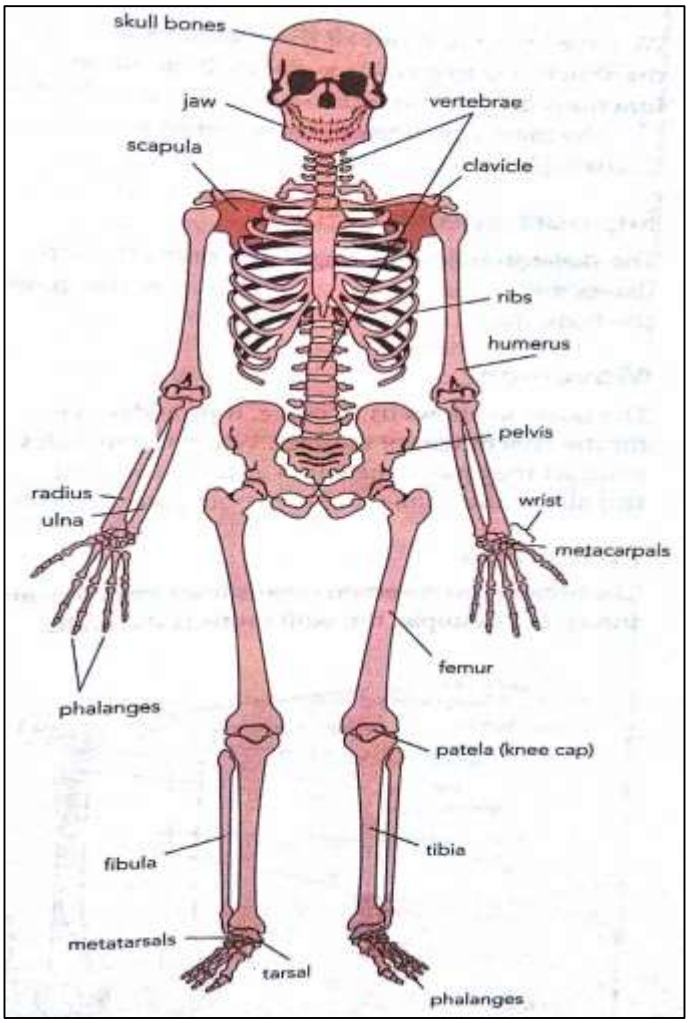
ii) Severe Diabetes

➢ May demand a daily injection of insulin.

Skeletal System

- A skeleton is a system of bones inside the body which provide support and acts as levers for movement and locomotion.
- The skeleton is made up of bones and cartilage.
- Bones and cartilage are living tissues.
- As one grows, the skeleton system also grows. It is made up of 206 bones.

Human Skeleton



Functions of the Skeleton

❖ Support – it raises the body from the ground and allows rapid movement, it suspends some vital organs and prevents them from crushing each other and maintains the shape of the body despite vigorous muscular activity. E.g. the backbone of the skeleton of a rat is bridge like arch which suspends organ of the body.

Structure of bones and support

- Bones must be hard enough to withstand knocks and strong enough not to bend or break.
- They need also to be light for them to move.

❖ Protection – certain delicate organs are protected in a casing of bones. The brain, heart, lungs, liver, reproductive of the female are protected by the skeleton from distortion due to pressure or injury resulting from impact.

❖ Movement – bones act as levers. When muscles pull on these levers, they produce movement such as chewing action of the jaws, breathing movements of the ribs and the flexing of the arms. Locomotion is movement of a mammal from place to place to find food.

❖ Muscle attachment – the muscles must be attached to the limb bones at one end in order to produce movement but, in addition have a rigid attachment at the other so that only one part of the limb moves when muscles contract. Bones have projections or ridges where muscles are attached.

❖ Production of cells- red and white blood cells are made in the red marrow of some bones such as long bones, ribs, sternum and hip bones.

❖ Storage-storage of minerals such as calcium and phosphorus and they are important for transmission of nerve impulses.

The bones of the hind limb

- At the hip there is a thighbone (femur) which is attached at the pelvic girdle by the ball and socket joint. See Fig 24.5(b).
- The pelvic girdle protects organs fron injury.
- At the knee, the femur makes a hinge joint with tibia (lower leg bone). See Fig 24.4.
- The fibula runs parallel to the tibia.
- Hence, the hind limb consists pf the fumur, patella, fibula,, tibia, 7 tarsals, 5 metatarsals and 14 phalanges.

