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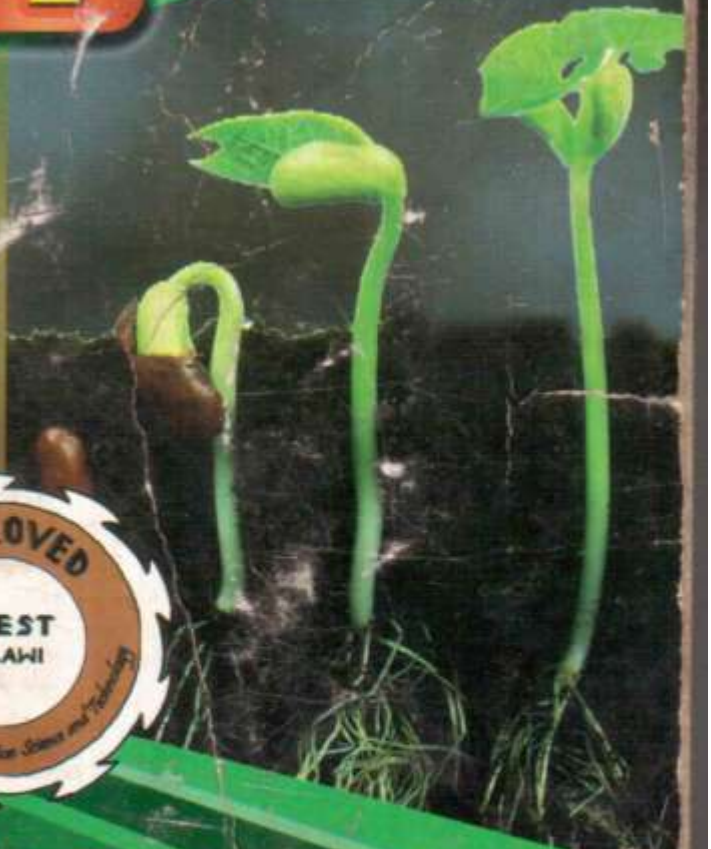
Junior Secondary Biology

Form 1



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Junior Secondary

Biology

Form 1

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Table of Content

Unit 1

Research skills

Success criteria

By the end of the unit,the student must be able to:

(a) Define Biology.

(b) State the importance of biology.

(c) Use apparatus safely.

(d) Describe apparatus and specimen using well labelled diagrams.

(e) Record measurements accurately.

(f) Summarise information from books in form of tables, flow diagrams and notes.

Introduction to Biology

Biology is the science that involves the study of living things. The word 'Biology' comes from Greek words bios (which means life) and logos (which means knowledge). Therefore, Biology means the knowledge of life.

People who study Biology are called Biologists. They carry out the study by doing experiments. The outcomes of these experiments are called experimental results. Biologists then make conclusions using the results they obtain. A study that goes through a process of experimentation is called a scientific study. Research skills are necessary during a scientific study.

Importance of studying Biology

The study of Biology is important because it enables us to do the following:

- To understand our bodies better by understanding the structure of our body parts and how they work.
- To identify the living things that can cause diseases and learn how to prevent and control these diseases in order to maintain good health.
- To learn how to take care of living things important to our lives such as trees, insects, birds and other animals like goats. In this way, we can conserve them for future use.
- To manage and take care of our environment better. This is by conserving soil, water and reducing pollution.
- To acquire knowledge that can be applied in personal hygiene, food preservation, proper nutrition and to carry out First Aid when accidents happen at home.
- To acquire knowledge and skills on HIV and AIDS. We get to learn what HIV and AIDS is, what causes it, how it spreads and how to prevent and control its spread. This knowledge can then be used to promote positive attitudes and values that can help reduce the spread of the disease.
- To teach us how to improve agricultural yields through use of new methods of farming.
- To study other science related fields for example, agriculture, medicine, veterinary, forestry and pharmacy.
- To acquire knowledge that makes

us understand the effects of drug and substance abuse in our bodies for example, glue sniffing, smoking *chamba* and the importance of avoiding activities that can lead us to drug addiction.

- To get into careers such as medicine.

Research skills

The knowledge of Biology helps in understanding why things are the way they are.

During research we use experiments and investigations to obtain information. The method tests whether given information is true. It also ensures that the results obtained are the same if the investigation is repeated by someone else or in another place.

Investigative techniques

Investigative techniques involve carrying out experiments through research. When carrying out experiments it is important to ensure safety for you and your classmates.

Introduction

In this section we will learn about safety measures, risk factors and handling of accidents. We will also compile safety rules for the laboratory and the classroom. We will also identify various scientific apparatus and discuss their uses.

Safety measures

Safety is a condition whereby an individual is free of danger or injury. Biology is a science that involves use of experiments. These experiments are carried out either inside or outside the classroom or in a special room called a laboratory. The science laboratory contains equipment, apparatus, materials and chemicals used in carrying out experiments.

In a science laboratory, activities are carried out using apparatus. These activities include cutting, burning, catching of organisms, washing of apparatus, among others. These activities can be risky when carrying out investigations.

Using glassware safely

Glassware, in Biology, are all the items used in the laboratory that are made of glass. Examples include test tubes, beakers, pipettes, measuring cylinders and volumetric flasks. All glassware is breakable and requires special handling.

Rules of using glassware safely in the laboratory

1. Laboratory glassware must not be used for food or drink.
2. Hot substances such as hot acids should not be put inside glassware.
3. Glassware should be well fastened to racks, ring stands or retort/clamp to prevent them from falling and breaking.
4. Glassware should not be stored together with metals. Metals may scratch and break the glassware.
5. At no time should you hold a hot beaker by the rim, instead use beaker tongs to remove the hot beaker from the heat.
6. Whenever possible, support round bottom flasks with cork rings and stopper openings to prevent them from rolling over.
7. Provide enough space between glassware during storage to prevent

them from vibrating and breaking each other.

8. During movement, place cushioning material between the glassware.
9. When heating substances, use glassware that are specifically made for heating. Avoid using any other glassware because the heat may break them.

Safety during heating

In the laboratory substances should be heated using a Bunsen burner or any other form of heating. When heating make sure that the mouth of the test-tube faces away from you and away from other students.

Fig. 1.1: Safe heating

- Always hold a test-tube or a boiling tube using a holder when heating. Do not hold it using your fingers.
- Do not dip hot tubes into water. This may make them to break.
- Always turn off the gas taps after conducting an experiment.
- Put off other burners, like stoves, after an experiment.

Safety when cutting specimens

Cutting is done by use of sharp razors or scalpels. Cut, specimens by placing the tips of fingers far from the cutting point. Also cut the specimen while placing it on a table and not on the palm.

Safety when handling live specimens

Biology investigations involve collection and handling of live specimens. Some specimens are poisonous and very dangerous. Such organisms include scorpions, spiders, wasps, crabs, centipedes among others. These animals should be handled with care. Some plant specimens are also poisonous and therefore, one need to be cautious when handling them. Use gloves to handle specimens with blood.

Safety signs in the laboratory

Supposing you are on the school field and you realise that it was about to rain, what would be the sign that would make you realise that it was about to rain? Probably, the presence of dark clouds and strong winds would. These are signs of rainfall. Also, suppose you were walking towards your home and you noticed thick clouds of smoke coming from a bush, what would this tell you? The smoke is a sign that the bush could be on fire. Have you ever seen the following symbol anywhere?

Below is an example of a warning sign. (A warning sign is a symbol used to indicate possible danger.)

Fig. 1.2: "No smoking" sign

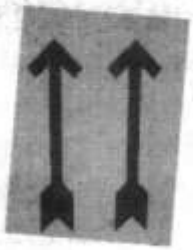
The sign is warning people not to smoke while in that particular area where the symbol is. In the laboratory, there are warning signs on various containers of

laboratory chemicals and apparatus. Some common laboratory warning signs are shown in the following table.

Table 1.1: Examples of laboratory warning signs and their meanings

Symbols	Warning	Meaning
	Electric shock	Can cause electric shock.
	Flammable	The material catches fire easily.
	Explosive	The material can explode easily.
	Corrosive	Handle the material carefully as it can cause corrosion or burning of skin.
	Irritant	Handle the material carefully as it can lead to irritation.
	Dangerous	Take care because it can cause death.
	Radioactive	Emits radiations or rays which are dangerous.
	Laser radiation	Beware of radiation waves.

Note: When certain laboratory apparatus are purchased, they are packed in carton boxes. The boxes have signs such as the ones shown below.



(a) The box should be kept upright.

(b) The box should not be held using hooks.

(c) The box should be kept away from rain or moisture.

(d) The box contains glassware or items that can easily break that is, they are fragile.

Fig 1.3: Warning signs

Note: A box may have one or more of the above signs.

Risk factors in a science laboratory

Risk factors in a science laboratory include the following:

(i) Burns as students use Bunsen burners, candles, paraffin lamps to burn or boil substances during investigations.

(ii) Poisoning as a result of contact with poisonous chemicals may used in the laboratory to carry out experiments. These chemicals include acids, bases, formalin, ethanol and some types of metals. The chemicals cause harm to humans when they come into contact with the body or when they are swallowed.

Handling of accidents

The most important rule in handling accidents in the school laboratory is to inform the teacher as soon as possible. The teacher will take correct measures to handle the accident.

In case of a fire break out in the lab, do not try to put it off, quietly move out of the room and help other students move out. Do not shout or scream as you move out. Do not block the other students from moving out.

In case of the smell of leaking gas in the laboratory, call the teacher immediately. Check all the gas taps to make sure they are closed. Ensure no open fire is burning in the laboratory.

In case of a cut when doing an experiment, do not touch the blood of the injured part. Pick the First Aid Box put on gloves and attend to the student. Contact with the blood of another person may lead to serious infections to you and also to the injured person.

Fig. 1.4: First Aid Box

In case an acid spills on your skin, do not wipe the skin, wash the acid off with lots of clean water. Do not rub the skin. Wash the skin until the itching stops.

In case of injury by a piece of broken glass, seek help from your teacher. Do not try to remove the piece. You may extend the injury.

In case of accidental swallowing of any chemical, do not take anything. Go to the teacher for attention as quickly as you can.

To be safe in the laboratory, one must follow the laboratory safety rules.

Laboratory or classroom rules

Laboratory rules are a set of instructions that ensure proper use of the laboratory facilities and safety to all laboratory users. The rules are placed on the notice board or on the walls of the laboratory. The following is a list of some laboratory rules.

1. Do not enter the laboratory without the permission of the teacher or the laboratory technician.
2. Do not run or rush into and within the laboratory.
3. Avoid unnecessary movement while in the laboratory.
4. Do not carry out any activity in the laboratory before getting permission from your teacher or laboratory technician.
5. Do not eat or taste or directly smell any substance that is in the laboratory including food substances brought into the laboratory for the purpose of experiments; not unless you are instructed to do so. Follow or seek the teacher's advice when smelling any gases, chemicals or substances in the laboratory.
6. Do not tamper with electrical or gas fittings in the laboratory.
7. Always turn off the gas and water taps after use.
8. Do not interfere with the experiments of other students.
9. Always check on the labels of reagents before using them and strictly follow the instructions given.
10. If a chemical gets into contact with the skin, wash the affected part with plenty of water thoroughly and then seek the assistance of the teacher.
11. Do not dispose hot materials into dustbins.
12. Always dispose of solid wastes for example remains of plants and fruits into a dustbin and not into the sinks.
13. Do not carry any laboratory item from the laboratory.
14. Always wash all the equipment and apparatus after using them for an experiment and store them well.
15. Do not mix substances in the laboratory before receiving instructions from the teacher or laboratory assistant.
16. Cut items carefully to avoid cutting onesself. Incase of a cut,

seek assistance from the teacher or laboratory technician.

17. Handle Biology specimens with care. They may carry disease-causing organisms.
18. Avoid shouting, joking or fooling around in the laboratory.
19. Cover your head if you have short hair when in the laboratory.

Scientific apparatus and their uses

Which apparatus are normally used in the kitchen at home? Probably pots, spoons, folks, fire burners, plates and bowls are used. In the same way, the Biology laboratory has important apparatus and equipment that are used to carry out various experiments.

These apparatus include the microscope, scalpels, Bunsen burners, boiling tubes, thermometers and various types of glassware. Carry out the following activity.

Activity 1.1:

To identify common Biology laboratory apparatus and equipment

Materials

- Test tubes
- Test tube holders
- Beakers
- Scalpels
- Pestle and mortar
- Droppers
- Cork and cork borers
- Microscope
- Dissecting kit
- Potometer
- Test tube racks
- Delivery tubes

Procedure

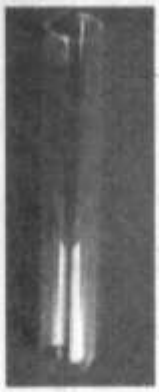
1. Examine each of the apparatus provided by the teacher.
2. Using instructions given by the teacher, identify each of the apparatus and state its use.

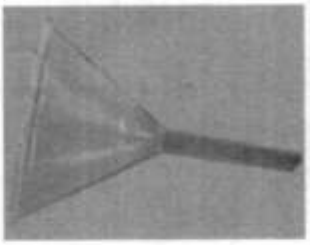
Discussion

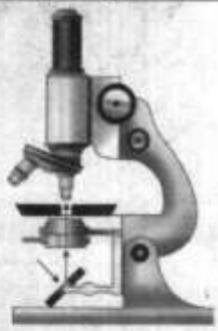
An equipment is a set of items assembled for a particular purpose. **Apparatus** is the particular equipment needed for a particular activity or purpose. The following table shows a list of apparatus and equipment found in a Biology laboratory and their uses.

Table 1.2: Laboratory apparatus and their uses

Apparatus/Equipment	Use
1. Hand lens	• To make objects look bigger (to magnify objects).
2. Test tubes	• For heating substances or holding liquids during reactions.
3. Ignition tubes	• Also for heating small substances and for other experiments.

Apparatus/Equipment	Use
4.  Boiling tubes	• For heating and carrying out experiments.
5. Test tube holders	• For holding test tubes during experiments.
6. Test tube rack	• For keeping the test tubes safely.
7.  Measuring cylinder	• For measuring liquids.
8. Thermometer	• For measuring temperature of different liquids.
9.  Conical flask	• For heating, mixing reagents and carrying out other experiments such as filtration.
10.  Ruler	• For measuring lengths of various things.
11. White tiles	• Provides white background to make clear observations.

Apparatus/Equipment	Use
12. Pestle and mortar	• For grinding simple materials.
13.  Beaker	• For measuring or holding liquid substances.
14. Spatula	• For scooping chemicals.
15. Tongs	• For holding hot substances.
16. Retort stand	• Holds other apparatus above the bench.
17.  Dropper	• For pouring chemicals and liquids drop by drop.
18.  Funnels	• For filtering substances and filling in liquid.
19. Cork borers	• For making cylindrical shapes such as of potatoes for experiments.
20. Scalpel	• For cutting.
21. Capillary tubes	• For testing capillarity.
22. Glass jars	• For preserving sample specimens.
23. Petri-dishes	• For keeping specimens during experiments.

24.  Bunsen burner	• For heating purposes.
25. Evaporating basins	• For evaporating liquids.
26. Crucible	• For strong heating of solids.
27. Filter funnel	• For supporting the filter paper.
28. Triple beam balances	• For weighing.
29.  Stop watches	• For timing.
30.  Weighing balance	• For weighing.
31.  Microscope	• For enlarging specimens
33.  Wash bottle	• For storing distilled water.

34.  Forceps	• For picking up dangerous small animals such as insects
34.  Specimen bottle	• For storing and preserving collected animals
35.  Hand lens	• For enlarging small animals to appear bigger than normal size
36.  Rubber bang	• These apparatus fit in delivery tubes during experiment to prevent gases or liquids from escaping out.

Activity 1.2:

To draw accurate diagrams of scientific apparatus

Materials

- Scientific apparatus such as beakers, measuring cylinders, the light microscope, Bunsen burner, crucibles, pestle and mortar, burettes, pipettes and specimen jars among others.
- Manilla papers and mark pens

Procedure

1. Examine the apparatus provided.
2. Using the guidelines learnt, make accurate drawings of each of the apparatus.

3. Using manila papers and mark pens, make large, well-labelled diagrams of the apparatus for display on the classroom walls.

How to use various laboratory apparatus

Biology experiments should be conducted using correct apparatus. The apparatus should also be handled properly to avoid breaking them.

Using microscopes

A **microscope** is an instrument that is used in the laboratory to magnify and observe organisms that are too tiny to be seen using an unaided eye.

There are two types of microscopes:

- Light microscope.
- Electron microscope.

The light microscope uses light to illuminate the objects and glass lenses to magnify the object. The electron microscope uses electromagnetic lenses to magnify the object.

The most commonly used in schools is the light microscope.

Study the diagram below of a light microscope and carry out the activity that follows.

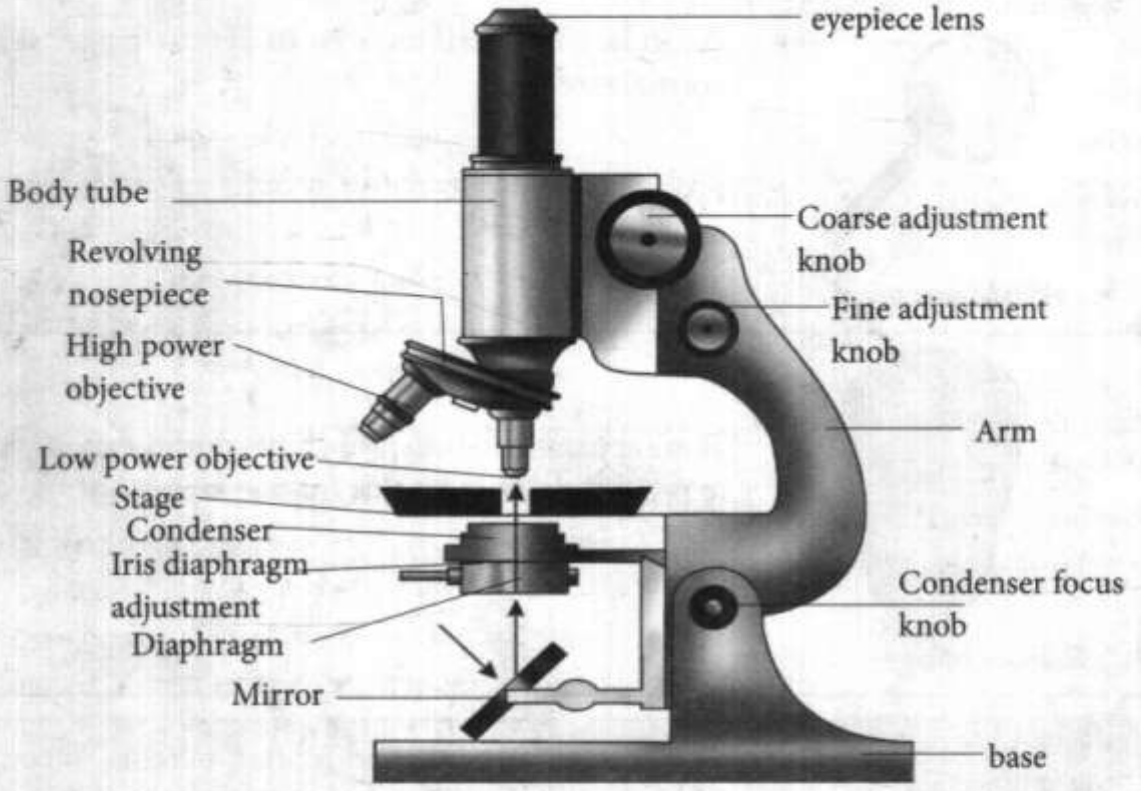


Fig. 1.5: Parts of the light microscope

To investigate the structure and parts of a microscope

Materials

- Microscopes
- Pencil
- Ruler
- Notebook

Procedure

1. Be in groups of about five students.
2. Look at the equipment you have in front of you. It is a light microscope.
3. Observe the different parts of the microscope. The teacher will guide you to give the names of the parts of this microscope. Use Fig.1.6 as a guide.

Questions

1. Draw the light microscope in your notebooks.
2. What are the functions of the parts that you have identified? What are the functions of the microscope?

Discussion

The following are the parts of a light microscope and their functions as seen in Activity 1.3.

Arm

- It supports the body tube. It is the part that you hold when carrying the microscope.
- Always carry the microscope in an upright position.

Base

- This is the lower, heavy part of the microscope.
- It rests on the bench and gives the microscope firm support and stability.

Eyepiece (or ocular lens)

- The eyepiece lens magnifies objects.
- The eyepiece is often unattached and may fall out unless the microscope is kept upright.
- It can be removed and replaced with an eyepiece lens of lower or higher magnification.

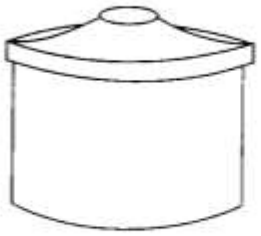


Fig. 1.6 : Eyepiece lens

- Microscopes have several inter-changeable lenses of different magnifications such as ×5, ×10, ×15.
- Eyepiece lenses are usually fitted into an opening at the top of the microscope.

The objective lens

- This is a magnifying lens.
- A microscope usually has three or four objective lenses.
- Their magnifications are generalised as **low power, medium power** and **high power** magnification.

The low power objective lens gives the smallest magnified image. Its magnification is usually written as ×10, ×15, ×20 or ×25. Low power objective is best used to view the whole microscopic organism. It is also easier to focus and use the microscope at low power objective lens..

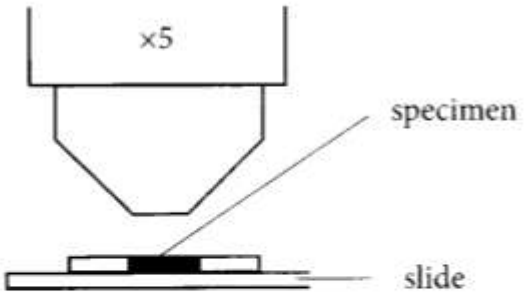


Fig. 1.7: Low power objective lens.

High power objective lens is best used to view detailed small part of the organism. It magnifies an object to ×40 or ×60 to give a larger image.

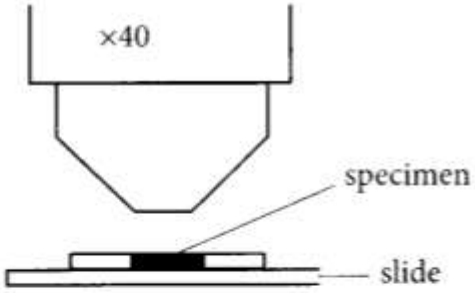


Fig. 1.8: High power objective lens.

Oil immersion objective lens is a high power objective lens of ×100 or ×125 where a drop of oil must be used with the lens. The drop of oil is placed on the slide and made to touch the objective lens.

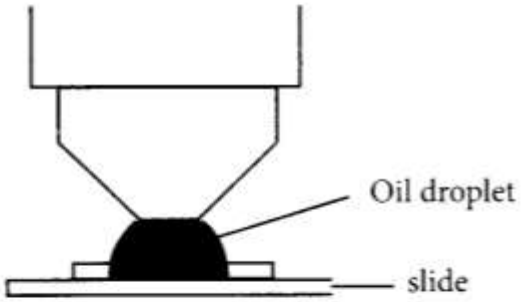


Fig. 1.9: Oil immersion objective lens.

Nosepiece

This is the part of a microscope to which the objective lenses are attached. It must be firmly clicked into position when the objective lens is changed. Mishandling can cause it to come off. Therefore, it should be handled with care.

Stage and clips

The stage is the flat surface onto which the microscope slide is placed. The stage has a hole so that light can pass through it to the specimen. The clips hold the slide in place.

The barrel or body tube

The barrel joins the nosepiece to the eyepiece lens. It is moved up and down by the coarse and fine adjustment knobs when focusing the image.

Coarse adjustment knob

The coarse adjustment knob moves the body tube (or stage in some microscopes) up and down to bring the specimen into focus. This knob is used with the low power objective. It is easy to see the tube moving when the knob is turned.

Fine adjustment knob

It moves the body tube (or stage) up and down to the right position so that the specimen is in sharp focus. It is used to achieve fine focus with the low power objective as well as the high power and oil immersion objectives. It is difficult to see the tube moving when this knob is turned.

Light source

The light source can be an electric bulb beneath the stage which is controlled by a push-button switch. In some microscopes, a mirror is used to reflect light from another source such as sunlight into the microscope. The light coming into the microscope lights up the specimen so that it can be seen.

Iris diaphragm

The iris diaphragm is used to control the amount of light passing through the hole in the stage and through the slide and specimen. This is done by adjusting the opening through which light passes.

Condenser (light director)

The condenser is a lens located above the diaphragm. It concentrates the light before it passes through the specimen. Its position is changed by a knob on microscopes in which it is adjustable.

Table 1.3: Summary of the various parts of a light microscope and their functions

Part	Description	Uses/functions
1. Eyepiece	• Uppermost part of the microscope. • It is made up of lenses fixed in a test tube like structure.	• Magnifies or enlarges the object under observation.
2. Body tube (Barrel)	• Holds the eye-piece on the upper side and nose-piece on the lower side.	• It enables up and down movement, lifting or lowering the lenses towards the object.
3. Coarse adjustment knob	• Rotating knob on the side of the arm.	• Used in lowering or raising the body tube. The movement of the tube gives a clear view of the image.
4. Fine adjustment knob	• Knob below or near the coarse adjustment knob.	• Used to bring the object into sharp focus.
5. Nose-piece	• Rotating part attached on the underside of the body tube.	• Used to select the objective lenses by placing the objective lens in line with the eye-piece and the object on stage.
6. Objective lens	• Lenses attached to revolving nose-piece. Are of three types: low, medium and high power lenses.	• Magnify the object. Low power lens magnifies the object 4-5 times, medium power lens 10 times and high power lens 60 or more times.
7. Stage	• Flat surface below the objective lens where the specimens are placed. • Has small holes at the centre to allow light from the condenser to pass to the object. • Has clips to hold the slides.	• Holds specimens on the slide. • Allows light from the condenser to pass to the object. • Holds slides in place.

Part	Description	Uses/functions
8. Condenser (light director)	• Made of lenses placed below the stage.	• It receives light from the source or mirror then concentrates the light to the specimen on stage.
9. Diaphragm	• Made of many small holes of different sizes.	• It controls the amount of light passing from the light source to the condenser.
10. Base	• Flat surface on which the microscope rests.	• It supports the microscope and all its other parts.
11. Arm	• It is the curved part of the microscope.	• It is used for holding the microscope when using or carrying it.