The bones of fore limb (arms)

- The forelimbs are attached to the pectoral girdle. The pectoral girdle is made up of scapula and clavcle.
- Humerus is the upper arm bone which is attached by the ball and socket to the shoulder blade.
- Humerus is attached at the elbow by the hinge joint to the lower arm bones.
- The radius and ulna can partly rotate round each other so that the hand can be held palm up and palm down. See Plate 32.
- Therefore, the forelimbs are made up of femur, ulna, radius, 8 carpal bones that form the wrist, 5 metacarpal bones forming the palm of the hand and 14 phalanges forming the fingers.

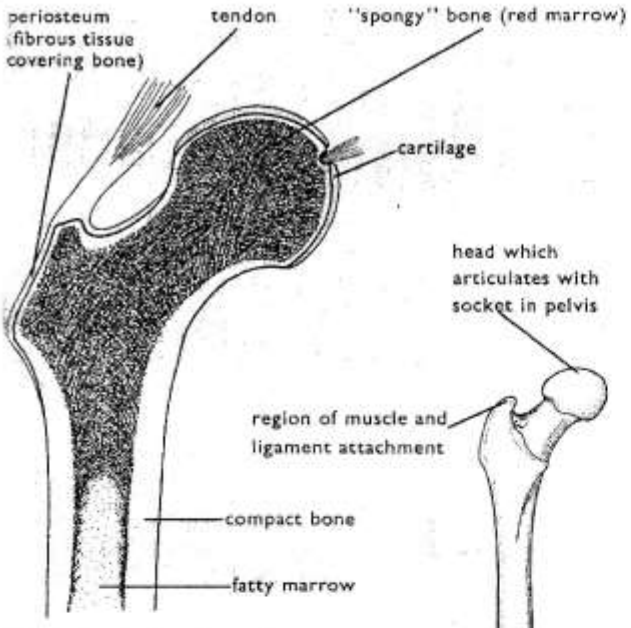
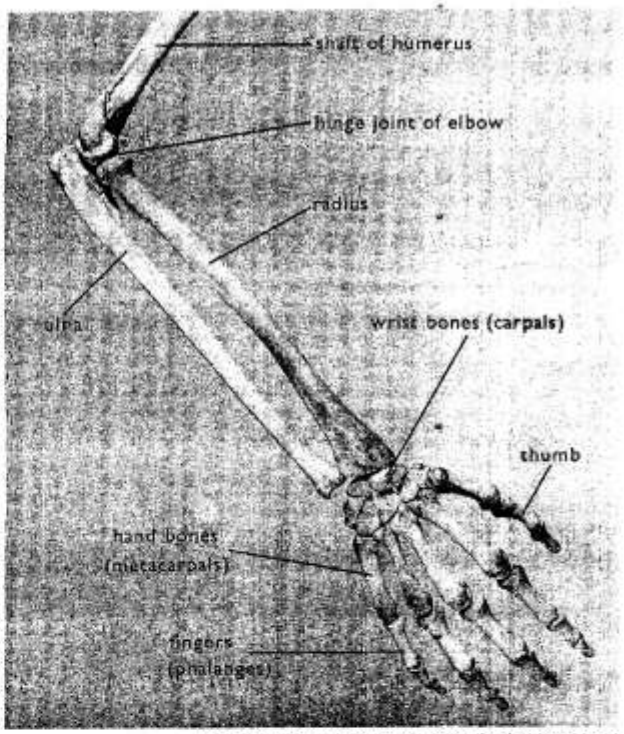


Fig. 24.2 Section through head of femur

Fig. 24.3 Femur



(From The Human Skeleton, Rank Audio Visual Ltd.)

Plate 32. SKELETON OF THE FOREARM

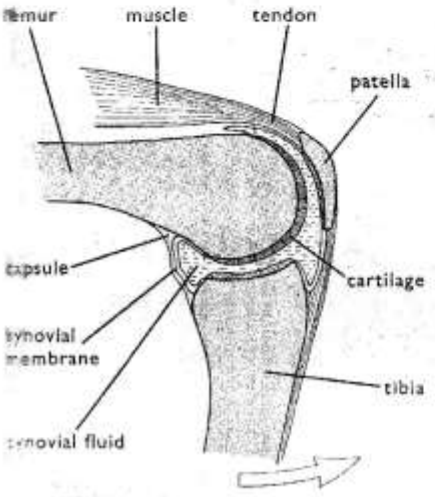
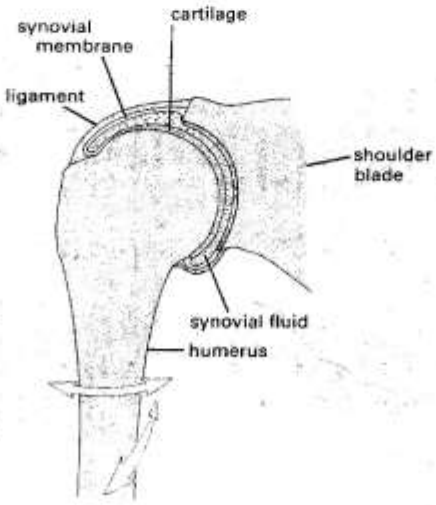
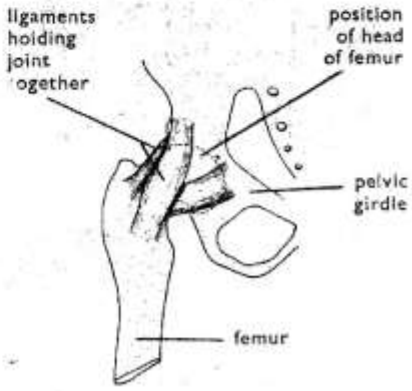