Use and care of the light microscope

Activity 1.4:

To handle and use the microscope

A. Lifting and carrying a microscope

Procedure

1. Hold the arm of the microscope with one hand.
2. Place the other hand at its base.
3. Lift the microscope while holding its base then transfer the microscope from one place to another. The figure below shows the correct way of carrying a microscope.

Fig. 1.10: How to carry a microscope

B. How to use a microscope

Materials

- Microscope
- Newsprint

Procedure

1. Place the microscope on the bench in front of you. The handle should be towards you. Make sure that the microscope is not at the edge of the bench.
2. Look into the eyepiece lens. What do you observe? Adjust the mirror below the stage so that light coming through the window falls on it and reflects it into the microscope stage.
3. Cut out a piece of newspaper print and place it on the stage. Hold it down with the clips. What do you observe? Can you read the print on the newspaper?
4. Rotate the revolving nosepiece until the low power objective lens clicks into position.
5. Lower the low power objective lens using the coarse adjustment knob. View all this from the side of the microscope.

6. Look into the eyepiece and keep adjusting the coarse adjustment knob until the print is visible. Very slowly use the fine adjustment knob to bring the print into sharp focus.

Additional points to note when using a microscope

1. Place the microscope on a bench, always in an upright position, with its arm towards you. Do not place it in bright sunlight to avoid too much light getting to the eye.
2. Use the iris diaphragm to increase or decrease the amount of light getting into the microscope from the light source. If the light is too much, it will be difficult to see details of the specimen.
3. Carefully mount the specimen on the microscope slide and cover it with a cover slip. Your teacher will provide the specimen or help you to prepare one.
4. Arrange the microscope slide on the stage so that the specimen is in the middle of the hole on the stage. Gently lower the stage clips to hold the slide in place.
5. Watch the slide from the side, and use the coarse adjustment knob to lower the body tube (or raise the stage) carefully until the end of the objective lens is about 2 mm above the cover slip. The lens should not touch the cover slip.
6. Look through the eyepiece lens. Keep both eyes open when looking through the eyepiece.
7. Turn the coarse adjustment knob slowly upwards, to raise the body tube or to increase the distance between the slide and the objective lens in order to focus the specimen. When focusing, do not move the body tube downwards. The objective lens could crush the slide and both may be damaged.
8. To examine the specimen under high power, rotate the nosepiece till the high power objective clicks into position. Again be careful that the objective lens does not touch the cover slip.
9. You may need to turn the fine adjustment knob slightly to get a better focus of the specimen.
10. **Never** use the coarse adjustment knob to focus specimens under high power objective. This is because the high power objective is too near the slide. It could damage the slide and the objective lens.

Field of view as seen with the light microscope

The ***field of view*** is the circular space in the microscope in which the image of the specimen is observed. It varies according to the magnification at which the specimen is viewed. Under low magnification power, the field of view is wider than under high magnification power.

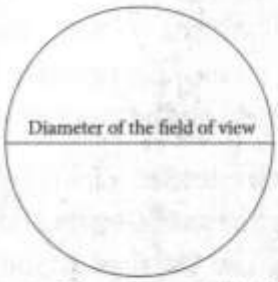
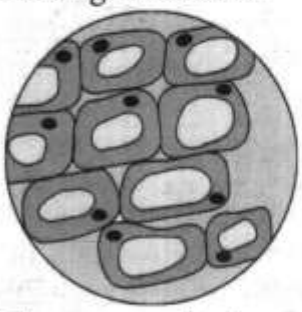


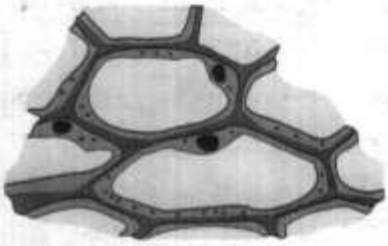
Fig. 1.11: Illustration of field of view

For example, if 25 plant cells are to be viewed under a microscope, all may be seen under low power magnification,

but only 10 of these may be seen at high power magnification. This is because at lower magnification, the cells are magnified less hence are smaller whereas under high power, the magnification is greater and the cells appear larger. As such, fewer cells are seen under high power. See the figures below.



(b) Cells as seen under low power magnification



(a) Cells as seen under high power magnification

Fig. 1.12: Cells as seen under low power and high power magnifications

Points to observe when using the microscope

A microscope is an expensive and delicate equipment that should be handled with care at all times. Read through the following rules. Remember to apply them when using the microscope.

1. Keep the lenses clean by carefully wiping them with special lens tissue. Do not use water or tissue paper. Do not touch the lenses with your fingers or allow them to get wet.
2. Never focus downwards when your eyes are looking through the eye piece lens. You could break slides and damage the objective lens.
3. Hold the microscope with two hands, one holding its arm and the other the base when moving it from one place to another.
4. To avoid eyestrain, learn to keep both eyes open when looking down the microscope.
5. Always cover the specimen with a cover slip and make sure the slides and cover slips are clean.
6. Avoid tilting the microscope. If you have a wet preparation on the slide, it could run off.
7. Always keep the stage of the microscope clean and dry.

Storing the microscope

It is important to store the microscope well after use. Follow the procedure below to prepare the microscope for storing.

1. Rotate the nosepiece to have the microscope under low power objective. **Never** store the microscope under high power objective lens.
2. Raise the body tube (or lower the stage) with the coarse adjustment knob so that the lenses cannot strike the stage accidentally.
3. Clean the oil immersion lens with xylene.
4. Clean all lenses with lens paper.
5. Turn off the light if using an electric microscope.

6. Cover the microscope with its cover. If there is no cover, improvise one to prevent accumulation of dust.
7. Pick up the microscope by its arm with one hand, support it under the base with the other hand, and return it to its storage box or cabinet.

There are other tools that are usually used together with the microscope. They include:

- Microscope slides
- Cover slips
- Lens papers

Microscope slides: These are rectangular pieces of glass on which the specimen is placed. The slide should always be cleaned before a specimen is placed on it. It is usually cleaned with water and dried using a lens tissue.

Fig. 1.13: A microscope slide.

Cover slip: This is a small, extremely thin and delicate piece of glass. It is used to cover the specimen placed on the slide.

Magnification power of a microscope is the ability of the microscope to enlarge specimens. However, a magnified specimen may not show finer details of the specimen. Therefore, the resolving power of a microscope is the ability of the microscope to distinguish between two close structures that would otherwise appear the same as separate objects.

Using a compound microscope both the eye piece lens and the objective lens magnification should be considered.

This is because in a compound microscope, the specimen is first magnified by the objective lens to form an image, which is again magnified by the eyepiece lens to give the final image.

When looking through the eyepiece lens and the objective lens, one multiplies the magnification of the two lens together, this is **eyepiece lens magnification × objective lens magnification = total magnification**.

For example, if the microscope has eyepiece lens of magnification × 10 and objective lens of magnification × 10 then total magnification is calculated as 10 times × 10 times = 100 times larger.

Most compound microscopes have several interchangeable objective lenses. This makes it possible to have a number of magnifications with the same microscope. Examples are given in table 1.4 below.

Table 1.4: Calculating magnification

Eyepiece lens magnification	Objective lens magnification	Total magnification
×10	×8	×80
×16	×10	×160
×25	×40	×1000

Using burners safely

Burners are used for heating substances when doing practical work. The most common burner used in the laboratory is a Bunsen burner. Other burners include spirit lamps and stoves. Burners come in a variety of designs and they operate on mixing Laboratory gas with oxygen in the air to form a hot flame. The parts of the Bunsen burner include; barrel, collar,

air intake openings, gas flow valve, gas intake tube and the base. The following figure shows a Bunsen burner.

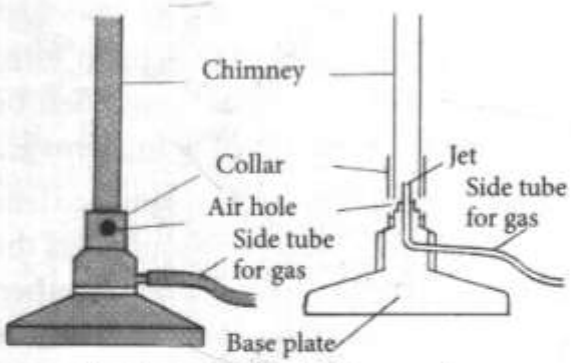


Fig. 1.14: Parts of a Bunsen burner

To use a burner safely you must be able to light the burner safely.

Procedure of lighting the burner

1. Connect the side tube hose to the table gas outlet.
2. Clear the table of any flammable material like hair and clothing.
3. Adjust the barrel so that the air intake openings are closed and then open the intake openings.
4. Open the gas valves on the table and light the burner.
5. Turn the barrel so that the flame is pale blue with a dark blue inner cone.
6. Set up the support stand, ring and wire screen.
7. Always allow the burner to cool before handling it after carrying out an experiment.

Safety measures when using a Bunsen burner

- Always turn off the gas taps after doing an experiment
- Incase you are using other burners like stoves, make sure they are put off after an experiment.

Activity 1.5:

To light the Bunsen burner

Materials

- Bunsen burner and a lighter

Procedure

1. Close the airhole and connect the burner to the gas tap using the rubber tubing.
2. Light a match or wooden splint and hold it at the top of the chimney.
3. Open the gas tap slowly half way then to fully open position. The gas should light. If it does not, switch off the gas tap then check to see that it is well connected to the gas supply before you try again. Ask for assistance from the teacher if you are still unable to light the Bunsen burner.

Using a pooter

It is an apparatus that is used to suck small animals from rock surfaces or barks of trees.

How to use a pooter to collect small insects in a specimen bottle

- Put the end of the pooter furthest from the joint into the mouth.
- Place the other end of the pooter within a few centimetres of the small insects being collected from the specimen bottle.
- Gently suck in so that the small insects are vacuumed into the straw and up against the nylon net.
- Place the pooter over a container, remove your finger from the end and gently tap the straw to release the small insects.

The diagram below shows how to use a pooter.

Fig. 1.15: A pooter

Using a hand lens

A hand lens is an apparatus used to enlarge an object or specimen. It is made of a biconvex lens mounted on a frame and is usually held by the handle.

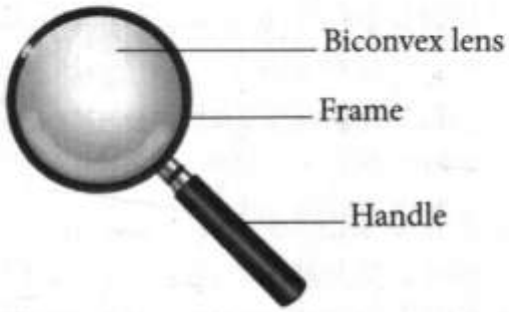


Fig. 1.16: A hand lens

Activity 1.6:

How to use the hand lens

Procedure

1. Hold the lens with one hand.
2. Place the specimen or object on a bench.
3. Bring the lens over the specimen as illustrated in Fig. 1.18.
4. Look down through the lens.
5. Move the lens up and down slightly until the image is in focus. This means that it can be seen clearly. What you see is a magnified image of the object.
6. Draw the image of the specimen as seen through the lens.

(a) Observing a specimen using a hand lens

Fig. 1.17: Hand lens in use

(b) Using hand lens with two hands

Fig. 1.18: Hand lens in use

Using a pitfall trap

A pitfall trap is a trapping pit for small animals. A container is sunk into the ground so that its rim is flush with the soil surface to prevent trapped animal from escaping or preying on each other, pitfall traps usually contain a preserving agent such as pet safe anti-free or soapy water.

The diagram below show a pit fall trap.

Fig. 1.19: Pitfall trap

Drawing biological diagrams

A drawing is a figure made to show the appearance of an object, a given part or a specimen.

It is a diagrammatic representation.

Throughout the Biology course, you will be required to make careful observations and make accurate recordings of your observations. Observations can be simple. They can also be complex requiring the help of magnifying instruments. One of the most important ways of recording the results of your observation will be by drawing. You will also prepare records in form of written descriptions or tables. The following are guidelines on how to make accurate biological drawings of plant and animal specimens.

1. Drawing using a sharp pencil.
2. Try as much as possible to draw on plain paper.
3. First draw an outline only of the plant or animal being studied.
4. Use suitable reference books to identify each structure or part of the specimens and include it in the drawing.
5. Do not draw a structure before you have identified it.
6. Never put aside a drawing to be finished later. Always complete the drawing.
7. Make large drawings and leave enough space around them for headings and labels.
8. Place the drawing at a suitable point on the page in the notebook. Do not squeeze it in a corner of the page.
9. Drawings should be clear, with firm lines and simple outlines. Avoid shading the drawing.
10. Make accurate drawings from the specimen in front of you and never copy from drawings or pictures in the textbook. Use the book only for reference.
11. Make sure you label everything in every drawing.
12. Never cross label lines. The lines should be straight and as horizontal as possible.
13. Label in pencil and keep the words horizontal.
14. A line should run from the label and end right in the centre of the structure named and not at its edge.
15. Never use arrows to label the diagrams rather use pointers.

Observing specimens and drawing accurate diagrams

A hand lens can be used to enlarge specimens which can be seen with the naked eye but too small to draw. Other diagrams can be drawn without magnifying them.

The diagram below shows a photograph of a maize grain and the biological drawing.

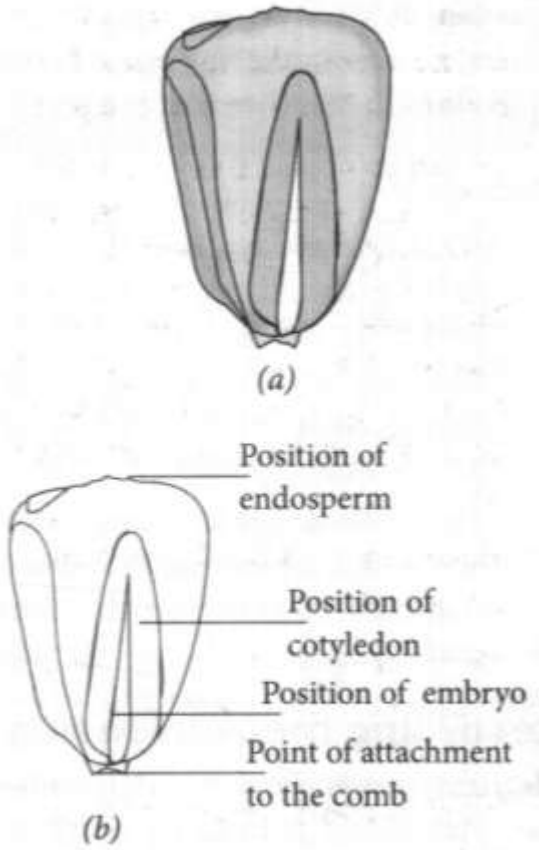


Fig. 1.20: Biological diagrams of maize grain

Activity 1.7:

To make biological drawings

Materials

- Different leaf specimens
- Pencils
- Rubber
- An uprooted plant seedling

Procedure

1. Make a clear drawing of the bean seedling such as roots, stems, leaves, nodes and internodes.
2. Label various parts of the seedling.
3. Make clear drawing of each of the leaf specimens provided.
4. Label parts of the leaf such as the petiole, lamina, midrib, veins and leaf tip.

Discussion

The figures below shows various biological drawings.

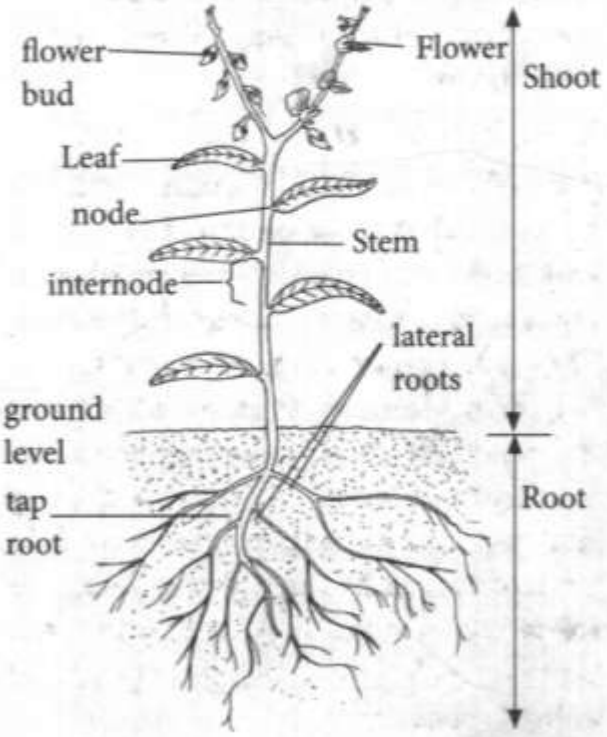


Fig. 1.21: External parts of a plant

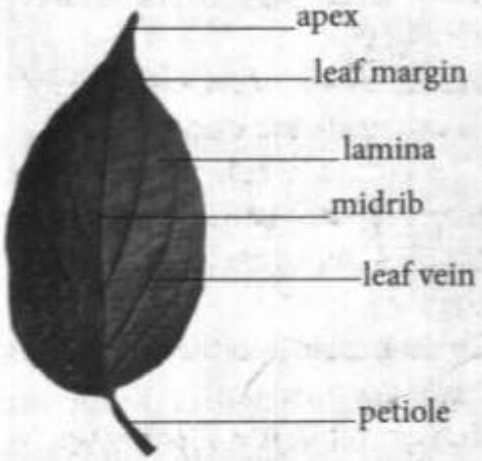


Fig. 1.22: External structure of a leaf

Calculating magnification

A biological drawing may be bigger or smaller than the object observed.

You can compare the length of the drawing with the length of the object by measuring the length of each.

The measurements you get are used to

determine the magnification of your drawing.

$$\text{Magnification} = \frac{\text{Length of drawing or image}}{\text{Length of the specimen or object}}$$

For instance, if a leaf is 20 cm in length and has a drawing of 50 cm in length;

Magnification of the drawing would be;

$$= \frac{50}{20} = 2.5$$

Therefore magnification is ×2.5

- This means that the drawing is two and half times bigger than the actual leaf specimen.
- It is also possible to have a drawing smaller in size than the drawing.

Carry out the following activity.

To calculate magnification of specimens

Materials

- Pineapple, a pumpkin or a water melon.
- A banana

Procedure

1. Make drawings of the two specimens.
2. Measure the length of the specimens.
3. Measure the length of your drawings.
4. Fill in your results in the table.

Specimen	Length of drawing	Length of specimen
Pineapple		
Banana		

5. Calculate the magnification of each of the specimens.

Question

What do you note with the magnification when drawing large sized specimens?

Discussion

- You may have realised that when making drawings of big sized specimens the drawing is smaller than the actual specimen. The magnification will therefore be less than for example ×0.5.
- When the magnification is less than one it shows that the drawing is smaller in size than the actual specimen.

Recording measurements

Measurement is the act of determining the quantity of something accurately. Variables such as temperature, height, volume, time, length and area can be determined through measurement. During measurement, it is important to make sure that the value of the measurement is accurate, that is it is as close as possible to the true or the acceptable value.

For example, the temperature of a normal adult is usually 37°C. Temperature of a normal adult should be as close as possible to 37°C to be considered accurate. Repeating measurements several times during experiments ensures precision and encourages accuracy.

Before 1960, there were several systems of measurements in use around the world. In 1960, an international system of units was established. This system is called the international system of units (SI). The table below shows some measurements, their symbols and SI unit.

Table 1.5: Some measurements, their symbols and SI unit

Measurements	Symbol	SI unit
Length	m	Metre
Mass	kg	Kilogram
Time	s	Second
Temperature	°C	Degrees Celsius

Measurement of length

Length is measured in meters. Although one meter is the standard unit of length, it is sometimes too big to measure some distances and too small to measure others. Therefore, other larger and smaller units related to the metre are used to carry out some measurements.

Table 1.6: Standard length and its relationship with smaller units of length

Unit	Symbol	Comparison with metre
1 kilometre	km	1000 m
1 metre	m	1 m
1 centimetre	cm	0.001 m
1 milimetre	mm	0.001m

Other instruments that can be used to measure length include rulers, tape measures and metre rules.

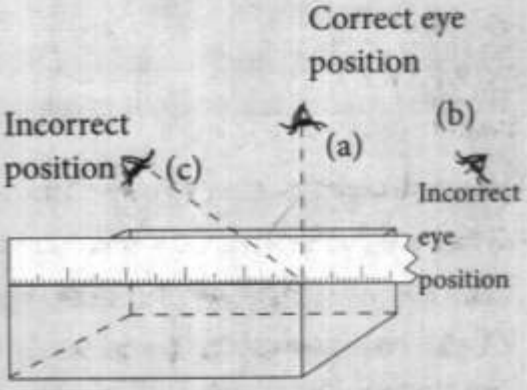
Fig. 1.23: A ruler

Fig. 1.24: Tape measure

Activity 1.9:

To measure the length of a wooden block

1. Place the metre rule in contact with the block as shown in diagram below. The zero mark on the scale is placed at the edge of the object.
2. Position your eyes right vertically above at the other end of the block as shown in position (a) in the diagram below.
3. Read off the measurements.
4. Repeat the procedure this time measuring the width (w) and height (h) of the block.
5. Record your readings in cm.



When making readings of the measurement, using a ruler it is important to position your eyes vertically above the reading to make correct readings.

Measurement of temperature

Activity 1.10:

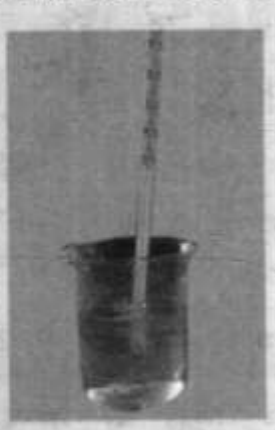
To show room temperature and boiling temperature of water

Materials

- Thermometers
- Beakers
- Tripod stand
- Means of heating

Procedure

1. Half fill the beaker with water.
2. Place a thermometer in the water and leave it there for 2 to 3 minutes.



3. Make a reading and record the temperature of water in degrees Celsius.
4. Place the same setup on the tripod stand and heat to boil.
5. Take the measurement of temperature of the boiling water (take care that the thermometer does not touch the beaker)
6. Record and compare the temperature of the water.

Measurement of volume

Volume is the amount of space occupied by a substance. The standard unit of volume is the cubic metre. In the laboratory, volume is measured using apparatus such as measuring cylinders, burettes and pipettes.

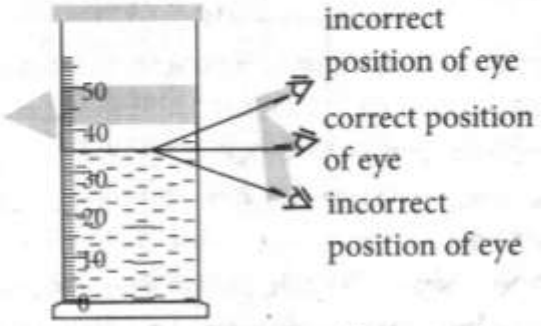


Fig. 1.25: How to read a measuring cylinder

Table 1.7: Standard volume and its relationship with other smaller units of volume

Unit	Symbol	Comparison with cm^3 cubic centimetre
1 litre	L	$1000cm^3$
1ml	ml	$1cm^3$
$1cm^3$	Cm^3	$1cm^3$

Activity 1.11:

To measure the volume of a liquid

Material

- Measuring cylinder
- Water / milk / juice

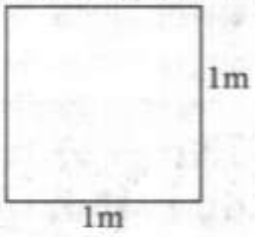
Procedure

1. Place a measuring cylinder on the table
2. Note the calibrations on the cylinder.
3. Take the liquid that has been provided to you by the teacher and slowly pour all of it into the cylinder.
4. Note that the level the liquid attains in the cylinder.

5. Use Fig. 1.25 on how to read a measuring cylinder and **note** the volume of the liquid.
6. Record the volume in cm^3 (centimetres cubed)

Measurements of area

Area refers to the amount of space that a surface or region covers. The standard unit for area is square metre (m^2). There are other smaller and larger units of area including mm^2, cm^2 and km^2. The area of an object is obtained by measuring the dimension and then applying the appropriate formula, that is L×W.



The area of the figure above is:

L×W

where L = Length

W = Width

$1 \times 1 = 1\ m^2$

Activity 1.12:

To measure and determine the area of the classroom

Materials

- Tape measure
- Notebooks
- Pencil

Procedure

1. Work in pairs.
2. Hold the tape measure at one corner at the front the classroom.
3. Let the second person stretch the tape to the other corner of the classroom at the board to measure the length of the classroom.
4. Repeat the procedure to measure the width.
5. Record your measurements.
6. Calculate the area of the classroom.
7. Compare your results with that of the other students.

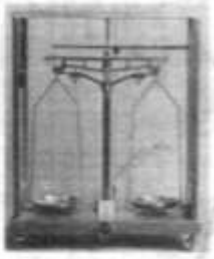
Measurement of mass

Mass is the quantity of matter in a substance. The standard unit of measuring mass is kilogram (kg).

Table 1.8: Relationship between mass in kg and other larger and smaller units of mass

Unit	Symbol	Comparison with kg
1 tonne	t	1000 kg
1 kilogram	kg	1 kg
1 gram	g	0.001 kg
1 milligram	mg	0.00001 kg

The mass is measured using balances. The following figures show many types of apparatus for measuring mass.



Beam balance

Traditional pan balance

Modern top pan balance

Fig. 1.26: Different types of balances.

Activity 1.13:

To measure the mass of a fruit

Materials

- Weighing scale
- Various types of fruits

Procedure

- Place the fruit on a weighing scale and read the weight.
- Record the weight in grams.

Measurement of time

Time is the duration a particular event or activity takes place. The standard unit of measuring time is the **second** and its symbol is *s*. Time is measured using watches and clocks.

A digital watch *A stopwatch* *A stop clock*

Fig. 1.27: Time is measured by watches.

Table 1.9: Relationship between time in seconds and other larger units of time

Unit	Symbol	Comparison with seconds
1 day	day	86400 seconds
1 hour	hr	3600 seconds
1 minute	minutes	60 seconds
1 second	s	1 second

Activity 1.14:

To measure time using a stop watch

Materials

- Stop watch
- School field/ground
- Notebook
- Pens

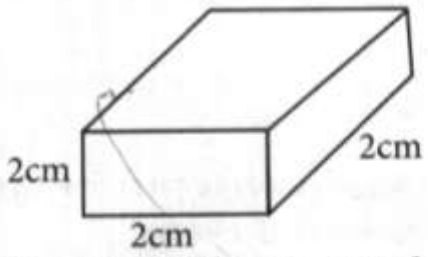
Procedure

1. Work in pairs, one of you to take the time and the other to run.
2. Start the stop watch and time how long it takes your partner to run 100 metres. Stop the watch.
3. Note down the time in seconds.
4. Allow your partner to do the same.