Fig. 24.4 Hinge joint of knee (section)



(a) SHOULDER



(b) HIP

Fig. 24.5 Ball and socket joints

Joints are points at which bones move against each other.

Types of Joints

- ✓ Immoveable / Suture – provide strength and support for the body for protection of delicate organs e.g. the skull, pelvic girdle.
- ✓ Partially moveable

  (a) gliding joints – they are separated by cartilages. These are joints between vertebrates wrist. The bones glide over each other to a limited extent. It provides wide range of movement and also strengthens the limb.

  (b) Swerved / rotating joint – is a joint between atlas and axis. It permits shacking of hands, head from side to side.
- ✓ Freely moveable / synovial joint – they are articulating bone surfaces which are covered by cartilage and separated each other by synovial cavity containing synovial fluid.
- ✓ Hinge joint – found on the elbow, knee and finger. Permits movement in one plane about an axis capable of bearing heavy load. See Fig 24.4 and Plate 32.
- ✓ Ball and socket joints – it is found on shoulder and hip. Permits movement in all directions. Unable to bear heavy loads [See Fig 24.5 (a) and (b)].

Parts and functions of synovial joints

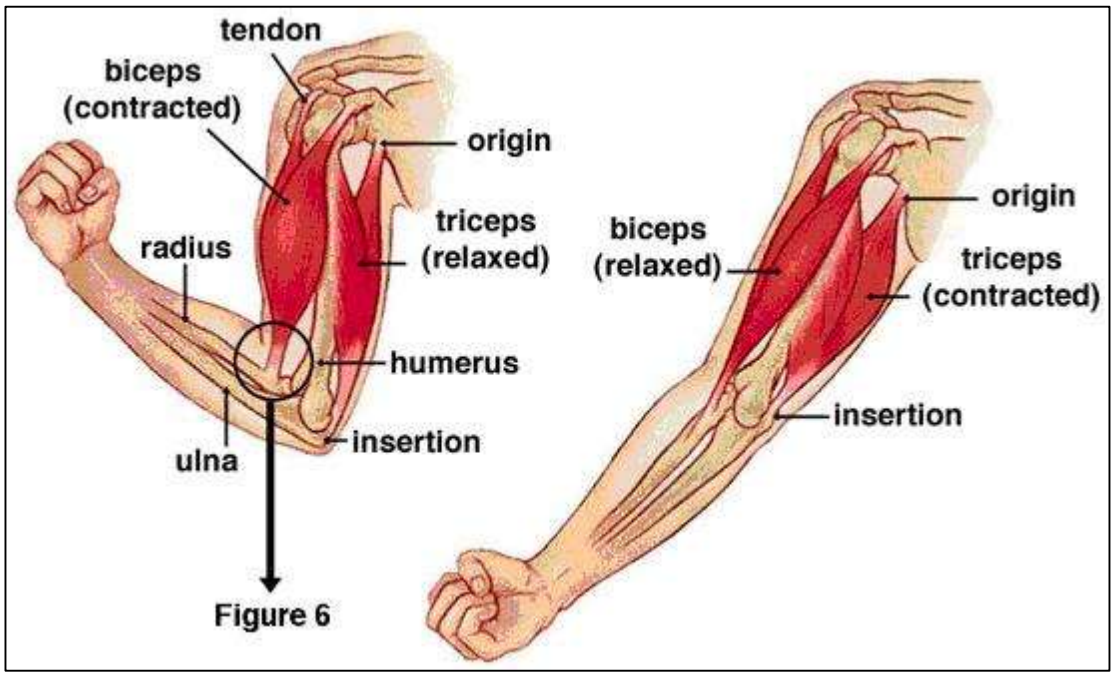
- ➢ Cartilages reduces friction between the bones.
- ➢ Synovial fluid allows friction – free movement. It is a lubricating fluid.
- ➢ Ligaments are fibrous bands which hold bones and prevents dislocation during normal movement. Synovial membrane secrets the synovial fluid.