Determination of surface area

Surface area is the total area of faces of a solid figure. It is obtained by adding up the area of all surfaces in the figure.

The figure below has a length of 2 cm, width 2 cm and height 2 cm. It is a cube and therefore has six surfaces.



Its surface area will be a sum total of the area of all its size surfaces.

This is calculated as follows:

$(2\times2) + (2\times2) + (2\times2) + (2\times2) + (2\times2) + (2\times2) = 24\ cm^2$

Carry out an activity to determine surface area of potato cubes.

Activity 1.15:

To calculate surface area

Materials

- Potato
- Razor blade
- Ruler

Procedure

1. Using a razor blade, cut cubes from the potato tuber with the following measurements:
   A. 1 cm by 1 cm by 1 cm
   B. 3 cm by 1 cm by 1 cm
2. Make another cube of any measurement. Measure its length, width and height. Label it as C.
3. Record the measurements of the three cubes in the table.

Cube	Length	Width	Height	Surface area
A				
B				
C				
D				

4. Calculate the surface area of each of the cubes and fill your results on the last column of the table.

Determination of force

Suppose you are playing football and you want to hit the ball so as to reach your friend who is 50 m away. In the field within a short time. Will you use the same energy as when you want the ball to reach him slowly?

You realise that for the ball to move faster, you must hit it hard. For it to move slowly you must hit it slightly.

When you use more energy the ball moves faster.

The energy used to move an object from one position to another at a certain speed is called force.

Force is calculated as follows:

Force = mass × acceleration

- Mass is weight of the object being moved.
- Acceleration is the speed of which the object moves at. It is measured in metres per second.

Activity 1.16:

To measure force

Materials

- A ball
- A weighing balance
- A tape measure
- A stop clock

Procedure

1. Work in a group.
2. Move out to the school field.
   Let two students stand in the field at a distance 50 m apart.
3. Using a weighing balance, weigh the ball and record its weight.
4. Give the ball to one student.
5. Set the stop watch.
6. Ask the student to hit the ball straight to the other student.
7. Start the clock as the foot of the student hits the ball and stop the clock as the ball reaches the other student.

8. Note the time taken by the ball to travel the 50 m distance.
9. Ask the student to repeat the procedure several times alternating hitting the ball hard and hitting it slightly.
10. Record your results in a table as shown below.

Weight	Distance travelled	Time taken in seconds
	50 m	
	50 m	
	50 m	

11. Calculate force using the following formula.

$$\text{Force} = \text{Mass} \times \frac{\text{Distance}}{\text{Time}}$$

Question

From your results, when was force:

(i) greatest

(ii) least

Discussion

You may have realised that when the ball was hit hard, the time travelled by the ball was shorter but the force was greater. When the ball was just slightly hit, the time taken was longer but the force was lower.

Study skills

Read the following story about Nelly.

One day, Nelly received a letter from her father. Her father works on the northern part of Malawi. While Nelly stays with her mother in Blantyre.

Dear daughter,

How are you my child? I do hope you are well and enjoying being in your new school. I promise that if you attain a score of B in your exam I will buy you a new dress. If you score an A, I will take you to a trip to Lilongwe for two days during the vacation. But if you score a C, I wont be happy and I may decide not to come to school to visit you. Work hard and you will make it in life."

Your dad

When Nelly went home she was asked by her mother what the father had said in the letter. Nelly said "Dad said that he will not come to visit me in school but if I pass well he will take me to Lilongwe for a trip.

Question

1. After reading Nelly's answer, do you think that is what the father really communicated?
2. Which areas in the letter did Nelly miss out.

Discussion

From the story, though Nelly read the letter, she left out so many important things that her father had wanted to communicate. This is because Nelly just read the letter. She did not take time to carefully go through the letter to get the whole information that her father had communicated. The practice of reading something and then carefully going through it to understand the information being delivered is what is called study.

If you read the story carefully, you will realise what Nelly's father had two good rewards for good performance: A dress and a trip. If you continue to study the letter carefully, you will realise that, the father also had one bad reward or

punishment if Nelly failed to do well in class.

What is study?

Study is the careful examination of something with an aim of understanding the information that is being communicated.

Study is therefore doing more than just reading.

It is reading something and then taking the important parts of the information.

From the story, Nelly's father wanted her to know that he is concerned about her performance and he was ready to reward it.

Study skills include all ways used to carry out effective study with an aim of understanding information being read.

Carry out the following activity.

Activity 1.17:

To summarise information in terms of tables, flow diagrams and notes

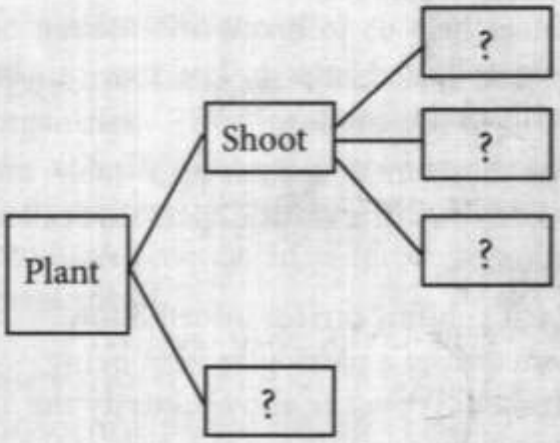
A plant has two main parts. The part that grows above the ground is called the shoot and the part that grows below the ground is called a root. The shoot is made of stem, leaves and flowers. Leaves help in the process of photosynthesis. The plant also has flowers. Flowers are involved in reproduction. The roots absorb water and mineral salts from the soil for use by the plant.

Read the above passage and answer the following questions.

1. How many parts does a plant have?
2. What is the colour of plant leaves?
3. What role do leaves play in a plant?
4. Use the information from the passage to fill in information required in the following table by indicating part on the left column and its function on the right column.

Part of a plant	Functions

(v) Using information from the table, fill in the blank boxes in the diagram below:



(vi) Write down five main points about plants that you have learnt from the above passage.

Discussion

To acquire good reading skills, one needs to read carefully to understand the information

From the activity you may have answered correctly by indicating that plants have two parts. Leaves are green and leaves are involved in photosynthesis.

For you to answer these questions carefully, you probably needed to read the passage more than once. In repeated reading you were able to note the important points in

the passage. This careful examination of the passage is called **study**. It enabled you to understand the passage and then answer the questions asked.

After understanding the passage it was possible for you to divide different parts in the passage into groups and other parts in another group.

This grouping enabled you to fill information on the table.

On the right side you filled all the parts of the plant.

On the left you filled their functions.

Tables help us to break information or data collected into groups that can be easily understood.

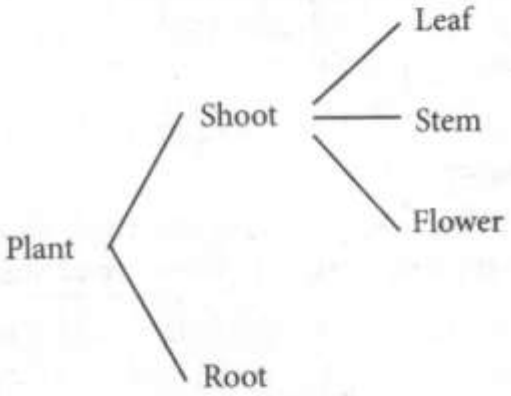
The horizontal spaces in a table are called rows. The vertical spaces are called columns.

Each column carries information concerning a particular item being studied. From the above activity the first column recorded the part of the plant only. The second recorded the function of the part recorded in the first column.

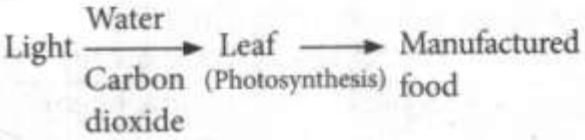
Part of a plant	Functions
Leaf	Photosynthesis
Stem	Hold leaves and flowers
Flowers	Reproduction

From the activity you may have also realised that the information in the passage can be presented in a diagram that shows how each part links to another. Such a diagram is called a **flow diagram**.

A flow diagram shows how various parts in a given information links to one another. For instance, leaves, stem and flowers are linked to the shoot. Shoot and roots form the whole plant.



A flow diagram can also be used to show how a process takes place. For instance, the leaf absorbs light, it carries out photosynthesis to make food for the plant.



This flow diagram shows how light, leaves, water and carbon dioxide are linked for the plant to make its food.

In the activity you may have realised that on understanding the information it was then possible to rewrite the same information in a simpler form using your own models.

You may have written down the following five points about plants among others.

- Plants are made of a shoot and roots.
- Shoots in a plant are composed of a stem, leaves and flowers.
- Flowers are reproductive structures.
- Stem supports leaves and flowers.
- Roots absorbs water and minerals.

The making of a summary of all the points learnt from a passage is called **note taking**.

Notes put complex information into simpler forms that can be easily understood and read in the future.

Carry out the following activity.

Activity 1.18:

To summarise information from books

Read passage from a given textbook and summarise the information in form of a table and short notes.

Functions of different parts of plant and animal cells

The cell wall

The cell wall is the non-living, outermost part of most plant cells. It is made up of a chemical substance called **cellulose**. Cellulose is tough and resists stretching. The cell wall gives **firmness** and a **fixed shape** to a plant cell. This is due to the presence of cellulose.

The cell wall has pores called **plasmodesmata**, through which the cell exchanges material with its environment. These pores allow movement of substances between cells.

The cell wall also protects the cell from bursting when excessive pressure of fluid builds up inside it.

The cell membrane

The function of the cell membrane is to hold or enclose the contents of the cell. It also regulates the movement of materials in and out of the cell.

Cytoplasm

Cytoplasm is composed of all the cell contents *except* the nucleus. It provides a medium for reactions in the cell. It stores food substances such as glycogen and starch. Many life functions are carried out in the cytoplasm by the different organelles suspended in it.

Nucleus

The nucleus is large, oval or spherical in shape. The nucleus stores the genetic material of the cell.

Mitochondria

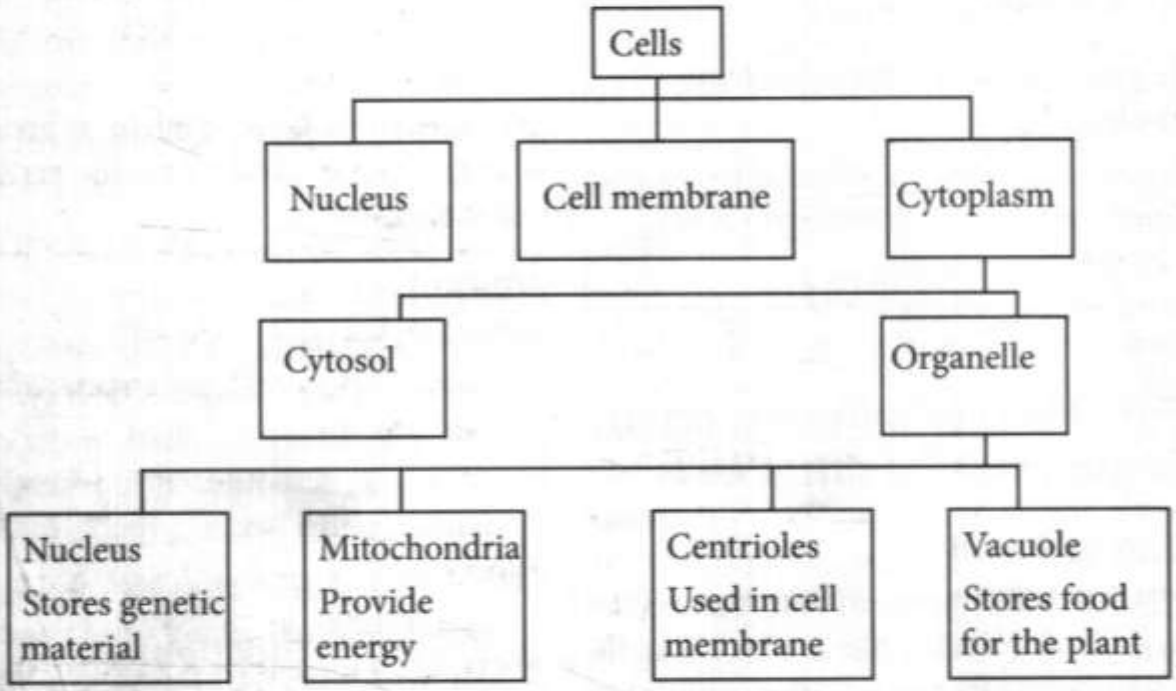
The mitochondria are oval-shaped organelles. They produce energy for the cell. This energy is used in the cell for various activities. Mitochondria produces energy in a process called **respiration.**

Summary of functions of different parts of plant and animal cells in a table form

Part	Function
Cell wall	Made up of cellulose, gives the plant cell its fixed shape. Has pores called plasmodesmata.
Cell membrane	Encloses cell contents, regulates movements of material in and out of cell.
Cytoplasm	Medium for all reactions, stores glycogen and starch.
Nucleus	Stores the genetic material of the cell.

Part	Function
Mitochondrion	Oval shaped, produces energy for the cell in a process called respiration.

Summary in form of a flow diagram



Summary in the form of short notes

The cell wall

Made up of cellulose, gives the cell a fixed shape, has pores called plasmodesmata through which material is exchanged with its environment.

The cell membrane

- Encloses the contents of the cell.
- Regulates the movement of materials in and out of the cells.

Cytoplasm

- Composed of all the cell contents except for the nucleus.
- A medium for reactions in the cell.
- Stores food substances such as glycogen and starch.

Vacuoles

- Large in cytoplasms and centrally placed in plant cells.
- Tiny and scattered in cytoplasm of animal cells.
- Store food substances in the cell.

Centrioles

- Red-like structures found in animal cells.

- Play a role in cell division to form new cells.

Nucleus

The nucleus stores the genetic material of the cell.

Mitochondria

Oval shaped, produce energy for the cell in a process called respiration.

Activity 1.19:

Summarising information from books

Ndarama is a student at Mzuzu Secondary School. He read the following passage about bees from a book.

Lifecycle of honey bees

Honey bees develop in four distinct life cycle phases: egg, larva, pupa and adult. The total development time varies a bit among the three castes of bees, but the metamorphosis process is the same: 24 days for drones, 21 days for worker bees, and 16 days for queens.

The honey bee metamorphosis begins when the queen lays an egg. The queen lays a single egg in each cell that has been cleaned and prepared by the workers to raise new brood. The cell must be spotless, or she moves on to another one.

The queen positions the egg in an upright position (standing on end) at the bottom of a cell. Three days after the queen lays the egg, it hatches into a larva (the plural is larvae). Healthy larvae are snowy white and resemble small grubs curled up in the cells. The worker bees called nurse bees first feed the larvae royal jelly, and later they're weaned to a mixture of honey and pollen (sometimes referred to as bee bread). Within just five days, they are 1570 times larger than their original size. At this time, the worker bee seal the larvae in the cell with a porous capping of tan beeswax. Once sealed in, the larvae spin a cocoon around their bodies.

The larva is now officially a pupa (the plural is pupae). After 12 days, the now adult bee appears.

Questions

Read the passage carefully.

(i) Make notes of at least ten points from the passage.

(ii) Make a flow chart showing the lifecycle of a bee.

(iii) Make at least two tables using the information in the passage.

Revision Exercise 1

1. Which of the following statements is true?
   - A. Biology is the study of people.
   - B. Biology is the study of air.
   - C. Biology is the study of living things.
   - D. Biology is the study of stones.
2. Which one of the following meaning is true for Biology laboratory warning sign?

A		Explosive	The material can explode easily.
B		Electric shock	Can cause electric shock.
C		Flammable	The material catches fire easily.
D		Dangerous	Take care because it can cause death.

3. Which of the following is a laboratory rule?
   A. Do not check on the labels of reagents before using them and strictly follow the instructions given.
   B. Do not enter the laboratory without the permission of a teacher.
   C. You can carry any laboratory item from the laboratory.
   D. Dispose of hot materials into dustbins.

4. Which of the following apparatus measures mass?

A.

B.

C.

D.

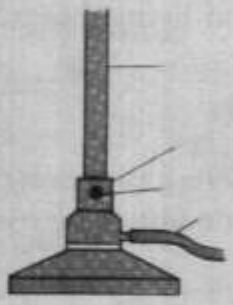
5. Which of the following is the first thing you do when you want to light a bunsen burner?
   A. Light a match or wooden splint and hold it at the top of the chimney.
   B. Open the gas tap.
   C. Switch off the gas tap.
   D. Close the air hole and connect the burner to the gas tap using the rubber tubing.

6. A box had the following measurements: Length = 2 cm, width = 3 cm, height = 2 cm. What was its volume?
   A. 12 cm B. 6 cm^3
   C. 6 cm D. 12 cm^3

7. You are given the length of an actual

leaf to be 10 cm and the length of biological drawing to be 5 cm. Calculate the magnification of the leaf.

8. Name the following common laboratory apparatus.



(a) _____

(b) _____

(c) _____

9. What is the most important rule in handling accidents in the school laboratory?

10. What is the common unit of measuring:
    (a) Temperature in the laboratory?
    (b) Area?

11. List two study skills of summarising information read from notes.
    (a) _____
    (b) _____

12. Give the formula of determining force: _____

Unit 2 Living things and their environment

Success criteria

By the end of the unit, the student must be able to:

(a) List the characteristics of living things.

(b) Classify living things.

(c) Identify living things using keys, hierarchy and scientific names.

(d) Construct food chains and food webs.

(e) Identify feeding structures in animals.

Introduction

As we learnt earlier, biology is a study of living things. Living things live in natural surroundings called environment. An environment is composed of both living factors and non-living factors that organisms interact with. Living organisms are affected by the environment and at the same time they affect the environment.

How would you know that an organism is living or non-living?

Suppose you came across an unfamiliar organism, what would you do to find out whether it was living or non-linving? In Biology, we would look for signs of life in an organism. For example

- Does the organism breathe?
- Does the organism move?
- Can the organism grow?

Carry out the activity below to observe living and non-living things.

Activity 2.1:

To identify living and non-living things outside your classroom

Materials

- Sweep nets
- Traps
- Anaesthetics
- Markers
- Pictures of specimens
- Containers/jars – transparent containers to hold the organisms

Note: Improvise where some of those materials above are not available.

Caution

Take care when handling dangerous or poisonous such as scorpions and snakes.

Procedure

1. Take a walk outside your classroom and list the first things you will see.
2. Use the list you have made above to sort out living things from the non-living things.
3. With the help of your teacher, trap a few organisms, place them in jars and take them back to the laboratory for closer examination.
4. Write down the points that made you decide which ones were living things and which ones were non-living things.

Discussion

From the list you probably realised that living things have certain characteristics which non-living things do not have.

Traits which can be observed in all living things include:

- Nutrition (feeding)
- Respiration
- Excretion
- Growth
- Reproduction
- Irritability or sensitivity
- Movement or locomotion

These are also called characteristics of living things because they are the processes that keep organisms alive.

Characteristics of living things

Nutrition

This is the process by which an organism obtains food from the environment. Green plants manufacture food materials like glucose using sunlight, carbon dioxide and water. Animals cannot manufacture their own food. They obtain their nutrients from plants and other animals in order to build up their bodies and get energy for various activities.

Respiration

Respiration is the process by which food substances are broken down in the body to release energy. The energy produced enables the organism to carry out the life processes while carbon dioxide is released as a waste product.

Excretion

Excretion is the removal of waste products of metabolism from the body. The waste products are produced from the breakdown of certain substances in the body. Some of the waste products may be harmful if left to accumulate in an organism.

Growth and development

Growth is the process by which organisms permanently increase in size and mass. It involves taking up substances from the environment and incorporating them into internal structures of an organism. Some of the new cells undergo certain modifications in their structures and become specialised to carry out specific functions.

This process of growth, modification and specialisation of the cells is called **development**.

Reproduction

When living things reach maturity, they produce young ones either by **asexual** or **sexual** reproduction. In asexual reproduction, a single parent produces offsprings that are identical to itself. In sexual reproduction, two parents are involved and the offspring are not identical with either parent. The production of offspring ensures that a species lives on and does not become **extinct.**

Sensitivity (irritability)

This is the ability of organisms to sense changes in their environment and respond to them. For living things

to survive in their environment, they need to sense danger so that they can escape or deal with it. They also need to sense the location of the food in order to obtain it. Plants need to sense the direction that light is coming from so that they can grow towards light and use it for photosynthesis.

Plant and animal cells

Plants and animals are made up of small units called **cells.** In Biology, the use of the word "cell" comes from the discovery by Robert Hooke (1665) of small chambers in the bark of a tree called the cork oak. He called the chambers **cells** because they looked like small sleeping rooms used by monks in a monastry. Some organisms have bodies made up of a single cell. They are called single celled or **unicellular** organisms.

Other organisms have body structures that are made up of many cells. They are called **multicellular** organisms. Therefore, the cell is a **structural** unit of organisms.

Many chemical processes take place in the cell. These processes keep the organism alive and functioning. For this reason, the cell is also referred to as a **functional unit.** Therefore, the cell is the **structural** and **functional** unit of any living organism.

Examination of plant and animal cells using a light microscope

In this section, we are going to use a light microscope to observe cells in the epidermis of a plant leaf and cheek cells from a human being.

Activity 2.2:

To examine plant cells in a leaf epidermis

Materials

- Iodine solution/ Eosin stain
- Microscope
- Microscope slides
- Canna lily leaf
- Charts
- Forceps
- Photomicrographs
- Distilled water
- Petri-dish

Procedure

1. Slice the canalily leaf using a clean scalpel.
2. Using forceps, pull away the thin lining of the inner surface of the leaf.
3. Dip it in distilled water in a petri-dish to prevent it from drying.
4. Cut out a small piece (about 5 mm square) of the thin lining.
5. Place the piece on the microscope slide then add a drop of iodine. (Iodine stains the cells making them more visible).
6. Put the cover-slip on top and press gently against the slide. This is to ensure you do not trap any air. Your temporary slide is now ready. Mount it on the microscope.
7. Observe the slide using the low power lens of the microscope. Draw two or three adjacent cells.

Discussion

From the activity, you may have realised that when plant tissues are observed through a microscope, one is able to see the cells clearly. The cells are large in size with a distinct shape. The cells are seen packed together to form a mesh-like structure as shown in the following figure.

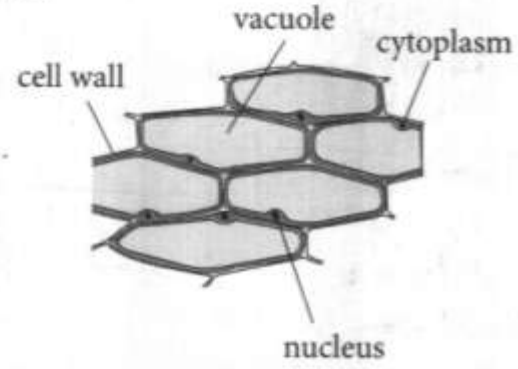


Fig. 2.1: Canna lily leaf epidermal cells

Activity 2.3:

To examine animal cell (cheek cells) using a microscope

Materials

- Microscope.
- Flat toothpick or cotton swabs.
- Slides.
- Cover slips.
- Methylene blue or iodine solution.

Caution

- Do not share toothpicks or swabs due to possibility of cross infections.
- This experiment must be done in the presence of your teacher.

Procedure

1. Gently scrub the inside of your cheek with a flat toothpick and place the scrappings on a clean dry slide.
2. Discard the used toothpick in a biohazard container for safe disposal.
3. Add a drop of very weak methylene blue or iodine solution.
4. Cover the slide with a cover slip and observe under the microscope.
5. Draw the cells as seen through the microscope.

Structure of plant and animal cells

We have seen that the cell is the basic unit from which plants and animals are made. The cell itself is made of smaller structures called **organelles**.

Each organelle carries out a specific function.

Activity 2.4:

To observe permanent slides of animal and plant cells

Materials

- Light microscope
- Slides
- Swabs
- Prepared slides of plant tissues
- Onion bulb.

Procedure

1. Using the apparatus provided, place a cheek tissue on a slide and observe it using low power lenses.
2. Draw and label the observable features in the cheek cells.
3. Repeat the procedure using permanent slides of onion bulb epidermis.
4. Identify plant cells observed.
5. Draw and label the plant cells.

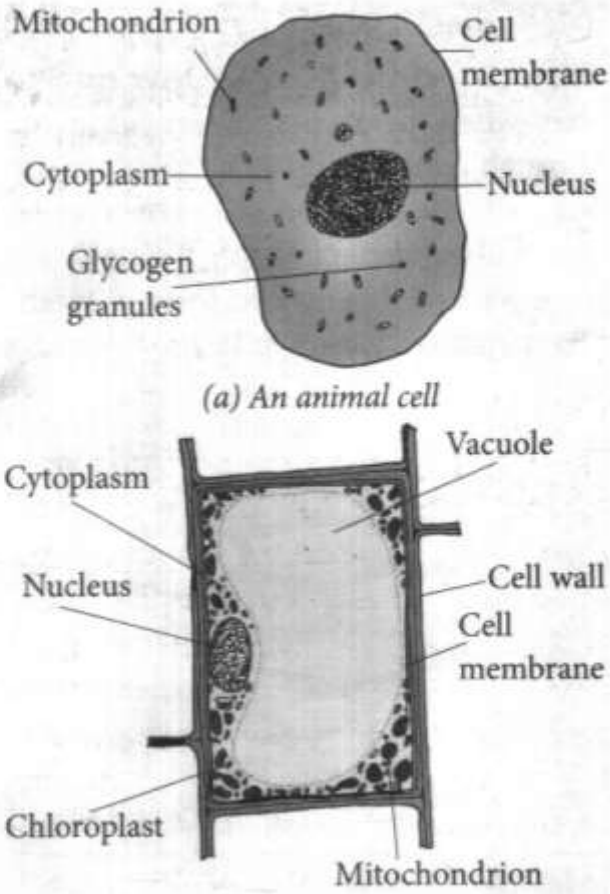
Discussions

From the experiment, you may have observed the following parts in plant and animal cells.

Not all organelles that are found in a cell can be seen with a light microscope. The organelles that cannot be seen would require higher magnification and resolution that are only possible with a more powerful microscope. An example of such a powerful microscope is an electron microscope. When observing plant cells using an electron microscope the following organelles can be seen: Cell wall, cell membrane, nucleus, chloroplasts, mitochondria, endoplasmic reticulum and vacuoles. In animal cells, the following organelles can be seen: Cell membrane, nucleus, mitochondria, endoplasmic reticulum, vacuoles and centrioles.

Both plant and animal cells have:

- Membranes
- Vacuoles
- Endoplasmic reticulum
- Cytoplasm
- Ribosomes
- Nucleus
- Golgi bodies
- Centriole
- Nucleolus



(a) An animal cell

(b) A Plant cell

Fig. 2.2: An animal cell and a plant cell as seen under the light microscope

Note the structures that are common to both cells and those that are not.

The table below gives the comparison between plant and animal cells.

Table 2.1: Differences between plant and animal cells

	Plant cell	Animal cell
1.	Have a cell wall.	Do not have a cell wall.
2.	They have a fixed shape.	They do not have a fixed shape.
3.	They have chloroplasts containing chlorophyll.	They do not have chloroplasts.
4.	Plant cells make their own food in the process of photosynthesis.	They lack chloroplasts and therefore cannot make their own food.
5.	They have a large centralised vacuole which is filled with cell sap.	They have numerous small vacuoles scattered in the cytoplasm.
6.	They do not have centrioles.	They have centrioles.

	Plant cell	Animal cell
7.	They store excess carbohydrates in the form of starch in starch granules.	They store excess carbohydrates in form of glycogen.
8.	They are usually larger in size.	They are usually smaller in size.

Classification of living things

There is a wide variety of plants and animals living in their natural habitats on earth. This great variety of living organisms is called **biodiversity**. Due to their great diversity, it is not easy to identify and study all living organisms individually. However, when put in groups according to some common criteria, it becomes easier to study them.

Carry out the following activity.

Activity 2.5:

To group living things

Materials

- Sweep nets
- Plant and animal materials
- Pictures
- Textbooks
- Local environment

Procedure

1. Take a walk outside the classroom.
2. Trap some organisms and place them in glass jars.
3. Collect some plant specimens and take them back to the classroom or laboratory.
4. Examine the specimen, pictures and photographs provided to you by your teacher.
5. Using your own criteria, separate the organisms you have examined into different groups.
6. List down the criteria you have used to separate the specimens into groups.

Discussions

From the activity you may have realised that you collected many different types of organisms. You may have put them into various groups based on different criteria. For example you may have put plants and animals into separate groups. Among the animals you probably used certain similarities and differences to further group them.

You could also have grouped the animals according to their feeding methods. For example you could have put animals that feed on plant materials in one group.

Among the plants you may have grouped them according to where they are found.

This process of putting organisms into groups according to certain criteria is called **classification**.

Definition of classification

The process of grouping organisms based on their similarities, differences feeding methods or habitats is called classification.

Importance of classification

Classification is necessary because of the following reasons:

1. When living things are divided into smaller groups whose members have common characteristics, it becomes easier to study them.
2. Classification makes it easier to identify relationships between groups of organisms. For instance, are bats closely related to birds because both of them have wings? Are whales closely related to fish because they both swim in the sea? Are whales and bats more closely related to each other than to either birds or fish? Organisms that have more common characteristics are more closely related. This shows that they may have a common origin (that is, evolutionary relationship)
3. Classification helps to organise all types of known organisms in order to make it easier to find information about them.
4. To provide a coherent and universal system of grouping organisms.

Arranging living things in groups

Living things can be grouped according to the following:

(a) Similarities and differences.

(b) Habitats.

(c) Feeding methods.

1. Grouping living things according to their similarities

Organisms like insects are similar because all have three body parts, wings and three pairs of legs. Other organisms like the large animals have mammary glands to feed their young ones.

Organisms like birds are similar because they all have wings, feathers and beak. The table below shows similarities of large animals.

Table 2.2: Grouping living things according to similarities

Animals	Similarities
  	All these animals have mammary glands.

2. Grouping living things according to differences

Similar things can be grouped according to differences. For example, birds can be grouped according to ability to fly and whether the bird in domestic or wild.

Other organisms which can be grouped according to the body appearance include human beings, dogs, cats, goats, sheep, cows among others.

The table below shows grouping of birds according to their differences.

Table 2.3: Grouping living things according to differences

Birds	Differences
	They have red beaks.
	Has blue tail.
	Has red combs.

3. Grouping living things according to their habitats

A habitat is a place where a living thing lives. Some organisms live in marine water, others in fresh water, some on land and others under the soil.

Living things can therefore be grouped according to where they live, that is, the habitat. For example, moles and mice live under the soil.

Most wild animals live on trees. Organisms living in the same habitat can therefore be grouped together. The table below shows different animals living in different habitats.

Table 2.4: Grouping living things according to their habitat

Animal	Habitat
	Trees
	Water
	Fresh water
	Under the soil

4. Grouping living things according to their feeding methods

Different organisms have different feeding methods. For example:

(a) **Carnivores:** These are animals which feed on flesh only. They include lions, tigers and leopards.

(b) **Herbivores:** These are animals which feed on plants only. They include zebra, cow, rabbit and goats.

(c) **Omnivores:** These are animals which feed on both flesh and plants. An example is man.

Living things can therefore be grouped according to each feeding method. For example, all carnivores can be grouped together.

The table below shows grouping of organisms according to feeding methods.

Table 2.5: Grouping living things according to their feeding methods

Animal	Feeding habit
	Carnivores
	

Animal	Feeding habit
	Herbivores
	
	Omnivore

Identification of living things

A dichotomous key

The following analogy illustrates the use of a dichotomous key to identify an unknown individual.

Assume you have gone to town to look for your lost cousin. You go to the town and first locate the house where the family lives but have been told that your cousin is at school.

You go to school but you can only remember your cousin's first name. You find a teacher who is willing to assist you find your cousin. The teacher tells you that there are five students with the same name as your cousin's first name.

1st girl in F1E	2nd girl in F1E
	
Curly hair, tall and slender	straight hair, tall and slender

3rd girl in F3E

straight hair, tall and stout

4th girl in F4E	5th girl in F4W
	
curly hair, short and slender	straight hair, short and stout

The teacher assisting you asks you if your cousin is tall or short. You say tall. You are told that of the five students who share your cousin's first name, three are tall.

1st girl in F1E	2nd girl in F1E
	
Curly hair, tall and slender	straight hair, tall and slender

3rd girl in F3E

straight hair, tall and stout

The teacher then asks you if your cousin has a stout body or a slender body. You say a slender body. The teacher tells you that out of the three tall students, two have a slender body.

The teacher then asks you if your cousin has straight or curly hair. You say that your cousin has curly hair. Your teacher then says that your cousin is in Form 1E. The teacher then goes to fetch your cousin of whom you are pleased to see.

1st girl in F1E	2nd girl in F1E
	
Curly hair, tall and slender	straight hair, tall and slender

Discussion

How was your teacher able to do this without knowing your cousin? The teacher used the following features:

- Height
- Body size
- Type of hair

Out of the five students who shared your cousin's name, only one girl was tall, slender and had curly hair. With every point of information you gave, the teacher grouped and eliminated one of the five students until only your cousin was found.

Biologists also use a similar way to identify unknown living organisms according to certain characteristics using a set of instructions called a **dichotomous key**. The term dichotomous comes from

the word "dichotomy" which means divided into two parts. A dichotomous key is a set of instructions used to identify unknown organisms by using descriptions of observable features.

Using a dichotomous key to identify organisms

We have learn that dichotomous keys can also be used to identify unknown organisms.

Study the figure below and the dichotomous key.

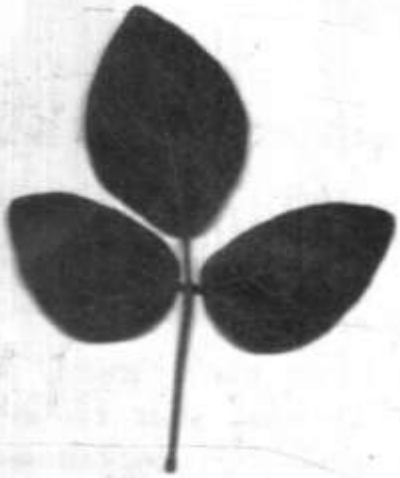


Fig. 2.3: Specimen

Dichotomous key

1. (a) Leaf simple..... go to 2
   (b) Leaf compound ..... go to 3
2. (a) Leaf with smooth margin ..... Bouganvillea
   (b) Leaf with margin serrated..... Hibiscus
3. (a) Leaf with two leaflets..... Garden pea
   (b) Leaf with three leaflets..... Cowpea

List down the features of the unknown organisms. For instance the above specimen has the following features:

It is a compound leaf. Its leaflets have smooth margins, it is trifoliate.

To identify specimen 2.3 follow the following steps:

Match the characteristics of the specimen with the variations in each step of the given key. Start with the first key that is, 1a or 1b.

Note: You may realise that some characteristics of the specimen do not apply to some steps. Move to the other variations as the key guides you with the phrases "go to".

For instance, when matching with specimen 2.1, you find that:

In Step 1: The specimen matches with variation 1b. (It is a compound leaf).

This step instructs us to go to step 3.

So we skip step 2 and go to step 3. In step 3 the specimen matches with 3b (its a trifoliate leaf)

The last variation in your path gives the identity of the unknown organism. For instance our last variation is 3b. It shows us that the identity of our specimen is a cowpeas. So we stop at this point.

Trace the path you followed in identifying the organism and show all the steps you followed in the identification of the organism. For example, in this case the steps are cowpeas; 1b, 3b.

Activity 2.6:

To use dichotomous key to identify a given organism

A student observed a given organism. The following diagram represents the organism that the student studied.

Use the dichotomous key given to identify the organism

Fig. 2.4: Cockroach

Dichotomous key

1. (a) Antennae absent..... Spider
   (b) Antennae present..... go to 2
2. (a) Have two pairs of antennae..... Crab
   (b) Have one pair of antennae..... go to 3
3. (a) Have six legs..... Cockroach
   (b) Have many legs..... go to 4
4. (a) Have one pair of legs in each segment..... Centipede
   (b) Have two pairs of legs in each body segment..... millipede.

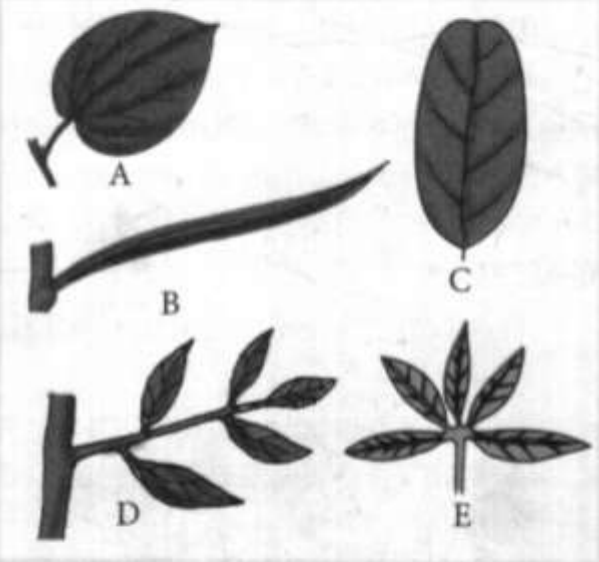
Discussion

First identify the characteristics of the specimen. It has six jointed legs. It has a pair of antennae and wings. Matching these characteristics, matches with step 1b. This directs to step 2b where the organisms is seen to have a pair of antennae. This step leads to step 3a and the organism is in class Insecta. The steps used are 1b, 2b and 3a to place the organism in its class. The organisms is a cockroach.

Activity 2.7:

To make a simple dichotomous key

Use the five leaf samples below to go through the steps of making a simple dichotomous key.



Procedure

1. List down the major characteristics of all the five leaves. For instance:
   - Type of leaf
   - Type of venation
   - Type of tip
   - Arrangement of leaflets
2. Study each leaf carefully. For each leaf, specify the variation it shows under each characteristic given in step (1) above.

   For example;

Leaf A

- Type of leaf – simple leaf
- Type of venation – network venation
- Type of apex – pointed apex

Leaf B

- Type of leaf – simple leaf
- Type of venation – parallel venation
- Type of apex – pointed tip

Leaf C

- Type of leaf – simple leaf
- Type of venation – network venation
- Type of apex – round tip

Leaf D

- Type of leaf – compound leaf (which is pinnate)
- Type of venation – network venation
- Type of apex – leaflets with pointed tips.

Leaf E

- Type of leaf – compound leaf (which is digitate)
- Type of venation – network venation
- Type of apex – leaflets with rounded tips.

3. To help construct the dichotomous key, summarise each characteristic of the leaves into two variations as shown in the table alongside.

Characteristic	Variations in characteristics
1. Type of leaf	• Simple leaf • Compound leaf
2. Type of venation	• Network venation • Parallel venation
3. Type of apex	• Pointed tip (apex) • Rounded tip (apex)
4. Arrangement of leaflets	• Pinnate • Digitate

4. Starting with one characteristic of the leaves, put the leaves into two groups according to the two variations of that characteristic. Assign the number "1" to the first characteristic for example type of leaf: 1. To the two variations, assign the letters (a) and (b). For example, simple leaf (a), compound leaf (b).
5. In the two groups of leaves obtained, sort them out using a different characteristic and regroup them into two new groups each according to variations in that characteristic. For example, sort out the simple leaves according to venation into those with network venation and those with parallel venation.

   Assign the number 2 to the new characteristic for example venation 2 and assign letters (a) and (b) to the two variations that is, parallel (a) and network (b)
6. Now group the leaves with a network venation according a different characteristic. For example, leaves with round tip and those with pointed tip. Assign number 3 to the characteristic and letter (a) to the round tip and (b) to the pointed tip.
7. Do the same to the compound leaves and sort them out into two groups according to the leaflet arrangement that is, those with leaflets attached at the tip of the leaf stalk (digitate) and those whose leaflets are attached along the leaf stalk (pinnate). Assign the number 4 to the leaflet arrangement, letter (a) to the pinnate arrangement and letter (b) to the digitate arrangement. The assignment of the numbers and letters should look like in above.
8. Use the information in the dichotomous tree to construct a dichotomous key as shown below:

1. (a) With simple leaves ..... go to 2
   (b) With compound leaves ..... go to 4
2. (a) With parallel veins .. B (maize leaf)
   (b) With net veins ..... go to 3
3. (a) With round tip ..... C (Guava)
   (b) With pointed tip ..... A (*Bougainvillaea*)
4. (a) Leaf pinnate ..... D *Eucalyptus*)
   (b) Leaf digitate ..... E (*Bombax*)

- The numbers 1, 2, 3 and 4 in the key represent the characteristic indicated in the tree.
- The letters (a) and (b) represent two variations in each characteristic (couplet).
- The phrase "go to" indicates the characteristic into which the specified leaves are to be further grouped. For example, in 1 (a) Simple leaves ..... go to 2, indicates that the simple leaves are grouped further into two according to the type of venation (2) that is parallel veined (a) and network veined (b).

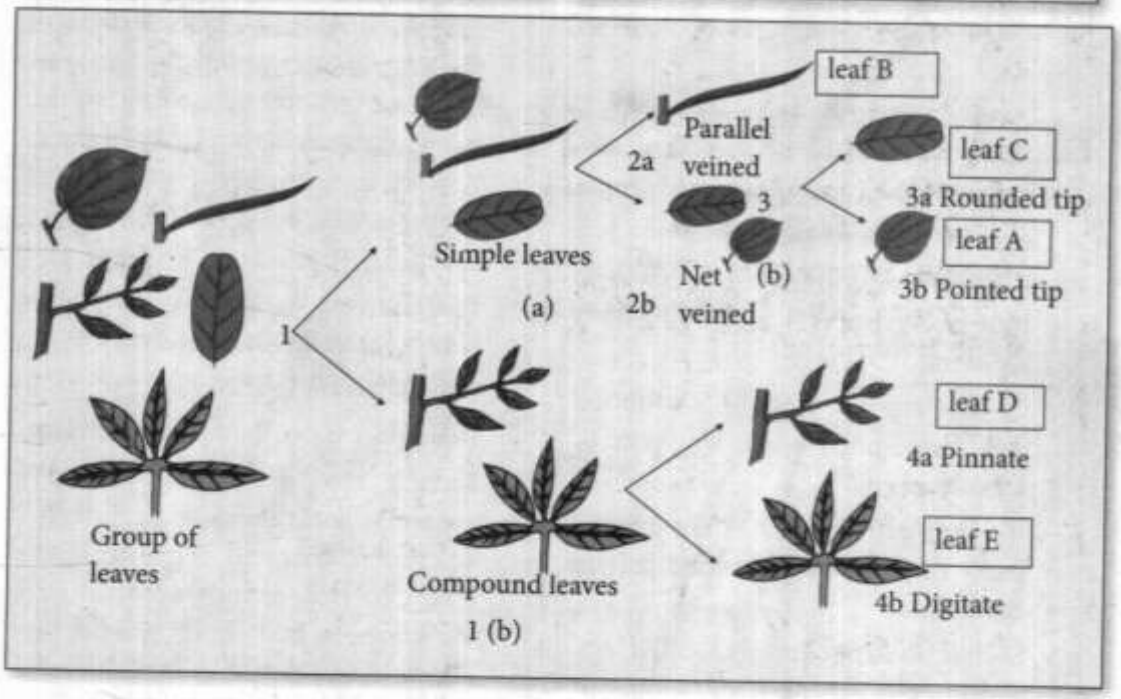
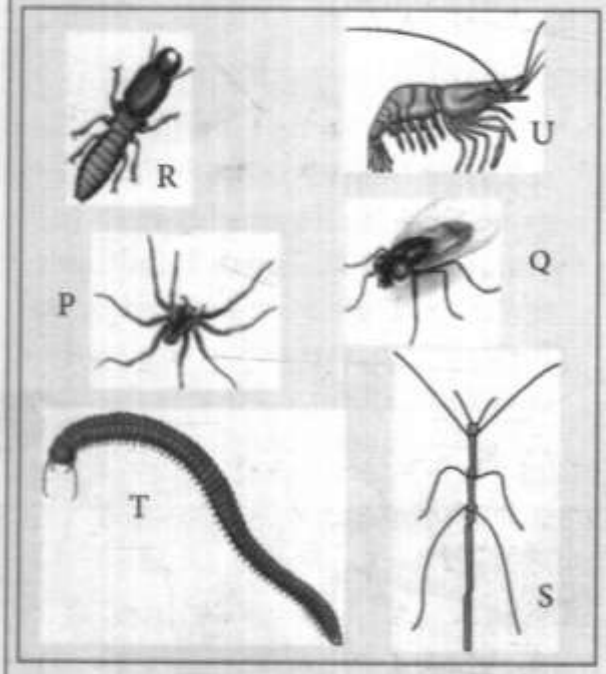


Fig. 2.5: Flow chart or spider key

Activity 2.8:

To make a simple dichotomous key of some animals

1. Study the diagrams below.



2. In each of the specimens we can list several characteristics.

- P – has eight jointed legs, no wings, two body parts - and it has no antennae.
- Q – has one pair of wings, six jointed legs, three body parts, one pair of antennae.
- R – has no wings, has six jointed legs, three body parts, one pair of antennae.
- S – has no wings, has six jointed legs, abdomen is very thin and long, one pair of antennae.
- T – has a cylindrical body, with many legs, one pair of antennae
- U – has two pairs of antennae, two body parts. It has ten legs of different sizes and shapes.

3. List down the major characteristics of all the organisms in a table like the one shown below.

Characteristic	Variations in characteristic
1. Number of legs	(a) Six jointed legs
	(b) More than six jointed legs
2. Antennae	(a) Present
	(b) Absent
3. Wings	(a) Present
	(b) Absent
4. Abdomen	(a) Broad abdomen
	(b) Narrow abdomen

4. Starting with one characteristic of the organisms, group the animals into two groups according to the two variations of that characteristic. Assign the number 1 to the first characteristic for example number of legs

   For the two variations assign the letters (a) and (b). For example;

   (a) With six jointed legs.

   (b) With more than six jointed legs.

5. In the two groups of animals obtained, sort them using a different characteristic and regroup them into two new groups according to variations in that characteristic. For example, sort out the arthropods with six jointed legs according to wings; into those with wings and those with no wings. Assign the number 2 to the new characteristic and assign letters (a) and (b) to the two variations that is, six jointed legs (a) and more than six jointed legs (b). Continue

grouping the animals obtained and sort them using " type of abdomen" as the new characteristic. You can sort them into arthropods with "long thin abdomen" and those with "broad abdomen".

Assign number 3 to the new characteristic that is, type of abdomen and assign letters (a) and (b) to the two variations,narrow abdomen (a) and broad abdomen (b).

6. Do the same for arthropods with more than six jointed legs and regroup them using "antennae" as the new characteristic. You can then sort them into arthropods with "no antennae" and those "with antennae" Assign the number 4 to the new characteristic, that is antennae; and letters (a) and (b) to the two variations, that is, "no antennae" (a) and "have antennae" (b).
7. Regroup the arthropods with antennae into those with "two pairs of antennae" and those with "one pair of antennae". Assign the number 5 to the new characteristic, that is, "Number of antennae 5" and letters (a) and (b) to the two variations that is "two pairs of antennae" (a) and "one pair of antennae" (b).

   The assignment of numbers and letters should be as shown in Fig. 2.3
8. Use the information in the spider key to construct a dichotomous key as shown below.

1. (a) With six jointed legs (Q, R, S) ..... *go to 2*
   (b) With more than six jointed legs ..... *go to 4*
2. (a) With wings ..... (Q) *Housefly*
   (b) With no wings (R, S) ..... *go to 3*
3. (a) Has narrow abdomen ..... (S) *Stick insect*
   (b) Has broad abdomen ..... (R) *Termite*
4. (a) Has no antennae ..... (P) *Spider*
   (b) Has antennae ..... *go to 5*
5. (a) With two pairs of antennae ..... (U) *Prawn*
   (b) With one pair of antennae ..... (T) *Millipede*

After you have completed the construction of the flow chart, show all the steps used in their correct sequence during the identification of the organisms that is to identify each organism, the following sequence of steps is followed.

Housefly (Q) 1a, 2a

Stick insect (S) 1a, 2b, 3a

Termite (R) 1a, 2b, 3b

Spider (P) 1b, 4a

Prawn (U) 1b, 4b, 5a

Millipede (T) 1b, 4b, 5b

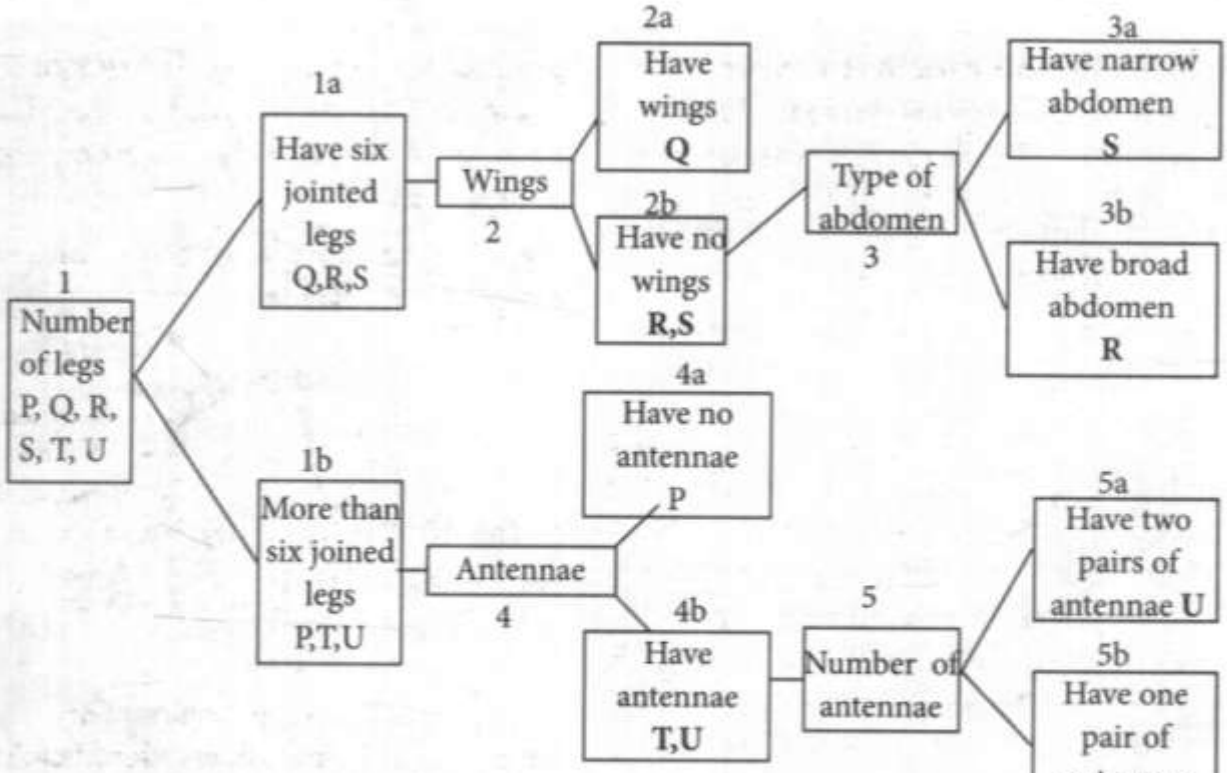
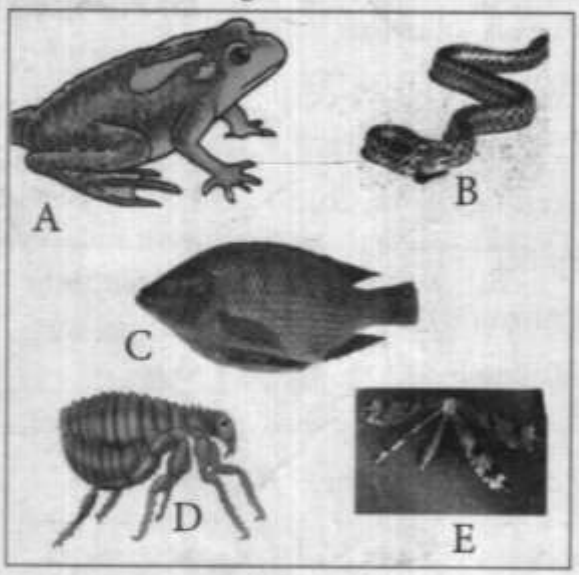


Fig. 2.6: Flow chart or spider key

Activity 2.9:

To use a constructed dichotomous key to determine the identity of a given organism

- The figures below represents some animals.
- Use the dichotomous key below to name the organisms.