Structure of muscles

- Are attached to bones and responsible for voluntary movement such as running and bending your arm.
- Voluntary muscles are made up of cells called muscle fibres.
- Are attached to bones by **tendons.**
- Muscles need a lot of energy released in the mitochondria during respiration.

Action of antagonistic muscles

- When stimulated, muscles contract get shorter).
- The biceps and triceps are antagonistic muscles - they have opposite effects when they contract.
- The biceps is attached to the scapula (shoulder blade) and the radius.
- Contraction of the biceps pulls on the radius, moving the lower arm toward the scapula.
- This results in the arm bending (flexing) at the below - the arm is raised.
- The triceps is attached to the scapula, humerus and ulna.
- Contractions of the triceps pull on the ulna, straightening (extending) the arm.
- In doing so, the triceps pulls the biceps back to its original lengths.
- Each movement of the finger toe and each movement of the jaw when chewing is controlled by a set of antagonistic muscles


tendon
biceps
(contracted)
origin
triceps
(relaxed)
radius
humerus
insertion
ulna
biceps
(relaxed)
origin
triceps
(contracted)
insertion
Figure 6

FORM 4 TERM 2
TOPIC 6
MICROBIOLOGY AND BIOTECHNOLOGY

Recombinant Gene Technology

- Refers to a DNA molecule that incorporates DNA from more than one species of organism.
- Also termed genetic engineering.

Genetic engineering

- Changing the genetic material of an organism by removing, changing and inserting individual genes.

Application of genetic engineering

- Medical – In the production of insulin (for people with type 1 diabetes)
- Human growth hormone which is used to treat people who are abnormally short.
- Agriculture – For crop plants to get resistant towards pests and diseases, for dairy cows to produce more milk.
- Hormones for women who struggles to become pregnant.
- For rice to produce more vitamin A (so that people with severe vitamin A deficiency can be cured).

Production of insulin

- Insulin is a polypeptide hormone which reduces blood sugar levels.
- Causes cells, especially muscle and fat cells to absorb glucose from the blood.
- Is essential for supply of energy to the body cells.
- Insulin is produced in the pancreas, pancreas failure will lead to diabetes.
- Traditionally was produced from pancreas of pigs and cows by extraction and chromatographic methods and however was unavailable in to human body cells.
- Insulin can be produced by recombinant DNA Technology for use in people with diabetes.
- This insulin can be produced in large quantities or amounts and is less likely to cause allergic reactions when administered to patients.

Production of human insulin using Recombinant DNA

- Some human cells are liquidised.
- The DNA is made to precipitate by addition of chemicals.
- Restriction enzymes are added to cut the DNA into pieces with specific length.
- Human DNA with sticky ends are formed.
- Simultaneously, restriction enzyme is used again to cut the plasmid(s) DNA
- Again DNA with sticky ends forms.
- Both the sticky ends are complementary (similar) to each other.
- Using ligase enzyme, the human gene for insulin and the plasmid DNA are joined.
- The plasmid acts as a vector putting the human insulin gene into a bacterium.
- This forms a genetically engineered bacteria.
- The genetically engineered bacteria are grown in a fermenter.

- They reproduce asexually and make human insulin.
- The insulin is filtered and purified and used.