Dichotomous key

1. (a) Has legs ..... go to 2.
   (b) Has no legs ..... go to 3
2. (a) Has 2 pairs of legs .....frog.
   (b) Has more than 2 pairs of legs ..... go to 4.
3. (a) Has fins ..... Fish.
   (b) Has no fins ..... Snake.
4. (a) Has wings ..... Dragon fly.
   (b) Has no wings ..... flea.

Question

Give the steps that were used to identify the organisms.

Sorting organisms into various hierarchy

The groups into which organisms are put are called taxa (singular taxon).

Biologists today use seven major classification groups (taxa) to classify organisms. The taxa are as follows:

- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species

The largest taxonomic unit is the kingdom. The kingdom contains the highest number of organisms. Each **kingdom** is divided into smaller groups called **phyla** (singular phylum). In plants, **division** is used instead of phylum. Each phylum or division is divided into **classes**. Within each class are **orders**. Orders are divided into **families**. A family consists of many related **genera** (singular genus). A genus is usually divided into more than one **species**. The species is the smallest taxonomic unit. A species is a group of organisms that can freely interbreed and produce fertile offspring. The organisms in a species are similar in characteristics. Each species contains the fewest number of organisms.

Fig 2.7 is an example of the taxonomic categories of organisms.

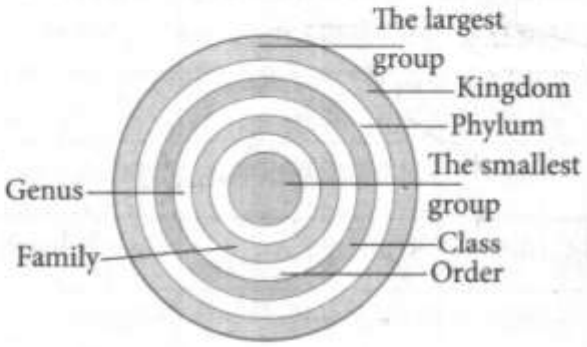


Fig. 2.7: Taxonomic hierarchy

Table: 2.6(a) below shows identification of living things according to taxonomic hierarchy

Table: 2.6(a): Classification of some members of Kingdom Plantae according to taxonomic hierarchy

Rank	Maize	Bean	Arabic coffee	Sisal
Kingdom	Plantae	Plantae	Plantae	Protoctista
Division	Spermatophyta	Spermatophyta	Spermatophyta	Spermatophyta
Class	Angiospermae	Angiospermae	Angiospermae	Angiospermae
Order	Monocotyledonae	Dicotyledonae	Rubiales	Monocotyledonae
Family	Graminales	Leguminosae	Rubiaceae	Asparagaceae
Genus	Zea	Phaseolus	Coffea	Agare
Species	Mays	Vulgaris	Arabica	Sisalana
Scientific name	*Zea mays*	*Phaseolus vulgaris*	*Coffea arabica*	*Agare sisalana*

Table: 2.6(b): below shows identification of living things according to taxonomic hierarchy

Table: 2.6(b): Classification of some members of Kingdom Animalia according to taxonomic hierarchy

Rank	Human	Leopard	Gazelle	Housefly
Kingdom	Animalia	Animalia	Animalia	Animalia
Phylum	Chordata	Chordata	Chordata	Arthropoda
Class	Mammalia	Mammalia	Mammalia	Insecta
Order	Primates	Carnivore	Artiodactyla	Diptera
Family	Hominidae	Felidae	Bovidae	Muscidae
Genus	Homo	Panthera	Gazella	Musca
Species	Sapiens	Pardus	Grantii	Domestica
Scientific name	*Homo sapiens*	*Panthera pardus*	*Gazella grantii*	*Musca domestica*

Using scientific names to identify organisms (Binomial system)

Naming of organisms, that is, the study of classification is called **Binomial Nomenclature**. It is a system whereby an organism is given two scientific names. The two names represent the **genus** and the **species** of the organism.

The system was devised by a Swedish scientist called Carolus Linnaeus in the 18th Century. The system is conventional in that it is accepted and used by all scientists all over the world irrespective of the language they use in their scientific studies.

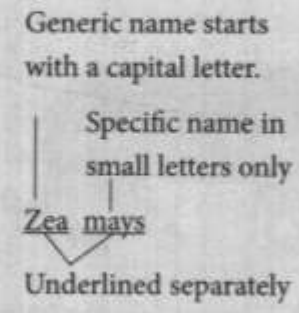
Rules of nomenclature

In giving organisms two scientific names, the following rules are observed:

1. The **generic** name is written first followed by the **specific** name.
2. The generic name always starts with a capital letter. The specific name is written in small letters only.
3. The two names should be underlined separately. If typed, they should be typed in italics to make them look different from other words in the paragraph.

Example:

The scientific names for maize is written as:



The following table summarises the scientific names of different organisms.

Table 2.7: Scientific names of different organisms

Organism	Scientific name
Domestic cat	*Felis domestica*
Dog	*Canis familiaris*
Cow	*Bos taurus*
Sweet potatoes	*Ipomea batatas*
Banana	*Musa deuminata*
Sodom apple	*Solanum incanum*

Food chains and food web

In any environment plants make their own food and animals feed on other organisms. Such relationship is called **feeding inter-relationships.**

Plants as food producers

Plants make their own food which they store as starch. Plants also take up mineral nutrients like nitrates from the soil and make plant proteins.

Plants as primary producers

The starch and plant protein made in the plant is used to make new cells and tissue for plant growth. Structures like leaves, seeds and fruits are made using food made by the plant. These nutrients can also be taken up by animals which eat the plant as food. This creates a food relationship between the plant and the animals that eat the plant.

In feeding interrelationships, it is not only nutrients that are passed on from one organism to another, but also **energy** contained in food in form of chemical energy.

The main source of energy in an ecosystem is the sun. The sun produces solar energy.

Light energy from the sun is trapped by **green plants** and used during the process of photosynthesis to form carbohydrates. The light energy is thus converted to chemical energy and stored in the plant. This explains why plants are termed as **primary producers.**

Animals as food consumers

Some organisms feed directly on the plants to obtain energy. These organisms are known as **herbivores**. They include cows, goats, sheep, zebras among others. Other organisms obtain this energy indirectly by feeding on the herbivores. These organisms are known as **carnivores**. They include lions, leopards, dogs among others. Collectively, both herbivores and carnivores are called **consumers** because they cannot manufacture their own food.

When an organism dies, some of the chemical energy in the organism is released into the surroundings when it decays. Some energy in animals is also lost as heat energy in their breath, urine, faeces and sweat.

Identify animals according to their mode of feeding

1. Herbivorous mode of feeding

In the herbivorous mode of feeding, animals feed on plant material only. These animals are called **herbivores.** The plant material may be grass or leaves and twigs. Animals that feed on grass only are called **grazers.** Examples include; cows and zebras.

Fig. 2.8: A zebra is an example of a grazer

Other animals feed on both grass, leaves and twigs. They are called **browsers.** Examples include goats and giraffes.

Fig. 2.9: A goat is an example of a browser

2. Carnivorous mode of feeding

In the carnivorous mode of feeding, animals feed on the flesh of other animals. Such animals are called **carnivores.** Examples include hawks, eagles, lions, leopards, jackals among others.

Some carnivores, like the leopard, kill the prey and feed on the flesh. Some scavenge and feed on the flesh left behind by other carnivores. Such animals are called **scavengers**. Examples of scavengers include vultures and hyenas.

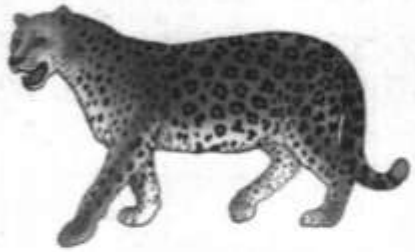


Fig. 2.10: A leopard is an example of a carnivore

3. Omnivorous mode of feeding

Omnivorous is a mode of feeding in which animals feed on a mixed diet of animal flesh and vegetable matter. The organisms are called **omnivores.** Examples of omnivores include humans.

Carnivores, herbivores and omnivores ingest complex food materials. This food material may be in solid form or in a liquid form. The solid food material needs to be broken down into smaller pieces. This is referred to as the **physical breakdown** of food. It increases the surface area of the food material in preparation for digestion by enzymes.

Constructing food chains and food webs

Activity 2.10

To establish feeding relationships between producers and consumers in your school compound

Material

- Pictures
- Textbooks
- Flip charts

- Markers
- Local environment.

Procedure

1. Go out into the school compound. Identify various organisms. Examine also photographs and pictures provided.
2. Note various types of plants.
3. Note the animals that feed on plants.
4. Note the animals that feed on other animals.

Discussion

From the activity you may have observed various types of plants. You may also have examined various animals that feed on plants. They may include caterpillars, goats, cattle, rabbits among others. These animals obtain food from plants.

You may also have observed other animals that feed on other animals. They may have included wasps, wild dogs, spiders, leopards among others. These animals can only obtain food by eating bodies of other animals.

The relationship between plants, animals that feed on plants and animals that feed on other animals can be described by use of food chains and food webs.

Food chains

A food chain is a sequence used to describe a feeding relationship between producers and consumers.

Plants are eaten by grasshoppers. This relationship can be represented by inserting an arrow between the plant and the grasshopper as follows:

Plants ⟶ grasshopper

The direction of the arrow indicates where food is being transferred to. The plant transfers food to the grasshopper or the plant is eaten by the grasshopper. If the grasshopper is eaten by a spider, another arrow is inserted between the grasshopper and the spider as shown below.

Plants ⟶ Grasshopper ⟶ Spider

This sequence is called the **food chain**.

Food webs

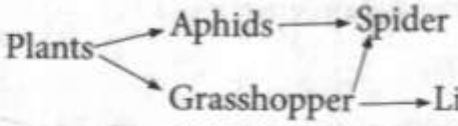
In an environment where more than one food chain are combined they form a food web. A food web shows all the animals in an environment and which animal is eaten by which. For instance, grass can be eaten by grasshoppers and aphids. Aphids can be eaten by spiders. Grasshoppers can be eaten by spiders and lizards. From the above information the following food chains can be obtained:

Grass ⟶ grasshopper ⟶ spider

Grass ⟶ grasshopper ⟶ lizard

Grass ⟶ aphid ⟶ spider

If the above food chains are combined they form a food web. It resembles the web of a spider.



Activity 2.11:

To construct food chains and food webs

Materials

- Plant specimens
- Animal specimens

- Sweet nets
- Jars

Procedure

1. Go into the school compound and sample as many organisms as you can.
2. Note what each organism feeds on by observing the organism feeding.
3. Identify the producers (plants) and the consumers.
4. Make a list of all organisms studied.
5. Using the organisms, construct food chains.
6. Using the food chains, construct a food web.
7. Compare your food web and food chains with those of your friends.

Feeding structures in animals

For animals to feed, they need feeding structures that enable them to obtain and eat their food.

Activity 2.12:

To investigate various feeding structures in animals

Material

- Local environment
- Pictures
- Textbook
- A skull of a sheep or goat with teeth
- Photos of various birds

Procedure

1. Study the specimens and photographs provided to you by your teacher.
2. Examine them and identify various structures used for feeding by the animals.
3. Draw and label various types of feeding structures.

Discussion

From the activity, you may have realised that animals have different types of feeding structures. Feeding structures for animals feeding on plants are different from those of animals feeding on other animals. The feeding structures in animals are the teeth, beaks and feet of birds.

1. Teeth of mammals

A tooth is a hard white structure in the mouth of an animal used in biting and chewing of food. The outer part is made up of a hard white material called **enamel** which protects the inner tooth from infection and damage. The external part of the tooth is made of the crown, neck and root.

Types of teeth

There are four types of teeth formed in herbivores, carnivores and omnivores.

These are incisors, canines, molars and premolars.

(a) Incisors

They are located on the front of the jaws. They are shaped like a wedge or chisel. This creates a flat surface with a sharp edge that makes the incisor teeth suited for **cutting** and **biting**.

Fig 2.11: Incisors

(b) Canines

They are located on the left and right of the incisors. Canines are pointed teeth. Their basic function is to **pierce** and **hold** food. In man, canines are poorly developed and are rarely used.

Fig. 2.12: Canines

(c) Premolars

They are located after the canines towards the back of the jaw. They have broad top surfaces usually with two projections called **cusps**, that give them a ridged appearance. They are used to **crush** and **grind** food.

Fig. 2.13: Premolar

(d) Molars

They occupy the back of the jaw in the cheek. They have broad top surfaces with four or five cusps which form a ridged surface. They are also used to **crush** and **grind** food.

We are advised to brush our teeth after every meal to prevent decay.

Fig. 2.14: Molar

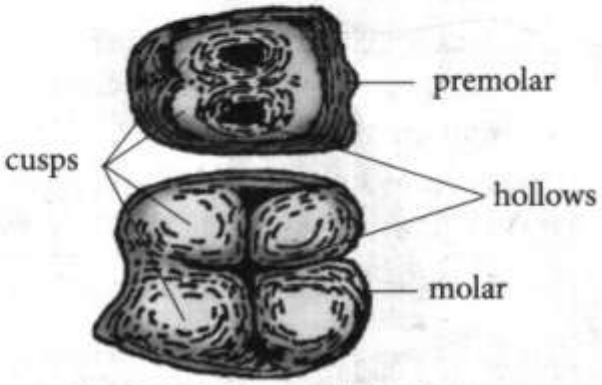


Fig. 2.15: Molar teeth showing cusps

The structure of a mammalian teeth

External features of teeth

A tooth has three regions. These are the **crown**, **root** and **neck**. The crown projects above the gum, the root is fixed in a socket in the jaw-bone and the neck is the narrow part which lies between the root and the crown.

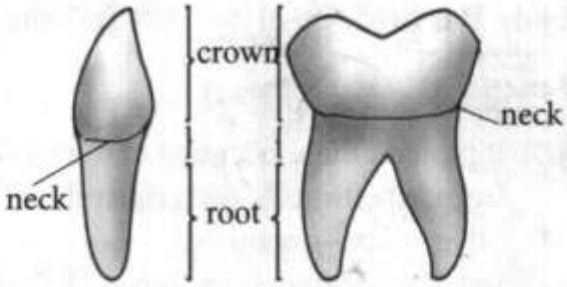


Fig. 2.16: External features of teeth

The internal structures of teeth

When a tooth is cut lengthwise into two, the internal parts. The internal structure of an incisor and molar tooth show the following parts.

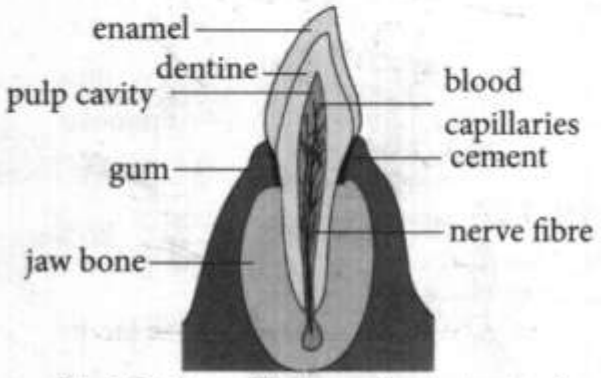


Fig. 2.17: Internal features of an incisor tooth

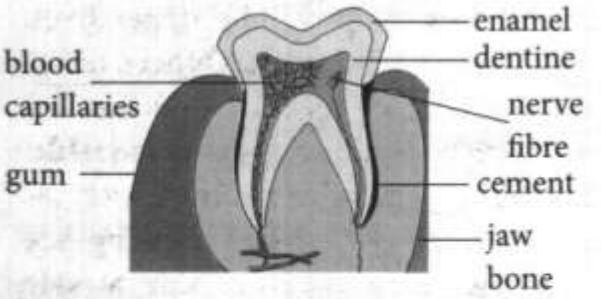


Fig. 2.18: Internal structure of a molar tooth

(i) Enamel

The enamel is the outer part of the tooth. It is the hardest substance in the human body. It is made up of non-living tissue.

Functions

- It protects the inner parts of the tooth from infection by bacteria and other micro-organisms.
- It protects the inside of the tooth from mechanical damage by hard food material such as bones.
- It provides a hard biting surface for effective chewing of food.

(ii) Dentine

This is the part of the tooth found immediately beneath the enamel. It is not as hard as the enamel. It is made up of living cells.

Functions

- It forms the bulk of the tooth.
- It replaces worn out enamel.
- It prevents the teeth from cracking.

(iii) Pulp cavity

It is found at the centre of the tooth. The pulp cavity contains numerous blood capillaries and sensory nerves. These enter the pulp cavity through a small opening at the bottom part of the root.

Functions

- The blood capillaries supply nutrients and oxygen to the cells of the pulp cavity. They also transport waste material and carbon dioxide from the tooth.
- The sensory nerve fibres have nerve endings that make the tooth sensitive to temperature and pain.
- Special cells in the pulp cavity produce dentine which forms the bulk of the tooth.

(iv) Cement

It is similar to a bone in structure. It lines the root and holds the tooth in its socket in the jaw.

(v) Periodontal membrane

This membrane is found between the cement and the jaw bone in the socket of the tooth.

Functions

1. It contains cells that secrete cement.
2. It allows the tooth to move slightly to avoid breaking during chewing.

Care of teeth

- We are advised to brush our teeth after every meal to prevent decay.
- We should avoid eating sugary foods such as sweets and sodas in between meals.
- We should eat foods such as sugarcane and carrots that strengthen our teeth when we chew them.

Teeth in a herbivorous mammal

The teeth in sheep are closely related to the food it eats which is mainly grass. The sheep has no upper incisors and canines. Instead, their place is taken up by a **horny pad** as illustrated in Fig. 2.19.

The lower jaw has incisors and canines which are chisel shaped. In herbivores, canine teeth are either absent, very small or form tusks like in elephants. When the sheep is grazing, the lower incisors and canines **press and cut** the grass against the horny pad.

The sheep also has a large gap called the **diastema** between the front teeth and the molars of the lower jaw. This creates space for the tongue to move in such a way that the chewed grass is separated from the recently ingested grass.

The molar teeth in sheep have broad upper surfaces which provide a large surface area for grinding grass.

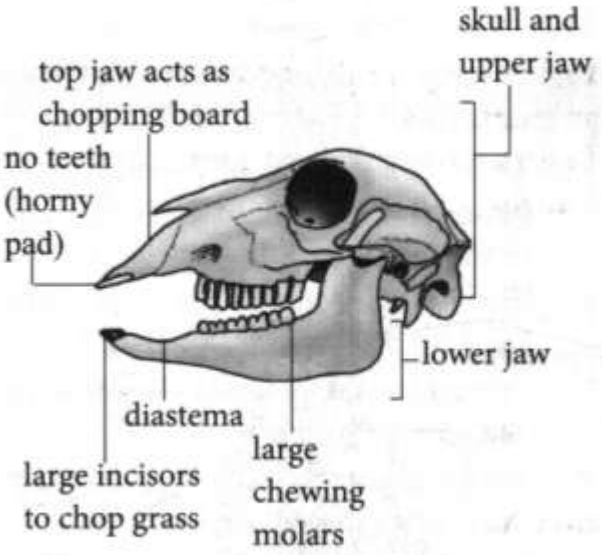


Fig. 2.19: Teeth arrangement in sheep

The surface area of molars is further increased by cusps in the upper teeth which form a W-shape, and those in the lower teeth which form an M-shape. The joint in the jaw of the sheep is **movable**. This makes it possible for the lower jaw to be moved easily. When chewing, the lower jaw is moved from side to side allowing the ridges of the upper jaw molars to fit closely into those of the lower jaw as they grind the grass.

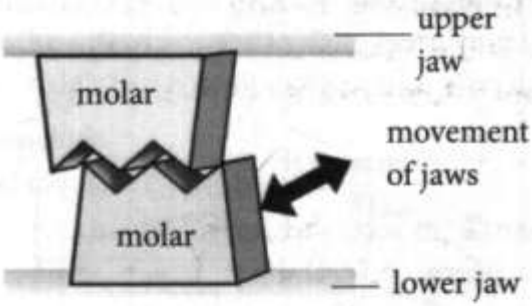


Fig. 2.20: Molars in the upper and lower jaws of the sheep slide against each other during chewing

Main features in the teeth of sheep

- There are no upper incisors or canines. In their place their is a **horny pad**.
- There is a gap called the **diastema** between the front and the back teeth in the lower jaw.
- The incisors in the lower jaw are large.
- Premolars and molars are large in size and similar in shape.
- Powerful cheek muscles move the lower jaw upwards and sideways.

Teeth in a carnivorous mammal

The dog is a carnivore. Carnivores are efficient in capturing and killing their prey. They have small, pointed incisors. These are used for picking up and stripping off small pieces of flesh or meat from the bone.

Their canines are sharp, pointed and long. They are used for stabbing and killing prey. They also pierce and penetrate the flesh so that the animal can hold firmly onto its prey to prevent it from escaping.

The molars and premolars in the dog have a broad surface with pointed cusps. They meet each other to crush and crack bones and to slice flesh.

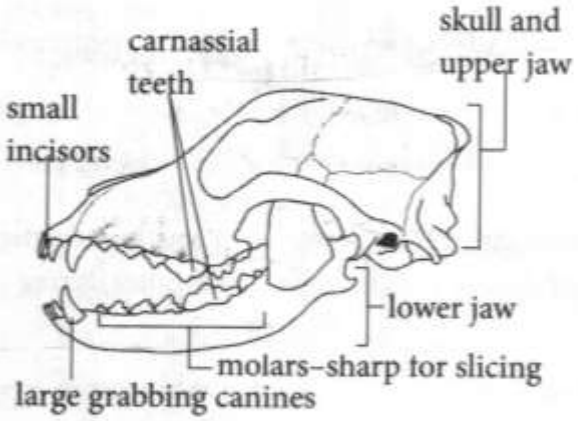


Fig. 2.21: Teeth arrangement in dog

The dog has **large carnassial** teeth. The carnassial tooth in the upper jaw is the last premolar in that jaw whereas the carnassial teeth in the lower jaw are the first molars in this jaw. Carnassial teeth have **sharp cutting edges**.

The upper jaw and lower jaw carnassial teeth pass against each other during the up and down jaw movement and act as **shears** or scissors. They **slice off meat** and **crack bones**.

The jaw muscles are strong and the hinge joint between the two jaws allow only up and down movement of the lower jaw. The table below summarises the type of teeth in an animal and their functions.

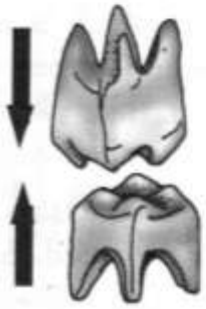


Fig. 2.22: Molars and premolars of the dog crush meat and bones when the jaw moves up and down

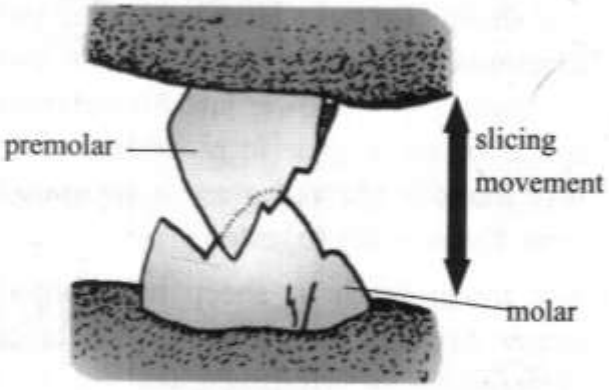


Fig. 2.23: A carnivore's carnassial teeth

Table: 2.8: Summary of type of teeth in an animal and their functions

Type of teeth	Mammal	Shape	Function
Incisor	Human	Wedge or chisel shaped; flat surface with **sharp edge.**	Biting and cutting
	Sheep	• No upper incisors, replaced by horny pad. • Lower incisors are chisel or wedge shaped with sharp edges.	Cutting
	Dog	Small and pointed.	Stripping off small pieces of flesh from bones
Canine	Human	Not very well developed, pointed.	Pierce and hold food
	Sheep	• No upper canines. • Lower canines are chisel or wedge shaped.	Cutting
	Dog	Long, sharp and pointed.	• Stabbing/piercing and killing prey. • Hold prey firmly to prevent it from escaping.
Premolar and molar	Human	Top surface is broad, has cusps which give it a ridged appearance.	Crush and grind food
	Sheep	Top surface broad and has cusps which give it a ridged appearance.	Grinding grass
	Dog	Broad top surface with pointed cusps.	Crushing and grinding bones and flesh.
Carnassial	Dog	Sharp cutting edges.	Shear or slice meat/flesh and crack bones

Main features in the teeth of a dog

- They have large canine teeth.
- They have massive **carnassial** teeth.
- They have powerful cheek muscles move the lower jaw up and down in a snapping action.

2. Beaks of birds

Feeding in birds

The method of feeding in a bird depends on the shape of its beak.

Different methods of feeding in birds are demonstrated by the differences in the shape of their beaks. The following figures illustrate different types of beaks of birds.

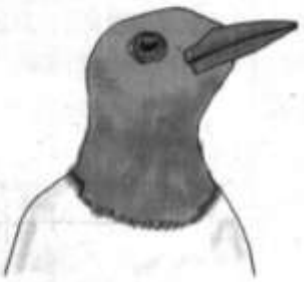
1. Hawk

Has short, thick curved and pointed beak for tearing meat. This beaks are found in all large carnivorous birds.

(a) Eagle

2. Wood pecker

Has a thick and a strong pointed beak that acts both as a chisel and a crowbar to remove bark and find hiding insects.



(b) Wood pecker

3. Chicken

Chickens have pointed beaks for picking seeds.

(c) Chicken

4. Stork

Storks have long beaks suitable for catching small aquatic animals such as small fish, frogs and crabs.

(d) Stork

5. Hornbill

Has strong beak for eating fruits.

(c) Hornbill

6. Parrot

Has strong hooked beak for cracking nuts.

(f) Parrot

7. Sunbird

Has long sharp beak for sucking nectar from flowers.

(g) Sunbird

8. Swift

For feeding on seeds.

(g) Swift

9. Duck

Has a wide beak to search for food in mud.

(i) Duck

Fig. 2.24: Beaks of different birds used for feeding

3. The feet of birds

The method of feeding in birds can also depend on the shape of their feet. For example, the feet of heron is adapted to walk on mud. The different methods are demonstrated by the difference in the shape of claws. The following figures illustrate different types of feet of birds and their adaptations to their mode of feeding.

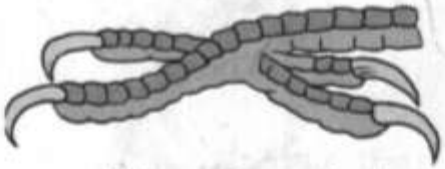
1. Hawk

Hawks feed on chicks, rats, small birds and other small animals. Their feet are important in hunting. Hawks locate their prey with their keen eyesight, catch and kill them with their feet. The feet have sharp claws called **talons** which are curved and strong. They also have rough bumps on their toes to hold on to slippery fish.

(a) Foot of a hawk

2. Woodpecker

Woodpeckers have feet that are equipped with two toes, two up front and two in the back. This helps to give them powerful grips to cling on the sides of trees. Woodpeckers feed on insects found in tree trunks, nuts and sap from trees.



(b) Foot of a woodpecker

3. Chicken

The feet of chickens contain only part of the ankle bones. The feet have five toes with short claws at the tip. Chickens use their feet for scratching food such as seeds and insects from the soil.

(c) Chicken

4. Heron

The heron has long toes suitable for walking on mud. This is because herons feed on small animals found in swampy areas.

(d) Foot of a heron

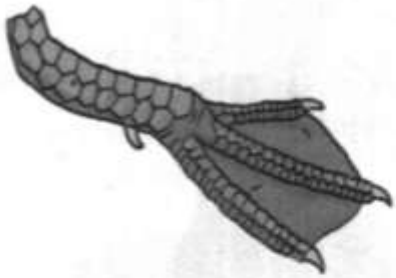
5. Sparrow

The sparrows have feet that are adapted for perching and grasping twigs. The feet are slender. Sparrows feed on seeds.

(e) Foot of sparrow

6. Water-duck

The feet of water-ducks have the three front toes connected with a web of skin. This helps them to paddle through water and walk on mud to be able to obtain food such as fish from the water.



(f) Feet of a water-duck

7. Pigeon

Pigeons feed on seeds and fruits. Their feet is made up of four toes that are adapted to hopping and clinging on branches.

(g) Feet of a pigeon

Fig. 2.25: Feet of different birds used for feeding

Revision Exercise 2

1. Which one of the following is not a characteristic of animals?
   A. Nutrition B. Movement
   C. Excretion D. Extinction
2. Which one of the following is not a taxonomic group?
   A. Class B. Order
   C. Species D. King
3. List four importance of classification.
4. Give two functions of periodontal membrane.
5. State the main features in the teeth of a sheep.
6. Define the following terms:
   (a) Classification.
   (b) Binomial nomenclature.

Unit 3 Flowering and non-flowering plants

Success criteria

By the end of the unit, the student must be able to:

(a) Describe characteristics of flowering and non-flowering plants.

(b) Describe the external features of flowering and non-flowering plants

(c) Describe habitats for different groups of plants.

Introduction

Some plants produce flowers which later develop into fruits. The fruits bear seeds which germinate to form new plants. Other plants do not produce flowers. They are propagated through other means. Plants are therefore classified as either flowering or non-flowering.

Carry out the following activity

Activity 3.1:

To categorise plants into flowering and non-flowering plants

- When carrying out this activity, care must be taken to avoid destruction of plants around the school compound. Uproot very few plants as much as possible. Only those plants that you need should be uprooted.
- Do not uproot plants that have medicinal value or those that are from rare species. It is better to cut off a part of a plant because the plant continues to grow.
- Where possible, exchange plants or leaves with other groups after you have studied yours instead of going out for more.
- Where the plants are very few, observe the plant parts on site, uproot only one or two if you need to.
- Your teacher will organise for you to grow maize or bean plants for observation of roots two weeks ahead of the lesson.

Materials

- Hand lens
- Scalpel.

Procedure

1. This activity will be done in groups of four. Go out into the school compound or surrounding environment and do the following:
   - Carefully uproot three small plants with roots still intact. (Your teacher may provide you with bean and maize seedlings already growing at a corner of the school compound).
   - Cut from different main plants ten different types of leaves.
   - Go to a damp place and uproot some moss plants.
2. Carry your specimens to the classroom or laboratory and spread them neatly on the bench or table.

Your teacher will also provide to

you some specimen plants not available in your school.

3. Examine the plant specimens carefully.
4. Categorise the plants you have collected into groups. In one group put all those plants that produce flowers. In the second group place the plants that do not produce flowers.
5. Draw and label any one flowering and on non-flowering plant.

Discussion

Plants are divided into two main groups, non-flowering and flowering plants.

Non-flowering plants

Non-flowering plants are plants which do not bear flowers. They are grouped into algae, mosses and liverworts, ferns and conifers.

Flowering plants

These are plants that bear flowers. They include all dicotyledonous and monocotyledonous. Examples include maize, beans, wheat and mangoes.

The table below show examples of flowering and non-flowering plants.

Flowering plants	Non-flowering plants
 *Maize plant*	 *Moss*

Bean plant

Pine tree

Fig. 3.1: Examples of flowering and non-flowering plants

Monocotyledonous and dicotyledonous plants

Monocotyledonous are flowering plants with one cotyledon only. Examples are maize and grass. Dicotyledonous are flowering plants with two cotyledons. Examples are beans and groundnuts.

Carry out the following activity.

Activity 3.2:

To categorise flowering plants into dicots and monocots

Materials

- Specimens of flowering plants such as maize seedling, bean seedling, (the seedlings should have all the roots.
- Seeds of beans and maize

Procedure

1. Examine the seedlings of maize and beans.
2. Note the structure of the leaves. Note the difference between their veins.
3. Note the shape of their leaves.

4. Examine the seed specimens provided to you by your teacher. How many cotyledons can you observe in the maize seed and in the bean seed.
5. Examine the roots of both plants.
6. Record your observations from the activity.

Questions

From the activity list down three ways in which maize differ from beans.

Discussion

The veins in the leaves run parallel to the midrib while in bean leaf the veins form a network like that of a spider web.

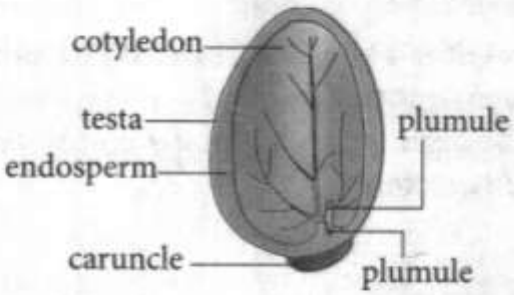
In the activity you may have noted also that the roots and the seeds of the two plants show clear differences. In beans there is one long root continuos with the stem. The one long root then forms branches. In maize there is no one root continuos with the stem. It has many roots growing from the bottom end of the stem. The root system in the bean is a tap root system, while that of the maize is a fibrous root system.

The seeds of maize have one cotyledon while those of beans have two cotyledons. The figure below summarises monocots and dicot plants.

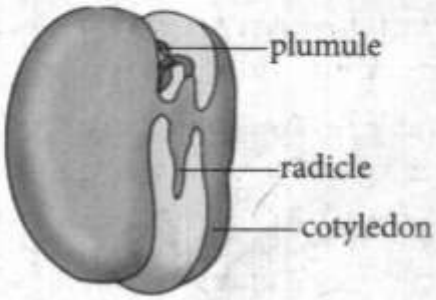
Monocot plants	Dicot plants
 *Leaf with parallel veins*	 *Leaf with network veins (reticulate venation)*

(a) Fibrous root

(b) Tap root



(c) Monocot seed



(d) Dicot seed

Fig.3.2: Parts of flowering and non-flowering plants

Dicots and monocots are therefore categorised according to the pattern of veins on their leaves, the root system and the number of cotyledons in their seeds.

Characteristics of non-flowering plants

Activity 3.3:

To investigate the features of moss and liverworts

Materials

- Hand lenses.
- Scalpels.
- Mature moss plants and liverworts for example *merchantia*, photographs or illustrations of the plants.
- White tile or paper.

Procedure

1. Place the moss plant on a white tile or paper.
2. Using a hand lens, carefully examine the moss plant.
   (a) a moss
   (b) pine
   (c) fern
   (d) algae in pond water
3. Study the parts of the following plants.
   (a) pine
   (b) fern
4. In each note the following:
   (a) their stems
   (b) their leaves
   (c) mode of reproduction
   (d habitat - where grown

Discussion

The following are characteristics of non-flowering plants.

1. Mosses and liverworts

Mosses and liverworts are simple plants with simple structures. They do not have true roots, leaves or stems. They reproduce by means of spores. They are found in damp places like walls or caves. The figures below shows a moss and liverwort.

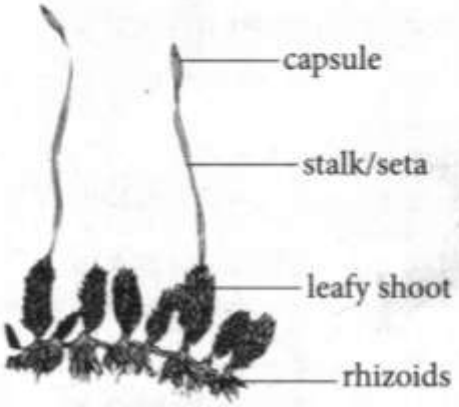


Fig. 3.3: A moss.

Fig. 3.4: A liverwort

2. Algae

Algae are simple plant-like organisms. They have chlorophyll and can photosynthesise. They are usually found in water. Examples of algae are spirogyra and sea weeds. The figure below shows a spirogyra.

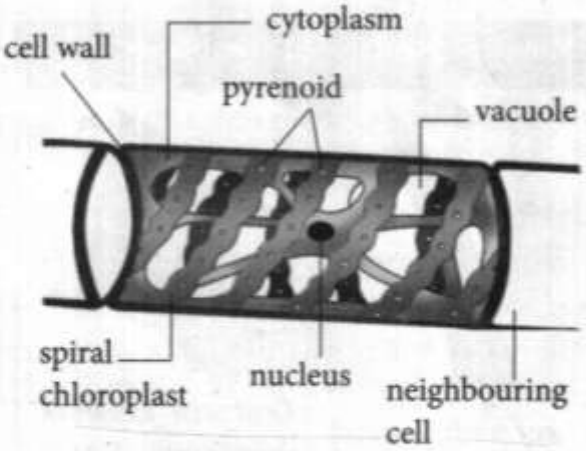


Fig. 3.5: Spirogyra.

Spirogyra reproduce by fragmentation or by production of spores.

Their bodies are made of simple elongated cells and they do not have roots, stems and leaves.

3. Ferns

Ferns are large green plants with true roots, stems and leaves. They have leaves with leaflets. They produce spores which grow into small plants. These small plants produce sperms and eggs which on fertilisation produce fertilised eggs which grow to form a new fern. They do not produce flowers. They are grown in shaded areas, some grow on the barks of other trees.

Ferns have underground stems called rhizomes.

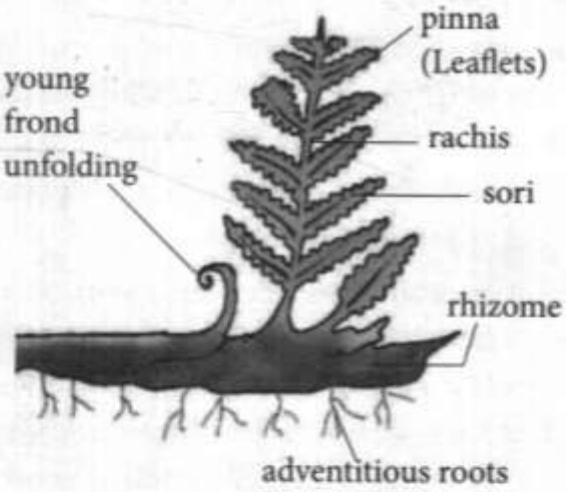


Fig. 3.6: A fern

4. Conifers

These plants do not produce flowers instead they produce structures called cones. Examples are pine, cedar, cypress, podo, cycards and junipers.

They have true leaves that are modified into needle-like structures.

They have woody stems and produce seeds in structures called cones.

Fig. 3.7: A conifer

Characteristics of flowering plants

Flowering plants are plants which produce flowers. Flowers contain reproductive structures which produce seeds. Flowering plants are divided into two main groups: **monocotyledons** and **dicotyledons**.

Flowering plants have true leaves. They have well developed stems and roots.

Monocotyledons

Monocotyledons have seeds which have one cotyledon. They have narrow leaves with parallel veins. They have a fibrous root system. An example of a monocot is maize.

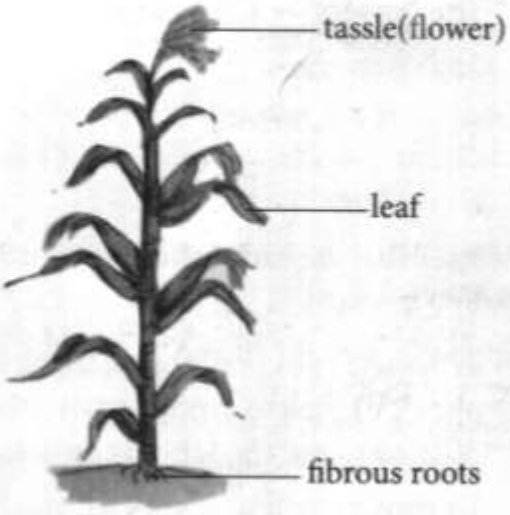


Fig. 3.8: A maize plant.

Dicotelydons

Dicotyledons are plants whose seeds have two cotyledons. They have broad leaves which have network veins. They have a tap root system. Examples include beans, peas, mangoes and jacaranda.

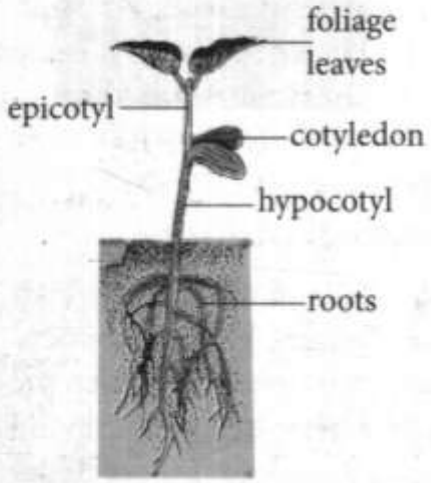


Fig. 3.9: A bean seedling

External features of flowering and non-flowering plants

The external features of flowering and non-flowering plants include:

- The leaves
- The roots and root-like structures
- The flowers
- The stems

Carry out the following activity.

Activity 3.4:

To observe external features of non-flowering plants

- When carrying out this activity, care must be taken to avoid destruction of plants around the school compound.
- Uproot very few plants as much as possible. Only those plants that the root system is needed should be uprooted.
- It is better to cut off a part of a plant because the plant continues to grow.
- Where possible, exchange plants with another group of students instead of going out for more.
- Where the plants are very few, observe the plant part on site, uproot only one or two if it's a must.

Materials

- Hand lens
- Scalpels
- Pencils
- Textbooks
- Non-flowering plants like algae, moss, ferns, pine trees

Procedure

Go out into the school compound or surrounding environment and do the following:

1. Carefully uproot three small plants with roots still intact.
2. Carefully observe the leaves, stem and other structures of pine tree, draw and label the parts carefully.
3. Carefully use the beaker to scoop algae from the school pond or nearby stream.
4. Carry your specimens to the classroom or laboratory and spread them neatly on the bench or table.
5. Observe the external features of the algae under the light microscope, draw and label the external features.
6. Observe the external features of moss, liverwort and ferns and draw and label the external features.

Activity 3.5:

To observe various parts of flowering plants

Materials

- Various parts of flowering plants for example stems, flowers and roots
- Hand lens
- Textbooks
- Pencils

Procedure

1. Collect various parts of flowering plants from both dicots and monocots. These includes root systems, leaves, stems, flowers and seeds.
2. Observe the features of the parts collected.
3. In the roots, note the root system of each specimen collected.
4. In the leaves note:
   (a) the venation of the leaves
   (b) the leaf arrangement
5. Draw and label various parts of a flowering plant.

Questions

1. What is the difference between the root system of a monocot and dicots.
2. What is the difference between the leaf venation of dicots and monocots?
3. How are leaves arranged on the stems of dicots and monocots?

Discussion

From the activity you may have realized that parts of flowering plants have different variations. Leaves of monocot are usually elongated and their veins are parallel. In dicots the leaves are less elongated and the veins are networked.

You may have also realised that the leaves of monocots are attached to the leaves of the nodes by use of a sheath. The leaves alternate each other. In dicots, leaves are arranged by use of petiole on the node. Some are arranged oppositely while others are arranged alternating. Monocot root systems are fibrous while dicot root system one tap root system.

The figures below show various features of leaves of plants

(b) Parallel veins

(b) Rough texture

(c) Smooth margins

(d) Trifoliate

(e) Broad leaf

(e) Serrated margin

Fig. 3.10: Photographs of common simple leaves

Leaf mosaic refers to arrangement of the leaves in the stem to avoid overlapping and overshadowing.

The figures below show various types of leaf arrangement in plants.

(a) Alternate leaf arrangement

(b) Opposite leaf arrangement

(c) Whorl leaf arrangement

Fig. 3.11: Leaf arrangement in plants

Plants have different flowers. The structure of the flower and its colour differ from plant to plant.

The figures below show various types of flowers.

(a) Hisbiscus rosa flower-sinensis flower

(b) Solanum incanum (sodom apple) flower

(c) Malvacaeae flower

(d) Nyctaginaceae (Bougainvillea) flower

Fig. 3.12: Different flowers

Habitat of different groups of plants

A habitat refers to a home of a place where an organism lives. A habitat provides all the conditions necessary for survival of a given organism In this section we will learn about habitats of different types of plants. Carry out the following activity.

Activity 3.6:

To investigate habitats of different groups of plants

Materials

- Hand lens
- Polythene bags
- Specimen jars
- Scalpels
- Photos of plants in different habitats
- Charts
- Plant specimens

Procedure

1. Make a field work to some of the following areas:
   - a river bank
   - a forest
   - a grassland
   - a garden
   - a dry area – arid and semi arid area
   - a water pond
   - a beach
2. Identify various plants found in the area you have visited.
3. You can also study photos, video clips or pictures of plants in various habitats provided by your teacher.
4. In each area note the following:
   - The climatic conditions of the area
   - The types of plants found in that area
   - Special characteristics of the plants found in the area
5. Note the differences between plants found in well watered areas and plants found in dry areas.
6. Note the types of plants found in shaded areas.
7. Using a scalpel cut some leaves from each plant examined and put them in the polythene bag. Also correct various types of seeds from each habitat and put them in the specimen jar. Each jar for each habitat studied. Take the specimen to the lab for future study.
8. Write a report on your findings.

Discussion

From the activity you may have realised the following:

Flowering and non-flowering plants are found in all habitats. Some are found in water others near water bodies, in gardens, forests and even in dry areas. Some plants are found on land where they are well exposed to the sun while others grow under shade. For instance the fern grows in shaded areas under forests. In some areas it is found attaching itself on the bark of trees.

The moss are found growing in moist walls or on the bark of trees in the forest. They are also found along the riverbanks and on the surface of rocks along river banks. Water plants such as the water lilies and the *salvinia* weed are found floating on water in the lake like Lake Malawi. They have their roots suspended in water and their broad leaves enable them to float on water.

In the ponds there are masses of algae that make the water to be green in colour. The algae are tiny and are in form of filaments. They grow in stagnant water.

In the garden and forest plants grow rapidly with very many leaves. This

makes them to become bushy and cover the ground. These plants have sufficient water and light exposure hence they grow very well.

In open land, monocots especially grasses grow and cover the ground.

However in dry areas, few plants are found. The plants include the cactus, the euphorbia and acacia. The plants in dry areas have small leaves and some do not have leaves. This enables them to reduce loss of water over their leaves. Due to lack of enough water many plants are not found in dry areas. Most of the ground is bare.

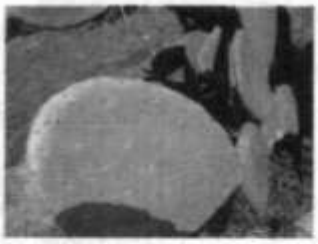


Fig. 3.13: Cactus

Fig. 3.14: Euphobia

Fig. 3.15: Acacia

In the savannah grassland the grass grows tall under the tree and it is usually tough. This makes it to survive the harsh conditions in the semi-arid area.

Fig. 3.16: Savannah grassland

Revision Exercise 3

1. Which one of the following is not an example of conifer plants?
   A. Podo
   B. Cycards
   C. Cypress
   D. Peas
2. Which one of the following is a characteristic of the moss plants?
   A. They have true roots.
   B. They reproduce by fragmentation.
   C. They have leaves with leaflets
   D. They do not have true stems.
3. State one major characteristic of flowering plants.
4. What features are used to categorise plants either as dicots or monocots?
5. List any two characteristics of spirogyra.

Unit 4 Animal Structure and Function

Success criteria

By the end of this unit, the student must be able to:

(a) Describe the characteristics of invertebrates.

(b) Describe characteristics of vertebrates.

Introduction

Animals are broadly grouped into two; vertebrates and invertebrates. Vertebrates are animals with a backbone while invertebrates do not have a backbone.

Characteristics of invertebrates

Carry out the following activity and use it to study characteristics of invertebrates.

Activity 4.1:

To investigate characteristics of invertebrates

Materials

- Sweep nets
- Nets
- Collecting bottles
- Gloves
- Alcohol (anaesthesia)
- Forceps
- Safety clothing

Procedure

1. Go out in the field.
2. Working in groups collect the following specimens guided by your teacher.
   (a) Ants, cockroaches, butterflies
   (b) Spiders, snails, earthworms and millipedes
3. Take a piece of cotton wool. Dip in alcohol, place the cotton wool in each bottle. The animals will inhale the alcohol and become calm and less mobile.

   Note: Avoid trapping dangerous animals such as bees, centipedes and scorpions.
4. Take the specimens to the laboratory.
5. Examine the specimens you have collected together with the preserved specimens provided to you by your teacher.
6. Observe the external features of these organisms.

Questions

1. What is the common characteristic of the organisms that you have observed?
2. Write down various external features of organisms you have observed.

Discussion

From the activity you may have realized that all of the specimens did not have a backbone. All organisms with no backbone are called **invertebrates**. They are usually small in size. Some have no legs, others have few legs while

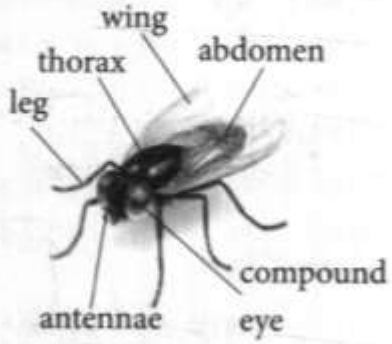
others have many legs. Examples of invertebrates include:

(a) Insects

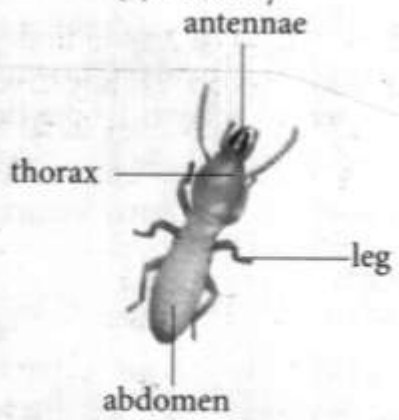
Insects have the following external features:

The body of insects is divided into three distinct parts: head, thorax and abdomen. They have 3 pairs of legs that are attached to the thorax. Some insects have wings while others do not.

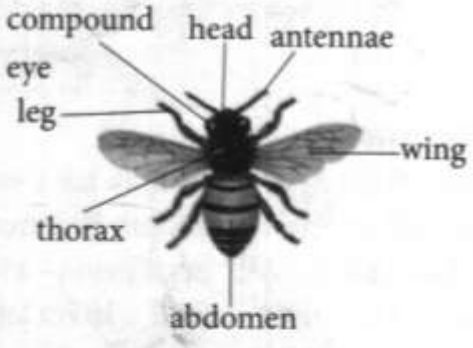
All insects have antennae and compound eyes.



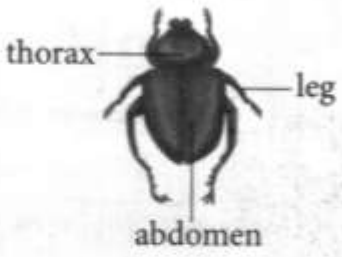
(a) Housefly



(b) white ant

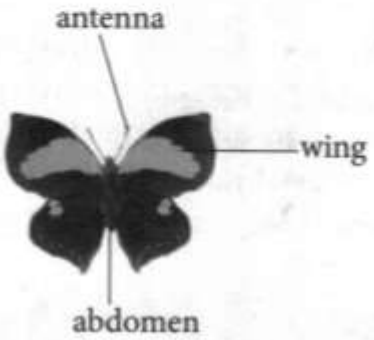


(c) bee

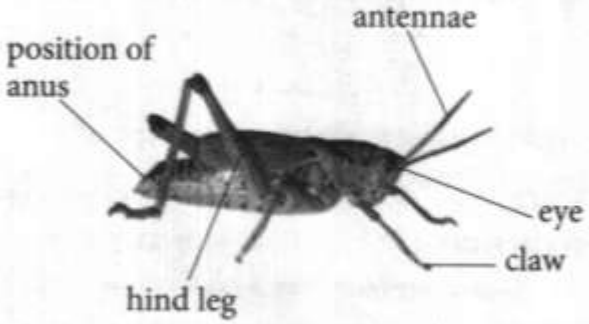


(d)beetle

(e) flea



(f) butterfly



(g) grasshopper

Fig. 4.1: Examples of insects

(b) Crustaceans

Crustaceans have many legs and two pairs of antennae. Their bodies are divided into two parts and covered with a hard shining coat. Examples of crustaceans include crabs *(Fig. 4.2)*, prawns, crayfish and shrimps.

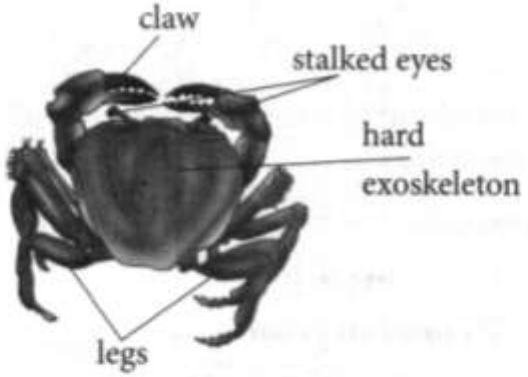


Fig. 4.2: Crab

(c) Nematodes

Nematodes have cylindrical bodies which are not segmented and they reproduce sexually, having separate sexes. Their bodies are pointed at both ends. Examples include *Ascaris spp. (Fig. 4.3)* and hookworms.