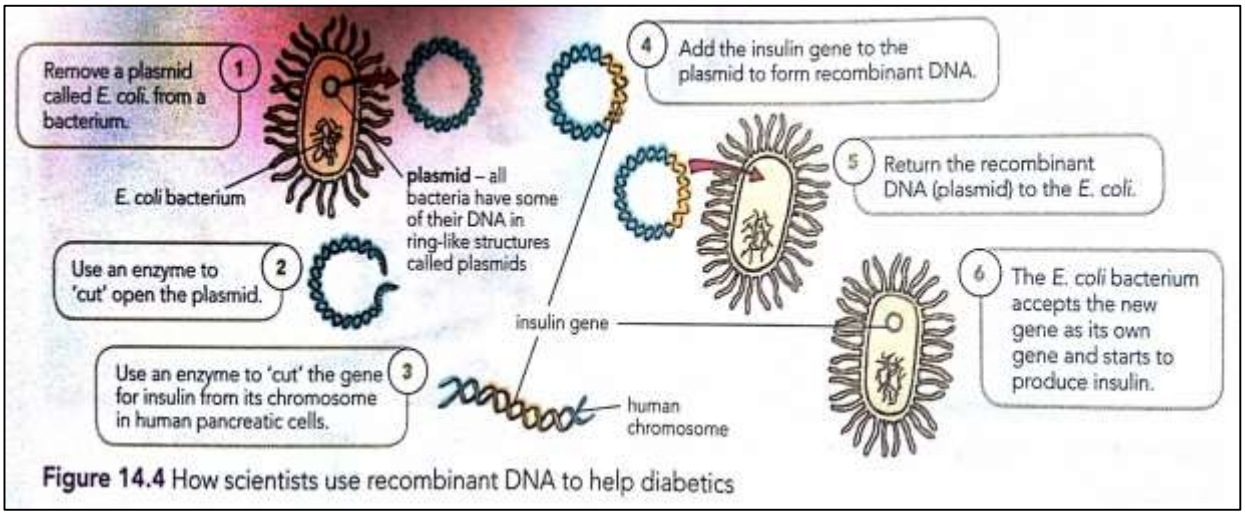


Figure 14.4 How scientists use recombinant DNA to help diabetics

Advantages of Recombinant Gene Technology

- Crop improvement for example development of plants that are resistant to pests, diseases and even drought.
- Production of human insulin which is safer, with no allergic reactions.
- Production of vaccines.
- Produces animals like cows for better milk or meat.
- Improvement of fermentation and industrial processes.

Disadvantages of Recombinant Gene Technology

- Destruction of native species in areas Genetically Modified Species are introduced.
- Recombinant organisms contaminating the natural environment.
- Plants from recombinant DNA are vulnerable to a single disease or pest.
- GMOs are perceived to have negative impacts on health.

TOPIC 7

GENETICS

Variation

- It means differences between organisms with reference to a specific characteristic.
- Individual of the same species may look similar to one another but often show variation in many aspects of their appearance e.g. range in height, from very tall to very short.
- Plants of the same species or kind can vary greatly in appearance, productivity and drought resistance etc.

Forms/Types of Variation

Continuous/environmental variation

- Shows a gradual range of differences between organisms and is due to interactions between the environment and the gene make up of an organism. E.g. (i) a person may have the genes required for tallness but if they are malnourished they may not grow to their potential full height.
- Examples include Size of leaves, height, weight/mass, number of seeds in pods etc.

Activity1: Measuring shoe size or height of pupils (form 4). Pupils to construct a graph showing continuous variation, in groups of five or six.

Discontinuous /genetic variation.

- This shows clear cut differences with no intermediates between the individuals that there have characteristics.
- Discontinuous variation is genetically determined. It is not usually affected by environment. Examples includes colour of maize, tongue rolling, blood group, sex etc.

Activity 2: Construct a graph showing discontinuous variation i.e. gender in the class or tongue rolling and non-tongue rolling.

Factors that cause variations

Genetic factors – these are due to in-built mechanism and they are genetic and heritable. These variations result when new mixtures of genes occur during sexual reproduction.

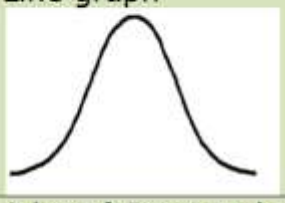
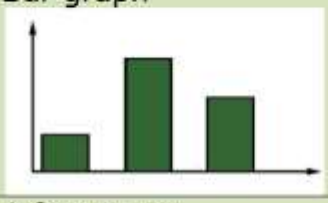
Environmental factors – there are due to environmental differences of organisms. They are non-heritable or cannot be passed from one generation to the other.

Causes of variation

Cause	Notes
Mutation	Mutation is the change in the base sequence in the DNA. In meiosis, homologous chromosomes exchange genes and separate from one another.
Meiosis	Thus the genes formed are not exactly the same. When two haploid gametes fuse together and form a zygote, an organism that is completely different from its parents (in terms of genotype) is born.

Fertilisation	This is why every person born is genetically unique! (I am sure you are as well unless you have a twin!)

Summary

	Continuous variation	Discontinuous variation
Properties	- No distinct categories - No limit on the value - Tends to be quantitative	- Distinct categories. - No in-between categories - Tends to be qualitative
Examples	• height • weight • heart rate • finger length • leaf length	• tongue rolling • finger prints • eye colour • blood groups
Representation	Line graph 	Bar graph 
Controlled by	A lot of Gene and environment → range of phenotypes between 2 extremes, e.g. height in humans.	A few genes → limited number of phenotypes with no intermediates e.g. A, B, AB and O blood groups in humans

Selection

- Is a process of perpetuating desirable organisms, while undesirable ones die out of a population.
- The fact that variations either small or marked do occur and can be passed on to offspring provides a mechanism for a species population to change.
- Plants that are better able to resist certain diseases and to tolerate drought may be produced. They will have been selected for by nature to survive better in unfavourable conditions.