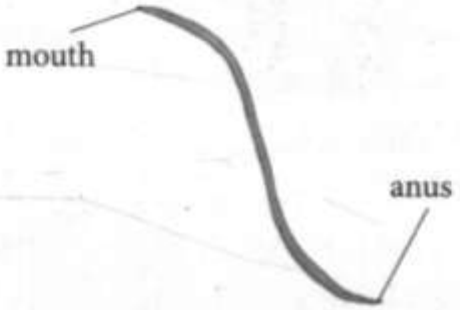


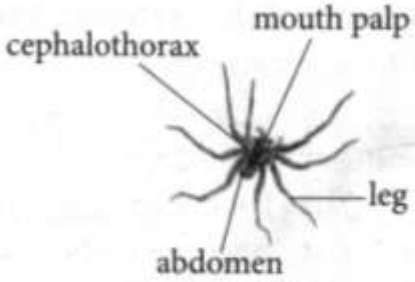
Fig. 4.3: Roundworm

(d) Arachnids

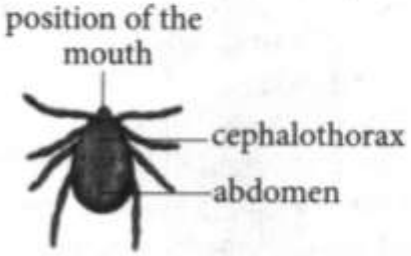
Arachnids include organisms like spiders, mites, and ticks. Some organisms like ticks are ectoparasites. They suck blood from animals like cows and dogs. In cows, ticks transmit diseases such as East Coast Fever. In some cases, they can cause death of animal in large numbers which can be a great loss to a farmer.

They have the following characteristics:

- The body is divided into two parts: cephalothorax and abdomen. The head and thorax are fused to form a cephalothorax.
- They have four pairs of jointed legs attached to the cephalothorax.
- They have simple eyes.
- They have no antennae.



(a) Spider

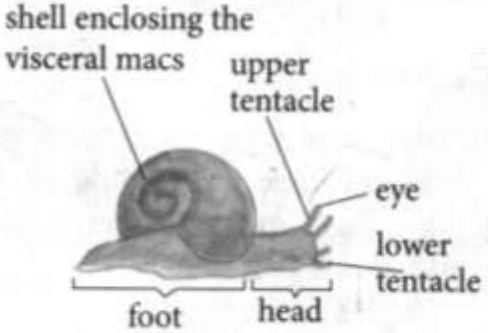


(b) Tick

Fig. 4.4: Examples of arachnids

(e) Molluscs

These are animals with soft bodies which are enclosed in a shell. They have a slimy muscular foot. Examples include snails, slugs *(Fig. 4.5)*, catfish and cuttlefish.



(a) Snail

(b) Slug

Fig. 4.5: Examples of molluscs

(f) Annelids

Annelids are segmented worms with chaetae (bristles). They live in moist soils. Examples include earthworms *(Fig. 4.6)*, lugworms and leeches.

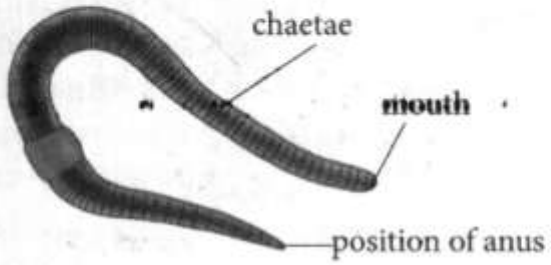


Fig. 4.6: An earthworm

(g) Millipedes

Millipedes have long cylindrical bodies. Their bodies are divided into two parts, the head and a segmented trunk. Each body segment has two pairs of legs.

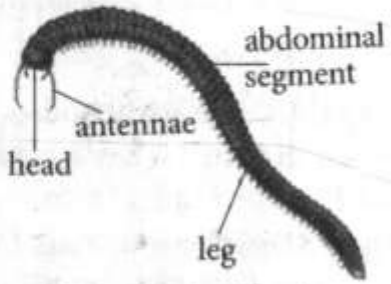


Fig. 4.7: A millipede

(h) Centipedes

Centipedes have long flat bodies with legs positioned on either side of the body. They have many segments. Each segment has one pair of legs.

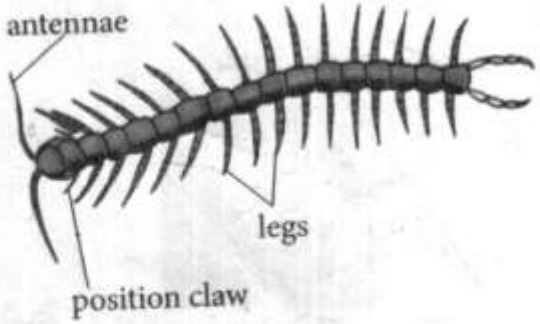


Fig. 4.8: A centipede

Characteristics of vertebrates

Activity 4.2:

To investigate the characteristic of vertebrates

Materials

- Collecting bottles
- **Pictures and charts**
- Anaesthesia or alcohol
- Sweepnets
- Basket nets
- Rats
- Fish
- Frogs
- Samples of dead or preserved animals
- Gloves
- Safety clothing
- ICT

Procedure

1. Go out in the local environment with your teacher.
2. Working in groups, collect the following specimens guided by your teacher using the sweep nets and basket nets.
   (a) frogs (b) fish (c) birds
3. Put them into the collecting bottles with a little anaesthesia to calm them.
   Note: Avoid trapping dangerous animals like snakes and toads.
4. Take the organisms back to the laboratory.
5. Observe these organisms together with specimen of preserved animals, pictures, charts and ICT provided.
6. List down their external features.

Questions

1. What are the common characteristics of the organisms that you have observed?
2. Write down various external characteristics of organisms you have observed.

Discussion

The organisms observed are all vertebrates. Vertebrates are animals with a backbone. Examples of vertebrates include:

(a) Fish

All fish live in water, their bodies are covered with scales, they have gills and have fins for movement.

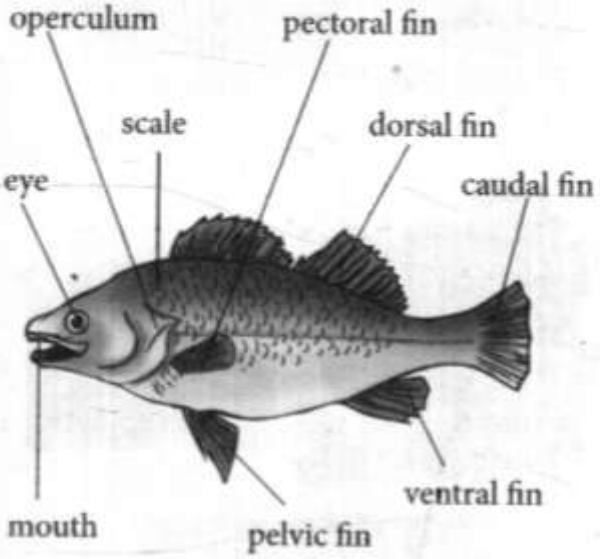
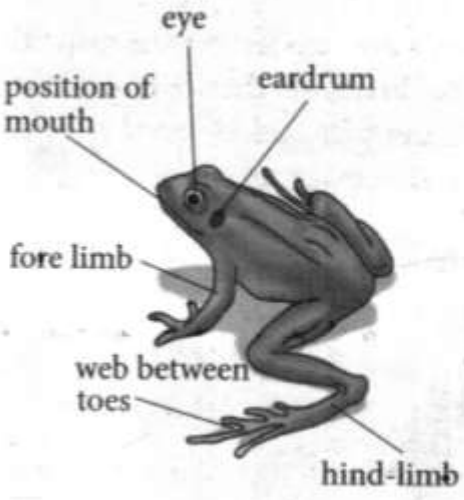


Fig. 4.9: A tilapia fish

(b) Amphibians

The word *amphibia* comes from 'amphi' which means 'dual' or two. They live in both land and water. They are several varieties of amphibians newts, salamanders, toads and frogs. They have mucous glands under their skin to keep the skin moist. Young amphibians have gills and live in water adults live on land.



(a) Frog

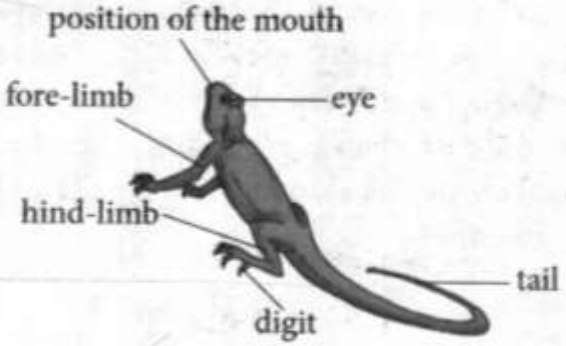
(b) Toad

(c) Salamander

Fig. 4.10: Examples of amphibians

Reptiles

The *'reptilia'* comes from Latin 'reptilis' which means to crawl. Reptiles move by creeping or crawling. Examples are snakes, turtles, tortoises, crocodiles and lizards.

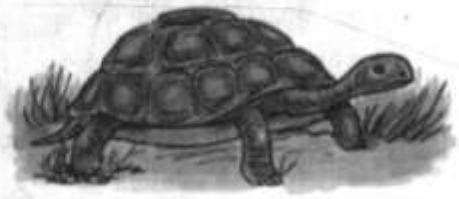


(a) lizard

(b) Snake

(c) Crocodile

(d) Chameleon

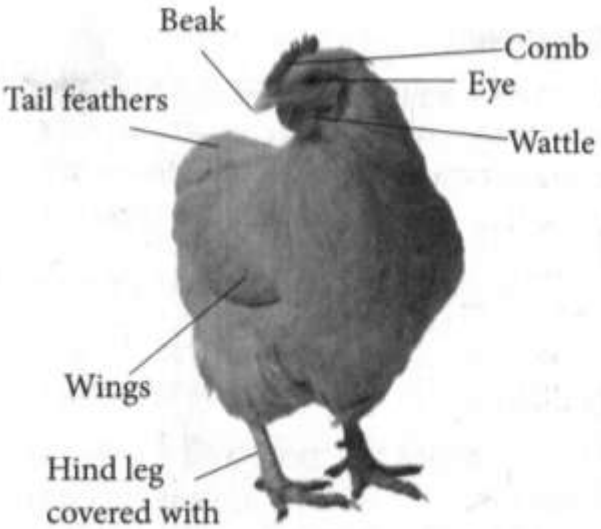


(e) Tortoise

Fig. 4.11: Examples of reptiles

(d) Birds

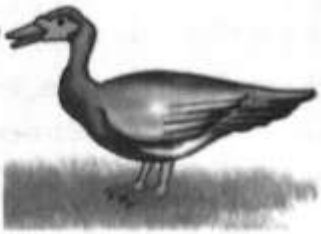
Birds have bodies covered with feathers, their legs are covered with scales. Their front limbs are in the form of wings. They have beaks for feeding. There are many examples of birds, some are as follows: hawks, sparrows, eagles, chicken, ostriches, parrots, sea gulls and many others.



(a) Domestic fowl

Fig. 4.12: Parts of a hen

(b) Guienea-fowl



(c) Duck

(e) Turkey

(d) Eagle

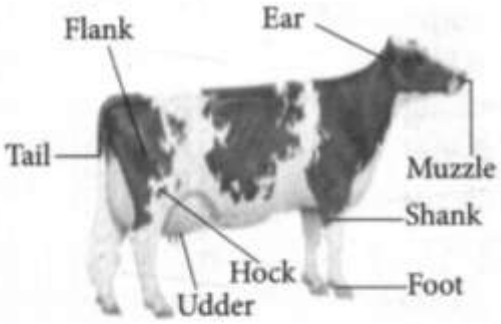
(f) Weaver bird

(g) Dove

Fig. 4.12: Examples of birds

Mammals

The word mammals comes from the Latin word *mammalia* which means the mammary glands. In female its the organs that secretes milk. The external features in mammals include the presence of mammary glands, bodies covered with hair or fur, external ears, and differentiated teeth. Some examples of mammals include, cats, dogs, cows, sheep, goats, whales, spiny ant eaters, polar bears, bats and kangaroos among others.



(a) Cow

(b) Goat

(c) Dog

(d) Sheep

(e) Zebra

(f) Lion

(g) Kangaroo

(h) Bat

(i) Rabbit

Fig. 4.13: Examples of mammals

Revision Exercise 4

1. Which one of the following is not an external feature of insects?
   A. They have three body parts.
   B. They have antennae.
   C. They have simple eyes.
   D. They have three pairs of legs.
2. Which one of the following is an example of molluscs?
   A. Earthworm
   B. Lungworm
   C. Leeches.
   D. Catfish
3. List any three characteristics of amphibians.
4. What is common about all mammals?
5. List any three examples of invertebrates.
6. List two characteristics of crustaceans.

Unit 5

Nutrition in humans

Success criteria

By the end of this unit, the student must be able to:

(a) Describe the different food nutrients.

(b) Test given food stuff for starch, proteins, reducing sugars, non-reducing sugars and lipids.

(c) Investigate common sources of food nutrients in the communities.

(d) Plan a balanced diet.

(e) Describe deficiency diseases.

Introduction

Nutrition is the process by which organisms take in food nutrients.

We have learnt that living things need food to grow. Food is made up of components known as food nutrients. All living things require food nutrients for them to stay alive.

Some nutrients provide the body with energy to grow, reproduce or move, some provide the body with building material while some strengthen the body. Without these nutrients, living things cannot stay alive.

Food nutrients

Food nutrients required by animals include carbohydrates, proteins, fats and lipids, vitamins, mineral salts and water.

Activity 5.1:

To identify different types of food nutrients

Materials

- Starch
- Sugar
- Kitchen salt
- Egg white
- Vitamin tablets
- Iron tablets
- Cooking oil
- Butter
- Margarine

Procedure

1. Study the food substances provided.
2. Identify the following types of food substances:
   (a) Carbohydrates
   (b) Lipids (fats and oil)
   (c) Proteins
   (d) Vitamins
   (e) Mineral salts

Discussions

You may have discussed and categorised the substances as follows:

Carbohydrates: Starch, sugar.

Lipids: (Fats and oils) cooking oil, butter, margarine

Protein: Egg white

Vitamins: Vitamin tablets

Mineral salts: Kitchen salt, iron tablets

The food nutrient required daily in your diet maybe grouped as:

- Macro-requirements for example proteins, carbohydrates, lipids and water. These are needed in larger quantities.
- Micro-requirements for example vitamins and mineral salts. These are needed in relatively smaller quantities.

Different types of food nutrients and their functions

Each food nutrient in the diet has a function in the human body.

1. Carbohydrates

These are chemical compounds made up of carbon, hydrogen and oxygen. Common examples include sugars and starch.

Sources of carbohydrates

The major sources of carbohydrates include:

- Maize
- Wheat
- Cassava
- Yams or plantain
- Millet
- Sorghum

Uses of carbohydrates

Carbohydrates are a source of energy for the various processes in all living things.

Carbohydrates are also used for formation of cell walls as cellulose.

2. Proteins

Proteins are compounds made up of amino acid units.

Sources of proteins

- Milk
- Beef or mutton
- Eggs
- Legumes such as beans, cowpeas, soya and peanuts.
- Fish
- Pork

Uses of proteins

They are body building nutrients; they help in the formation of enzymes and hormones in the body.

3. Fats

Fats are complex compounds made up of building blocks called fatty acids and glycerol.

Sources of fats

Fats are found in foods like groundnuts, coconuts, cooking oils, fatty meats, butter and margarine.

Uses of fats

They provide energy to the body.

They are used for formation of cell membranes.

4. Vitamins

Vitamins are complex substances which are essential for normal body growth.

There are several vitamins which are required in the body. They include:

- Vitamins A found in fish, carrots and liver.
- Vitamin B complex found in liver, eggs, meat and green vegetables.
- Vitamin C found in citrus fruit, vegetables and potatoes.
- Vitamin D found in egg yolk, fish oil, liver, dairy products.
- Vitamin E found in green vegetables, legumes, wheat and meat.
- Vitamin K found in green leafy vegetables, liver and egg yolk.

Table 5.1: Summary of names of vitamin, their sources, uses in the body and deficiency signs

Name of vitamin	Use in the body	Sources	Deficiency signs
Vitamin A (Retinol)	• Maintains healthy epithelium growth. • Promotes growth.	Fish, cod liver oil, liver, carrots.	Night blindness. Protective tissues of the eye become dry and thick.
Vitamin D (Calciferol)	• Strengthens bones and teeth. • Enables absorption of calcium and phosphorus.	Sunlight, egg-yolk, fish oil, liver, dairy products.	• Rickets. • Osteomalacia or painful bones that fracture. • Dental cavities.
Vitamin E	• For cell metabolism. • Strengthens muscle. • Prevents infertility in some animals.	Green vegetables, legumes, wheat, meat, yeast.	Muscle weakness and paralysis.
Vitamin K	• For blood clotting.	Green leafy vegetables, liver, egg-yolk.	Failure of blood to clot leading to prolonged bleeding even from small wounds.
Vitamin C (Ascorbic acid)	• Maintenance of healthy cells, tissues, blood vessels. • Promotes absorption of iron. • Promotes healing of wounds and prevents infections	Citrus fruits, vegetables, tomatoes, potatoes.	Scurvy characterised by bleeding gums.
Vitamin B_1 (Thiamin)	• For cell respiration. • Promotes nerve activity.	Liver, peas, beans, meat.	Beriberi characterised by muscle weakness, paralysis and oedema.

5. Mineral salts

Mineral salts are inorganic elements which are required in very small quantities by organisms for normal body growth.

Some important minerals and their sources

Calcium

Calcium is found in milk, cheese, nuts and green vegetables. They are used in the formation of strong bones and teeth.

Iron

Iron is found in liver, meat, egg-yolk and green vegetables. It is important in the formation of red blood cells.

Sodium

Sodium is found in common salt and it keeps the nerves in a good working order.

Iodine

Iodine is found in eggs and sea foods, vegetables and iodised salt. It is important in the formation of a hormone called thyroxine.

Potassium

Potassium is found in meat, fish, cereals and vegetables. It is important in the proper functioning of nerve cells.

Magnesium

Magnesium is found in all foods and is important for the proper functioning of muscles and nerves.

Phosphorous

Phosphorus is found in milk, cheese, eggs, and spinach. It is important in the formation of strong bones and teeth.

Table 5.2: Minerals, their sources, uses in the body and deficiency symptoms

Name of mineral	Sources	Use in the body	Deficiency symptoms
Calcium	Milk, cheese, nuts, green vegetables.	• Formation of strong bones and teeth. • Needed for muscle contraction. • Clotting of blood. (Pregnant and breastfeeding mothers need more)	• Weak bones and teeth.
Phosphorus	Milk and milk products like cheese, eggs, spinach.	• Formation of strong bones and teeth	• Weak bones and teeth.
Iron	Liver, meat, egg-yolk, green, vegetables.	• Formation of haemoglobin in red blood cells and myoglobin in muscle. (Pregnant women and young people need more).	Anaemia (iron deficiency).

Name of mineral	Sources	Use in the body	Deficiency symptoms
Sodium	Common salt	• Keeps nerves in good working order.	Muscle cramps, weakness, dullness.
Potassium	Meat, fish, cereals, vegetables	• Proper functioning of nerves and muscles as well as enzymes.	Muscular weakness, paralysis and drowsiness.
Magnesium	All foods	• Strong bones and teeth. • Proper functioning and convulsions of muscles and nerves.	Muscle tremors.
Iodine	Eggs, sea food, vegetables, iodised salt	• Formation of thyroxine.	Goitre, swelling of thyroid gland in the neck.

6. Water

Water is very important. It makes up most of our body tissues. It enables many processes to take place in our bodies. The following are some ways that our bodies use the water that we drink.

- Water helps in digestion.
- Digested food can only be absorbed when they are dissolved in water.
- Water dilutes harmful substances in our bodies and helps in their removal.
- Water helps in normal functioning of the heart.
- Water is used to transport substances in the cell and blood.

7. Dietary fibre

Dietary fibre is an indigestible component of carbohydrate rich-foods. The fibre is important in that:

- It provides a bulk to the digestive tract.
- It promotes peristalsis.

Table 5.3: Summary of food nutrients and their functions

Food nutrients	Function
Carbohydrates	Are broken down to release energy.
Proteins	Are used in making new cells for growth and repair.
Lipids	Are broken down to release energy.
Vitamins	Are important to body immunity.

Mineral salts	Some are involved in blood formation, others in bone formation.
Water	Are main components of body fluids like blood.
Dietary fibre	Promote peristalsis.

Food tests

The tests that are used to determine nutrients contained in foods are called **food tests**. Most food tests use reagents to test for the presence of food nutrients.

Reagents are chemicals that change their colour when they react with certain specific substances. The change in colour of the reagent shows the presence of a nutrient material for instance, **Benedict's solution** is a reagent which when boiled with a certain sugar, its colour changes from blue to red. In testing for carbohydrates, three tests are carried out. These are:

1. Test for starch
2. Test for reducing sugars; tests for presence of monosaccharides and maltose.
3. Test for non-reducing sugars such as sucrose.

Other tests done to determine food values include: tests for proteins, tests for vitamin C and tests for lipids.

Starch test

Activity 5.2: To test for starch

Materials

- Some glucose solution
- Starch solution
- Water
- Test tube
- Iodine solution
- Dropping pipettes
- Test tube rack and measuring cylinder.

Procedure

1. Measure about 2 cm^3 of the following solutions into separate test tubes: Starch solution, glucose solution and water. Each time, rinse the measuring cylinder thoroughly before using.
2. To each test tube, add a few drops of iodine solution and note any colour change.
3. Record your results in the table like the following table.

Solution tested	Observation	Conclusion
Starch solution		
Water		
Glucose solution		

Discussion

If the colour of iodine remains brown, then there is no starch in the solution. If the colour of iodine turns to blue-black, this indicates the presence of starch. Starch is the storage form of glucose in

plants. Each starch molecule has about 300 - 1000 glucose units. Most starch in plants can be found in seeds and storage organs like potato tubers. It gives a blue-black colour with iodine in potassium iodide solutions. This is the laboratory test for starch.

Proteins test

Activity 5.3:

To test for proteins

The Biuret test

Materials

- Egg-white
- Water
- 10% sodium hydroxide solution
- 1% copper sulphate solution (Biuret's reagent)
- Four test tubes
- Means of labelling the test tubes.

Procedure

1. Place 2 cm^3 of egg-white and water into two separate test tubes.
2. To each of these test tubes, add some sodium hydroxide solution
3. Add 1 cm^3 of 1% copper sulphate solution to each test tube then shake. Add sodium hydroxide.
   Shake and observe colour change.

Questions

1. What colour change was observed in each of the test tubes?
2. What is the role of the test tube with water?

Discussion

Copper sulphate is pale blue in colour. In the presence of a protein, its colour changes to purple. The appearance of purple colour, therefore, is a confirmation of the presence of a protein.

Proteins are complex compounds. They are made up of the elements, carbon, hydrogen and oxygen. In addition, they have nitrogen. Some proteins may also contain sulphur or phosphorous. These elements make up units called amino acids. Amino acids are the building units of proteins. There are about twenty different types of amino acids which occur naturally in plants and animals. These amino acids combine differently in a chain to form different types of protein. There exists a large variety of proteins.

Reducing sugars test

Activity 5.4:

To test for a reducing sugar

Materials

- Test tubes
- Source of heating
- Glucose solution
- Starch solution
- Benedict's solution
- Labels
- Measuring cylinder

Procedure

1. Put 2 cm^3 of each of the solutions to be tested into separate test tubes.
2. Label the test tubes with the solutions in them.
3. To each test tube, add 2 cm^3 of Benedict's solution.
4. Heat for about two minutes and observe the colour change.

Results

Record your observations in a table similar to the following table.

Solution tested	Observation	Conclusion
Sucrose		

Discussion

Benedict's solution is the ***chemical reagent*** used to test for the presence of ***reducing sugars***. When boiled with glucose an orange precipitate forms. The orange precipitate is also described as brick-red. When boiled with sucrose solution, the colour did not change.

A reducing sugar is one that reacts with Benedict's solution changing its colour from blue to orange.

Reducing sugars change the colour of Benedict's solution from blue to orange because they reduce an element in Benedict's solution known as copper (II) which is blue, to copper (I), which is an orange brown precipitate.

All monosaccharides are reducing sugars. Most disaccharides are reducing sugars except sucrose.

Reducing sugars

All monosaccharides

- Glucose
- Fructose
- Galactose

Some disaccharides

- Maltose

Note: Sucrose is a disaccharide which is not a reducing sugar.

Nonreducing sugars test

Activity 5.5:

To test for non-reducing sugars such as sucrose

Materials

- Benedict's solution
- Dilute hydrochloric acid
- 10% sucrose solution
- Sodium bicarbonate solid
- 4 test tube
- Measuring cylinder
- Dropping pipette
- Water
- Means of labelling
- Test tubes rack

Procedure

1. Arrange the 4 test-tubes in a test-tube rack and number them 1-4.
2. Put 2 cm^3 of sucrose solution into the test tube labelled 1 and add 2 cm^3 of Benedict's solution then boil. Note down any observations.
3. Measure 2 cm^3 of dilute hydrochloric acid and pour into test tube numbered 2 then add to it 2 cm^3 of Benedict's solution and boil. Note down any observations.
4. Follow the following procedure for the test tube labelled 3.
   (a) Measure 2 cm^3 of sucrose solution into a test tube. Add a few drops of the dilute hydrochloric acid and boil.
   (b) Allow the contents of the test tube to cool then add a little sodium bicarbonate slowly until the fizzing stops.

(c) Measure 2 cm^3 of Benedict's solution and add it into the test tube then boil and make your observations.

5. Compare the colour of the contents of test tube 3 with that in test tube 1 and test tube 2. Record your results in a table similar to the following table.

Contents	Observation
Sucrose + Benedict's solution; boiled	
Dilute hydrochloric acid and Benedict's solution; boiled	
Sucrose solution + dilute hydrochloric acid; boiled, cooled, then sodium hydrogen carbonate added Benedict's solution added then boiled	

Boiling the sucrose with dilute hydrochloric acid breaks down sucrose to glucose and fructose. Both of these are reducing sugars and as such, the colour of the Benedict's solution changes from blue to brick-red. Any excess acid is **neutralised** by the sodium bicarbonate. Boiling is a requirement for the **hydrolysis** to occur. Heating Benedict's solution with the acid will prevent the possibility of the acid being the one changing the colour of Benedict's solution from blue to orange. Note that, any excess bicarbonate does not affect Benedict's solution.

Lipids test

Activity 5.6:

The translucent spot test

Materials

- Vegetable oil
- Blotting or absorbent paper.

Procedure

Put a drop of oil on some absorbent paper, hold it up against light from the window and note what you observe.