Types of selection

Natural selection

Used to describe the effect of the environment on the survival of organisms. Organisms that are better adapted to any changes in the environment will survive and pass on their genetic make up to the next generation.

Natural selection arises because:-

- Organisms produce large numbers of offspring that show variations
- Many offspring die and only some offspring survive to breed.
- These individuals who do reach their reproductive potential are usually stronger, more resistant to diseases etc and it is these characteristics that they pass on in their genes to their offspring.
- Natural selection is therefore a result of a sequence of events which involve a large number of off springs being produced and these show differences, only the fittest survive.

Artificial selection

Man influence breeding of plants and animals by choosing the parent stock, keeping seed from the best.

Applications of artificial selection

- ❖ Artificial selection has now become more complex. It can involve the transfer of a selection of a gene into another organism of different species in the processes of genetic engineering.
- ❖ For example genes for resistance to disease can be identified in plant species and transferred into the cells of different plant species so that they also develop resistance to diseases.
- ❖ Other examples of genetic engineering include genes for tolerance to drought, high yields of fruit, high yields of milk and meat etc.
- ❖ Increase grain size in cereal crops for example maize.

Stages involved in artificial selection

1. Choosing individulas with disirable features.
2. Crossing the breeds to produce next generation.
3. Select offspring that show good feature to breed together.

Breeding

- ✓ It is the production of off springs.
- ✓ It is practiced in Zimbabwe mostly in cattle and maize production.
- ✓ There are two types of breeding considered.

Cross /out breeding

- ✓ Is the mating of two different but pure strains of organisms with a view to combining the good qualities of the organisms.
- ✓ Animals of different breeds that have good qualities are sometimes cross-bred to obtain the best from both breeds.

Advantages

a. Desirable characteristic are produced. The cattle will be worth more money and provide good breeding stock for future generation.
b. Improvement of genetically controlled characteristics.
c. Improved quality.
d. Increased productivity.

Disadvantages

a) Appearance of undesirable characteristics or lethal genes.
b) Predominance of the same variety with no new characteristics appearing and therefore loss of variety.
c) Takes tins because of need for through research.
d) Requires a lot of materials and finance resources for its success.

Inbreeding / line breeding

It is the mating of closely related animals.

Advantages

-Good qualities of an organism are maintained from one generation to the next.

Disadvantages

a) It is less productive.
b) Variation is reduced.
c) Undesirable characteristics increase.
d) Natural selection is reduced.
e) Adaptation to the environment is also reduced.

TOPIC 8
BIODIVERSITY

Biodiversity

- Is the variety of life on Earth, it includes plant and animal species, their genetic variation and ecosystem they form.

Three levels of biodiversity are— genetic, species and ecosystem diversity.

1. Genetic diversity is all the different genes contained in all the living species, including individual plants, animals, fungi, and microorganisms.

2. Species diversity is all the different species, as well as the differences within and between different species.

Species Richness is the total count/number of species in a defined area.

Species Abundance is the relative numbers among species.

3. Ecosystem diversity is all the different habitats, biological communities and ecological processes, as well as variation within individual ecosystems.

Threats to Biodiversity

Deforestation

- Why are forests important?
- What are the causes and effects of defoestation?
- How can it be controlled?

Invasive/ alien species

- List some invasive species found in Zimbabwe.
- What are the effects and measures to alien species?

Habitat destruction

What are the causes of habitat destruction?

- Urbanisation.
- Deforestation.
- Monoculture and overstocking.

Climate change

- Define climate change.
- What are the causes and effects of climate change?
- State ways to curb climate change.

Pollution

- Define pollution.
- State all forms of pollution and their causes,
- Suggest effects of pollution and control measures.

The need for conservation of species

- Many species of animals and plants are in danger of extinction, due to factors such as habitat destruction, the introduction of other species, international trade and pollution.
- Loss of a species also means that its genes are lost: these may be important in the future for genetic engineering (e.g. to improve crops) and the production of useful chemicals such as medicines.
- The presence of rare species can be an important source of money for poor communities, through tourism.
- The species may play an important role in a food chain: its loss could endanger other species.

Ways of conserving biodiversity

Conservation - is the sustainable use of resources and encompasses protection as well as exploitation and;
Preservation - is an aspect of conservation meaning to keep something without altering or changing it.

- Initiating laws to protect them.
- Afforestation.
- Use of alternative sources of energy.
- Reuse, reduce and recycle of materials- why is recycling importany to a country?
- Using methods such as captive breeding and re-introduction
- Controlling human activity such as hunting, poaching, deforestation, etc.
- Appointing forest guards to ensure the animals are not poached illegally.
- Setting up seed banks where the seeds of millions of plant species are stored
- Increasing focus on the implementation of Multilateral Environmental Agreements related to biodiversity such as:
  a. The Convention on Biological Diversity (CBD).
  b. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
  c. The Convention on Migratory Species (CMS).
  d. The Ramsar Convention on Wetlands and
  e. The World Heritage Convention.
- Increasing "Communication, Education and Public Awareness" (CEPA) programmes related to biodiversity with an aim to relate biodiversity to people and their livelihoods.
- Ensuring local people benefit from the conservation of the biodiversity around them.
- Protected areas / National parks- increased tracking systems **using GIS and remote sensing**.
- Ecosystem restoration.
- Sustainable intensification of agriculture.
- Sustainable use of resourses.
- Slowing and adapting to climate change.

TOPIC 9

ECOSYSTEMS

Management of ecosystems

Ground cover

Ground cover takes the form of natural litter, artificially applied mulching and cover of ground by ground level plants and taller trees.

Advantages of ground cover

- ✓ Increases water holding capacity.
- ✓ Decreases evaporation of water from soil.
- ✓ Improves humus content.
- ✓ Improves soil fertility and texture.
- ✓ Reduces weed growth and reduces soil composition.
- ✓ Adds to the organic matter.
- ✓ Helps entry of water into the soil.
- ✓ Helps reducing water run-off

Effects of human activity in ecosystems

-Agriculture, industrial, mining and social pressures on ecosystemscauses:

- ✓ Soil inferility
- ✓ Soil erosion.
- ✓ Desertification.
- ✓ Reduced bio-diversity.
- ✓ Overgrazing.
- ✓ Eutrophication. Define the term. (4)
- ✓ Pollution which can cause acid rain and global warming or greenhouse effect.

Qn: Suggest measures to the harmful human activities mentioned above. [6]

- Good farming practices or methods.
- Use of technological methods such as irrigation.
- Providing training, information and support.mixed cropping and intercropping.
- Provide good quality water for irrigation.
- Organic farming and pest control to avoid use of pestcides and other chemicals.

Carrying capacity

It is the maximum number of animals which can be sustained by an area of land without damaging it. Plant biomass determines the carrying capacity. The limiting factors are oxygen, food, water, space and shelter.

Effects of exceeding carrying capacity

- ✓ It results in overstocking which in turn causes overgrazing and deterioration of veld.

- ✓ Soil erosion.
- ✓ Diseases.
- ✓ Pollution and ecosystem degradation.

Ways of maintaining and controlling animal populations within carrying capacity of a habitat.

- ✓ Culling – killing of animals to maintain carrying capacity.
- ✓ Destocking – reducing numbers to sustainable levels.
- ✓ Paddocking – keeping animals in paddocks and rotating them accordingly

TOPIC 10

HEALTH AND DISEASES

Drug Uses and Abuse

Drugs

A drug is any substance taken into the body that modifies or affects chemical reactions in the body is called as a drug.

Medical use of drugs

- Medical drugs are used to help prevent or cure a disease or infection. These include painkillers, antiseptics, antibiotics, sedatives and even contraceptives.

Antibiotics

- Antibiotics like penicillin are chemicals that kill bacteria by destroying their cell walls. They do not hurt body cells when doing so.
- They are very useful for killing bacteria unless they are used intensively (as intensive use exerts a selection pressure upon them, causing the bacteria to get resistant to them)
- However, they are useless against viruses as viruses don't have cell walls! So next time you have a cold or 'flu they won't be any use.

Qn 1 a. What are analgesics? [2]

b. Give examples of analgesics. [4]

Anti-malarial drugs

- Are called antimalarials for example chloroquine and paludrine.
- Are used to prevent or cure malaria

Alcohol and Alcoholism

Alcohol is a very commonly used drug as people enjoy its effect on the body. It helps them get rid of their woes and worries and boosts their ability to interact socially with people.

However, it has a many drawbacks as well:

1. Alcohol lengthens reaction time: which means that it acts like a depressant and slows down the metabolic reactions in the body. This can be very risky during situations when people drink and drive.
2. Alcohol can boost aggression in some people: Intake of alcohol can cause a person to succumb to committing crimes and being violent with family members.
3. Enormous volumes of alcohol consumption can kill: Alcohol is like a poison; it can be life threatening if a person consumes alcohol in huge volumes, resulting in ecstasy, excitement, confusion, stupor, coma and even death.

Alcoholism

Alcoholism is a disease where a person gets addicted to alcohol. Alcoholics drink huge volumes of alcohol regularly.

Effects of alcohol consumption

- Liver cirrhosis: Alcohol is poisonous to cells and can damage them. One such example is the liver which has the task of breaking it down. In liver cirrhosis, fibres grow inside the liver. This can be fatal.
- Brain damage: Alcohol consumption can also cause loss of memory and a lot of confusion.
- Alcohol in the body fluids draws water out of the cells through osmosis:

  a) When this happens with the brain cells, they get irreversibly damaged.
  b) This damage gets worse when alcohol prohibits the secretion of a hormone that is responsible in the re-absorption of water. This causes too much of urine to be produced in a dilute form, resulting in low water levels in the blood.

Tobacco smoking

The main components of tobacco are carbon monoxide, nicotine, tar and carbon particulates

Effects of Carbon monoxide

- Carbon monoxide is also known as the silent killer as it is a poisonous gas.
- It reduces oxygen carrying capacity of the blood.
- It gets into the alveoli of our lungs and diffuses into the red blood cells.
- In the RBC, it interferes with the haemoglobin and slowly starts to decrease the volume of oxygen each cell carries.
- This is why smokers experience breathlessness.

Effects of Nicotine

- Nicotine is addictive
- It is also a stimulant (a substance that makes the person feel more alert)
- Nicotine damages the circulatory system
- It makes the smoker's blood vessels to get narrower
- This can cause an increase in blood pressure
- And finally, cause hypertension
- Nicotine is the substance behind Coronary Heart Disease.

Effects of Tar

- Tar contains many different chemicals such as carcinogens
- Carcinogens are substances that cause cancer
- These substances cause unusual behaviour in the cells inside respiratory passages.
- This can lead to the formation of a tumour.

- If the tumour is malignant, then it can cause cancer by breaking away from the cell and dividing uncontrollably.
- This causes lung cancer.
- Along with lung cancer, there are many other components in tar that can cause different types of cancers to the smoker.

Effects of carbon particulates

- Carbon particulates are tiny smoke particles that get into the smoker's lungs.
- Soon they travel through respiratory passages and reach the alveoli
- The alveolar walls are extremely delicate and when these smoke particles get stuck in them, WBCs try to eradicate them by secreting chemicals.
- While the chemicals remove the smoke particles, they also damage the delicate alveolar walls.
- This leads to Chronic Obstructive Pulmonary Disease (COPD)
- It causes the surface area of the lungs to decrease and thus decreases the efficiency of obtaining oxygen.
- The person is said to have emphysema.
- A person with emphysema is forced to be less active to such an extent that they may not have the energy to even walk.

Other effects of smoking

When the chemicals present in cigarette smoke enter the circulatory system, they:

1. Decrease the number of cilia.
2. Decrease the efficiency of the remaining cilia.
3. Increase the production of mucus in goblet cells.
4. Change the direction in which the mucus flows.
5. Encourage the growth of bacteria in the mucus.
6. Cause mucus to get trapped inside lungs.
7. Decrease the efficiency of gas exchange.
8. Decrease the rate of diffusion of oxygen and carbon dioxide.
9. Cause long term infections in the lungs and bronchi.
10. Cause chronic bronchitis.

Addictive means that it makes the person dependent on it

Depressant means that it slows down the functions of the brain and the hypothalamus hence slow down reactions.

Smoking and Coronary Heart Disease

- Smoking can cause coronary heart disease by developing a high blood pressure.
- These activities are done by a component in cigarette called nicotine.
- Nicotine damages the circulatory system.
- It also makes blood vessels narrower.
- Moreover, nicotine decreases the elasticity of arteries, disabling them to stretch and recoil much.
- Smoking also increases the probability of a blood clot being formed in the coronary artery.

Mandrax and Cannabis

- It is a hallucinogen drug and was prescribed as a sleeping pill. It is now banned.
- These drugs play tricks on the brain and alter the bahaviour after one takes them.
- Mandrax is illegal and addictive drug.
- Cannabis is another dangerous drug.
- Sniffing of solvents and glues is a problem and as a result one lose self-control, damage muscles of the body and heart and causes addiction.

FORM 4 TERM 3

REVISION

Revision

- 4025 Paper 1

  Paper 2

  Paper 3

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