Discussion

A translucent mark indicates presence of oil or fat.

Vitamin C test

Activity 5.7:

To test for vitamin C

Materials

- Test tubes
- Droppers
- An orange fruit or lemon fruit
- DCPIP solution
- Water
- Glucose solution

Procedure

1. Put about 1cm^3 of DCPIP in a test tube.
2. Cut the lemon or the orange fruit into 2. Squeeze the juice into a small beaker.
3. Take a dropper and add the juice into it.
4. Add the juice into the DCPIP and observe.
5. Repeat the procedure but this time use the glucose solution.
6. Observe and record your results.

Questions

1. What is the colour of DCPIP?
2. How many drops of the lemon juice did you add to the DCPIP to get a colour change?
3. What observation did you make upon adding glucose solution drop by drop into the DCPIP?

Discussion

DCPIP is deep blue in colour. The colour of DCPIP disappeared when one drop of the lemon juice was added into the DCPIP.

When glucose solution was added, no change of colour was observed.

The lemon juice contains vitamin C. Glucose solution does not contain vitamin C.

Vitamin C decolourises DCPIP.

Common sources of food nutrients

Activity 5.8:

To investigate sources of food in the local community

Materials

- Charts on various food stuffs
- Pictures of different types of foods in Malawi

Procedure

1. Work in groups.
2. Study the charts and photos provided by your teacher.
3. Identify various sources of food for different communities in Malawi.
4. For each community note the type of food that they use to obtain carbohydrates, proteins, vitamins, lipids, vitamins and mineral salts.
5. Write a report on your investigation.
6. Prepare to make a presentation to the class.

Discussion

In Malawi, *Nsima* is the most common type of meal. The meal is made from cooked ground maize and often eaten with fish, vegetables or bean stews.

What food nutrients are contained in 'nsima'? Other types of meals include sweet potatoes *(mbatata)*, finger millet *(mawere)*, vegetables such as cabbage, carrots, *situmbuwa* (banana fritters) *mtedza* (peanut puffs) among others.

Nsima, rice and cassava provide carbohydrates. Groundnuts and beans are good sources of proteins.

People living along the lake use fish as their main source of protein.

In some communities maize is ground into a flour called *mgaiwa*, while in some communities the bran and embryo of the grains is removed to form *ufa*. The bran and embryo contains proteins and vitamins hence *ufa* is less nutritious.

Mineral salts and vitamins are obtained from vegetables and fruits eaten all over Malawi.

Balanced diet

A balanced diet is one that contains **all the food** nutrients in the required amounts. A balanced diet should contain all the following:

- Proteins
- Carbohydrates
- Lipids
- Mineral salts
- Vitamins
- Water

When all the above nutrients are present in a diet, a person cannot suffer from any deficiency disease. To get a balanced diet one needs to choose food substances and mix them during cooking to get a balanced diet. A balanced diet must contain carbohydrates, proteins, fats, vitamins, mineral nutrients and fibre, in their correct proportions. A balanced diet need not be expensive because all these nutrients are available in locally available foods.

Planning a balanced diet

Planning a simple balanced meal requires you to remember a few basic nutrition principles in locally available food. First choose a food from each category like lean protein, low starch, vegetable, healthy fat or oil and a whole grain product.

- Examples of a lean protein includes skinless chicken, lean meat, eggs and fish.
- Examples of low starch vegetables include cabbage, carrot, green beans, onions, peppers, spinach, among others.
- Examples of healthy fats include avocado, olive oil, peanut oil and most nuts.
- Examples of whole grain products include brown rice, maize, *mawere*.
- Examples of starchy vegetables include maize, green peas, potatoes and sweet potatoes and cassava.

Water is perhaps the most essential of nutrients since we can do without it only for a short time.

Deficiency diseases

These are diseases or disorders that occur in a body when nutrients in a diet are not sufficient. The inadequate nutrients make some body processes not to take place resulting to disorder in the functioning of the body. These disorders bring about signs and symptoms that can be observed.

Some of the common deficiency diseases in humans include:

1. Rickets

This is a deficiency disease caused by lack of vitamin D and enough calcium in the diet.

Calcium is required for the development of healthy bones and teeth.

Symptoms

- Bow leggedness or knock-knees in children. This is because the bones of the legs are unable to support the body well because of soft and weak bones.
- Soft teeth that easily form cavities.

Fig. 5.1: A child suffering from rickets.

Effects

- Poor bone and teeth development especially in children.
- In adults, calcium is withdrawn from the bones making the bones to be weakened.
- Those who have suffered from this disease in their childhood remain bow-legged to adulthood

Control

- Provide diets rich in vitamin D and calcium. These include milk, egg yolk, fish and liver.
- Frequent exposure to sunlight especially for children.
- Fruits should also be part of the diet to help in the absorption of calcium by the body.

2. Scurvy

This is a deficiency disease caused by lack of vitamin C in the diet.

Symptoms

- Gums become tender and bleed easily.
- Teeth become loose.
- Wounds take long to heal.
- Joints become swollen and painful.
- Blood capillaries in the skin becomes weak and easily burst.

Effects

- Lowered immunity.
- Weakened blood vessels.
- Poor iron absorption.
- Poor healing of wounds on injury.

Control

Provide foods rich in vitamins. These include citrus fruits, vegetables and tomatoes.

3. Kwashiorkor

This is a deficiency disease caused by lack of proteins in the diet. It occurs mostly in children.

It occurs when a child is stopped from breast feeding before the first six months after birth or when the mother fails to produce enough milk for the child. If at this time the child is fed only on carbohydrates food like bananas, porridge and cassava, the child will suffer from kwashiorkor because it lacks proteins in the body.

Fig. 5.2: A child suffering from kwashiorkor.

Symptoms

- Retarded growth as a result of deficiency in protein.
- Hair changes in texture and becomes short. There is also a change in hair colour making the hair to turn brown. The hair is also easily plucked.
- Protruding stomach and swollen lower parts of limbs. This is caused by accumulation of body fluids in these parts.
- The skin becomes dry and cracks easily.
- The child becomes weak, dormant and easily upset.
- The child loses appetite and usually develops diarrhoea.
- The child has low resistance to diseases.

Effects

Poor absorption of body fluids which leads to the protrusion of the stomach and swollen lower parts of limbs. If the condition is not rectified, a child cannot live beyond the age of five because death will occur.

Control measures

- In order to curb this disease, breastfeeding should not be supplemented with foodstuffs rich in carbohydrates.
- All children should be provided with food rich in proteins.

4. Marasmus

This is a deficiency disease caused by lack of enough quantities of a balanced diet in children. The body of the child lacks enough oxygen and this affects all the body tissues. Common during famine. It can also affect adults.

Symptoms

- Loss of body weight.
- Shrunken body parts especially on the face, buttocks and thighs. This is because the body tissues do not get sufficient energy to carry out their processes. This leads to the tissues themselves being broken down to produce energy for body processes.
- Thin arms and legs.
- Reduced resistance to diseases.
- The brain is affected and the child becomes a slow learner.

Fig. 5.3: A child suffering from marasmus

Control measures

Provision of enough food which is balanced.

5. Beriberi

Beriberi is caused by insufficient vitamin B_1 in the diet.

Symptoms

- Lack of appetite.
- Weakness of the limbs.

- Lack of nervous sensation in the ends of nerves leading to paralysis.
- Weakening and shrinking of muscles which leads to malfunctioning of muscular organs such as the heart.
- Mental disturbances.

Effects

- Vitamin B_1 is involved in the working of nervous system. When not sufficient, some nerves and sensory cells would not work properly. This can lead to **paralysis.**
- Muscle contraction and relaxation is reduced. This leads to malfunctioning of body organs such as the heart.
- The deficiency affects coordination of the nervous system. This can lead to mental disturbances.

Control measures

Provide foods rich in vitamin B_1. These include liver, peas, beans and meat.

6. Night blindness

This is caused by insufficient amounts of vitamin A in the diet.

Symptoms

- Retarded growth.
- Drying of the skin in the cornea of the eyes and the moist membranes of the respiratory tract and urogenital system.
- Failure to see in dim light. This is called night blindness.

Effects

- Inability to see properly in dim light.
- Skin and throat are affected.

Control measures

Provide a diet rich in vitamins A. Such foods include fish, liver, oil and carrots.

7. Anaemia

This is a deficiency disease caused by lack of iron in the diet.

More of these to be discussed under human circulatory system in unit 7.

8. Goitre

Goitre is caused by the lack of iodine in the diet. It causes the thyroid gland in the throat region to enlarge.

Signs and symptoms

- Enlargement of the thyroid glands around the neck region.
- Weight gain
- Cold intolerance
- Constipation
- Weakness

Prevention and control

- Provide Iodine in the diet through usage of iodised salt.
- Thyroid hormone replacement incases it becomes severe.

9. Vitamin B_2 deficiency

This is a deficiency disease caused by insufficient amount of Vitamin B_2 in the diet.

Symptoms

- Retarded growth in children
- Sores on lips and tongue.
- Growth of blood vessels in the cornea of the eyes which become weak.
- Skin around the nose forms cracks and becomes scaly.

Effects

In its absence, the skin becomes unhealthy.

Control

Provide foods rich in vitamin B_2. They include eggs, milk, liver, and green vegetables.

10. Pellagra

This is a deficiency disease caused by insufficient vitamin B_3 in the diet.

Symptoms

- The skin becomes dry and rough and develops red patches.
- The mouth and tongue becomes sore and finally swollen.

Effects

When not sufficient, vitamin B_3 will lead to poor release of energy in tissues.

Control

- Provide foods rich in vitamin B_3
- Such foods include meat and whole bread.

11. Pernicious anaemia

This is a disorder that occurs when the body is not able to absorb vitamin B_{12}. This causes the body to produce few red blood cells.

Symptoms

- Person feels tired even after doing light tasks.
- Pale mucus membranes for example, pale cornea and pale dry lips.
- Feeling of sharp pin like pains on fingers and toes.
- Memory loss.

Control

Provide food rich in vitamin B_{12} such as green vegetables.

12. Poor blood clotting

Causes

This condition is caused by insufficient vitamin K in the diet.

Symptoms

Prolonged bleeding in case of injury.

Effects

Poor blood clotting; the blood takes too long to clot. This leads to excessive loss of blood, in case of an injury.

Control

Provide foods rich in vitamin K. These include vegetables, egg-yolk and liver.

General causes of deficiency diseases

Deficiency diseases are as a result of several reasons. Most of them are caused by the following:

1. Lack of specific food nutrients in the diet. For example, the lack of iodine causes the goitre, lack of vitamin A leads to night blindness, and lack of iron in the diet may lead to anaemia.
2. Body's inability to absorb nutrients from the gut. For example, heavy consumption of alcohol results in vitamin B deficiencies, because alcohol interferes with vitamin B complex absorption in the gut.
3. Poverty. The poor may not be able to get a balanced diet because the food is too expensive for their income level. They suffer deficiency diseases because they cannot buy all the

different sources of food nutrients as required.

4. The illiteracy level may cause deficiency diseases even when the person has a farm where all types of foods can be grown at considerably low prices. Illiteracy level also makes people eat too much of certain foods for example too much starch in the diet. These people eat food to get a filling instead of quality.
5. Poor food preparation methods. For example overcooking vegetables destroys vitamin C.

Effects of deficiency diseases

Some of the general effects of deficiency diseases include the following.

1. Some deficiency diseases such as rickets causes deformity of legs among the young.
2. Loss of parts of the body for example, teeth due to lack of calcium.
3. Retarded growth may occur due to lack of proteins in diet.
4. Mental retardation as a result of anaemia and kwashiorkor. Death may also occur due to deficiency because the body can no longer function.
5. Stress on the economy because money is spent on managing medical conditions which results from deficiency diseases like goitre or gout.
6. Loss of human resources as a result of death following a deficiency disease. Deficiency diseases increases visits to the doctor therefore putting pressure on health services.
7. People must prepare food properly to avoid destruction and loss of nutrients. Practises like washing of meat after cutting to small pieces leads to loss of soluble nutrients.

Ways of treating deficiency diseases

The treating of deficiency diseases among our family members may be done by giving food with the required nutrients, and consuming vitamin and mineral tablets as instructed by a doctor.

Prevention of deficiency diseases

- The best method of preventing any deficiency disease is to eat a balanced diet. The diet does not have to be expensive, but must contain all nutrients in the proper proportion. Water is a component of a balanced diet therefore it must also be drunk in correct amounts.
- There should be civic education in food preparation methods and balanced diet for all members of the family. Education in food preservation methods would help ease food spoilage and reduction in quality.
- Where the fortified food are available, they should be manufactured and consumed. For example, the maize flour could be fortified with mineral ions and margarine may be fortified with fat soluble vitamins like vitamin K, E, D and A.

Obesity

The deficiency diseases we have learnt about are as a result of certain substances missing in our diet.

Some diets may contain extra nutrients more than the body can use at a given

time. Such diets can lead to health problems. A good example is when the diet of an individual contains more than is required. Extra fat, carbohydrates and protein can be converted to body fat. This does not necessarily mean that the person eats a lot. It means that the body uses less than is eaten and the extra is stored as fat. This will cause the weight of the person to increase beyond what is normal for the age, height and body framework.

The person is then described as being overweight or obese.

Obesity is a condition whereby the body weight of a person is considered greater than what is normal. This takes place when the body accumulates too much fats resulting in negative effects on the person's health.

Causes of obesity

1. Consumption of more food than what the body requires.
2. Sedentary lives – having lives with less walking and working. In this modern world, people are becoming engaged in tasks that require less activity and less movement. This has led to accumulation of fats in the bodies leading to obesity.
3. Lack of physical activity.
4. Heredity – Some individuals are born with a trait of growing obese. The body of a person fails to produce enough hormones that control breakdown of foods and controls food intake.
5. Feeding on a diet of simple sugars. Simple sugars are readily absorbed into the body if the feeding is higher than what the person uses. All the excess sugars are converted to fats and stored.
6. Use of some medicine that reduce body activity. These medicines slow down breakdown of sugars to produce energy. All excess sugars are stored as fats.

Ways of controlling obesity

1. Avoid overfeeding.
2. Avoid too much of foods with simple sugars only.
3. Carry out body activities such as walking, sporting activities and manual work to burn all excess fats in the body.
4. Feed on diet with more vegetables and less starch.

Fig. 5.4: An obese person

Revision Exercise 5

1. Which of the following is **not** a type of food substance?
   A. Water B. Maize
   C. Vitamins D. Minerals salts
2. Macro-nutrients contain:
   A. large quantities of carbohydrates

B. large quantities of lipids.
C. large quantities of lipids, proteins, carbohydrates and water.
D. large quantities of proteins.

3. Which of the following is mismatched?
   A. Glucose-carbohydrates.
   B. Nucleotides- nucleic acids.
   C. Fatty acids- glycerol.
   D. Saccharides-sugars.
4. Lipids are used to store
   A. energy
   B. food
   C. structural components
   D. waterproofing material.
5. Which one of the following is a function of proteins?
   A. To provide support.
   B. To destroy enzymes.
   C. To transport mineral salts.
   D. To make cell membranes
6. Name the food substance oxidised to release energy.
   A. Carbohydrates
   B. Mineral salts
   C. Water
   D. Hormones
7. Which of the following is a fat soluble vitamin?
   A. Vitamin C
   B. Vitamin B_6
   C. Vitamin B_{12}
   D. Vitamin K
8. Which of the following is a component of red blood cells?
   A. Iodine B. Calcium
   C. Fluoride D. Iron
9. How much water should a person drink daily?
   A. 2 litres
   B. 1.5 litres
   C. 8 glasses
   D. 6 glasses
10. Which of the following is a deficiency disease?
    A. Constipation
    B. Diarrhoea
    C. Pellagra
    D. Both A and C
11. Name four types of food nutrients.
12. Give the uses of the following food nutrients in the body:
    (a) Lipids
    (b) Proteins
    (c) Mineral salts
13. State the importance of the following in a balanced diet:
    (a) Water.
    (b) Roughage.
14. What is a balanced diet?
15. (a) What is a deficiency disease?
    (b) Name four deficiency diseases and their causes.

Unit 6

Human Digestive System

Success criteria

By the end of this unit the student must be able to:

(a) Describe the parts and functions of the human digestive system.

(b) Outline the process of digestion.

(c) State the end products of digestion

Parts and functions of the human digestive systems

Introduction

Human beings take in solid food into the mouth by ingestion. Before the food is utilised in the body, it must be digested, absorbed and assimilated.

Digestion in humans takes place in a special system called the **digestive system**. The digestive system is also called the **alimentary canal** or **gut**.

Carry out the following activity.

Activity 6.0:

To examine parts of a human alimentary canal

Materials

- Models of the alimentary canal.
- A dissected rabbit showing parts of the alimentary canal.

3. Charts on parts of the alimentary canal.

Procedure

1. Examine the materials provided to you by your teacher.
2. Note the various parts of the alimentary canal.
3. Note the following parts:
   - Mouth
   - Oesophagus
   - Stomach
   - Colon
   - Rectum
   - Anus
   - Intestines
4. Draw well labelled diagram of the digestive system.

Parts of a human digestive system

The alimentary canal of human is composed of the following parts; the mouth, gullet, stomach, small intestines, large intestines, rectum and anus. The organs associated with the alimentary canal are the liver and the pancreas. The following diagram shows parts of the human digestive system.

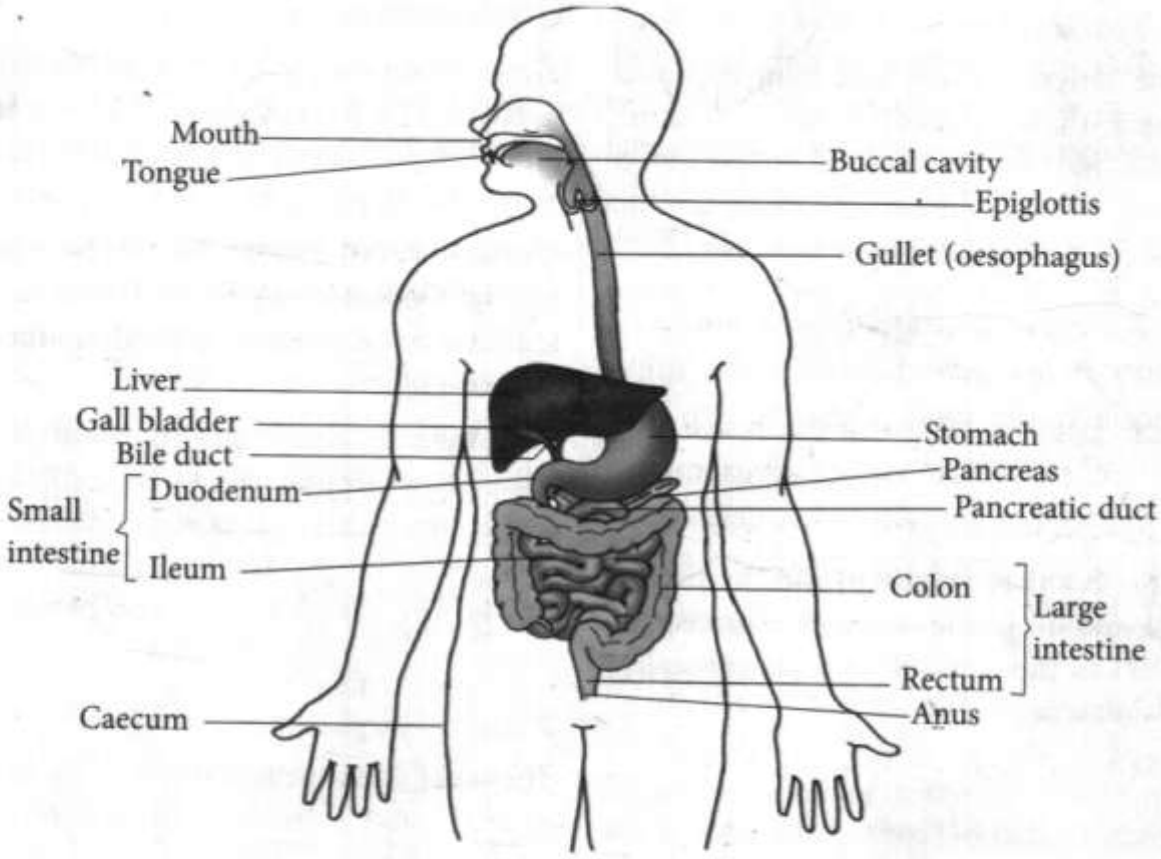


Fig. 6.1: The human digestive system

Functions of parts of the digestive system

The alimentary canal is composed of the following parts:

1. The mouth

The mouth has teeth and salivary glands. The teeth break food particles into smaller particles providing a large surface area for enzyme activity. Enzymes are chemicals that enable breaking complex food molecules into simple soluble substances.

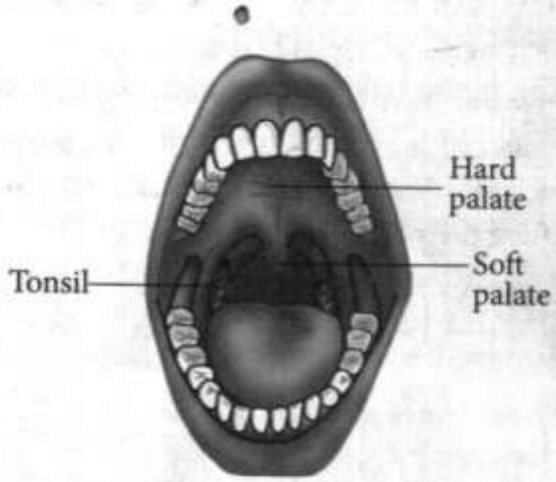


Fig. 6.2: An open mouth

2. The tongue

The tongue, which is a long muscular organ on the floor of the mouth, contains taste buds for tasting food. It also moves food around inside the mouth. This allows the food to mix with saliva.

3. Salivary glands

They secrete a fluid called saliva. Saliva moistens the food. It makes dry food easy to swallow.

4. Oesophagus

This is a tube running from the back of the mouth to the stomach. It transports food to the stomach in a process called swallowing.

6. Epiglottis

This is a flap of tissue at the back of the mouth above the trachea. It closes the trachea during swallowing to ensure no food enters into the trachea. This can cause death if it happens.

The figure below shows the position of epiglottis during swallowing.

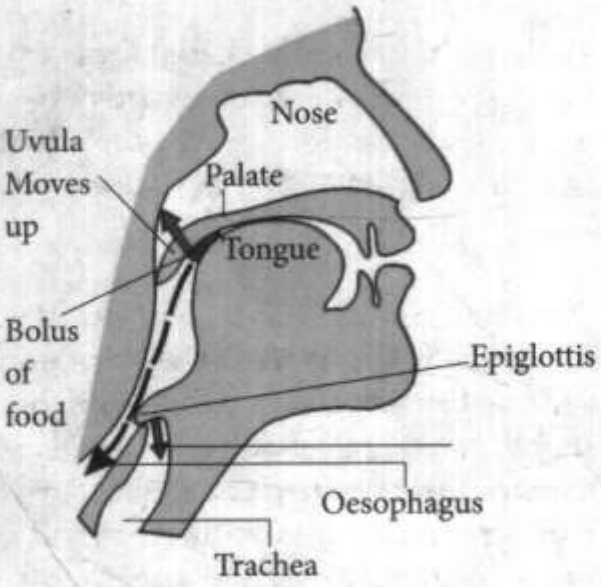


Fig. 6.3: Swallowing of food

6. The stomach

The stomach is a thick muscular bag that stretches as it fills with food. It is located on the left side of the abdomen just below the **diaphragm**.

The stomach wall moves by contractions mixing the food with water. This makes the food to be a semi-liquid form called **chyme**.

The stomach also holds the food and releases it slowly by slowly to the duodenum. This makes sure that food is digested by the intestines slowly by slowly. The stomach walls also produce enzymes that digest the food.

7. Small intestines

The small intestine is about 6 – 7 m long in a human. It is made up of two parts:

- The duodenum
- The ileum

The duodenum is the first part. It is short and slightly wider than the ileum.

It is associated with two organs:

- **The pancreas**. Pancreas secretes pancreatic juice which is passed to the duodenum through the pancreatic duct.

  The juices contain enzymes for digestion in the duodenum.
- **Liver**. Liver secretes the bile juice which is stored in the gall bladder. The juice contains bile salts for emulsification of fats and neutralisation of acidic chyme from stomach.

(a) The duodenum

The duodenum is the first part of the small intestine. It is about 25 - 30 cm long and is shaped like the letter C. The

pancreatic duct and **bile duct** open into the duodenum.

The pancreatic duct carries **pancreatic juice** from the **pancreas**. The bile duct carries **bile** from the **gall bladder**.

Bile is made in the liver and stored for a short while in the gall bladder. The two ducts join and form a common duct that empties its contents into the duodenum.

The figure below shows the relationship between the liver, pancreas and the duodenum.

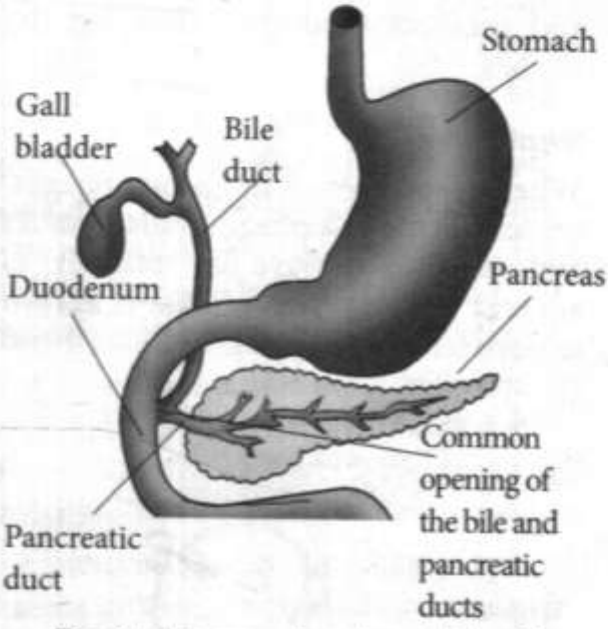


Fig. 6.4: Diagram showing relationship between liver, pancreas and the stomach

Functions of the duodenum

It is the site for chemical digestion of starch, lipids and proteins.

(b) The ileum

The ileum is the second part of the small intestine. The ileum has two main functions.

- To completely break down food
- It is the site for absorption of digested food into the blood.

5. Large intestine

The large intestine is sometimes called the **colon**. It is about 1.5 metres in length and is composed of the **caecum** with the **appendix**, the colon and the rectum.

Colon is the site of water absorption in the large intestine and active absorption of salts.

In humans appendix is not functional. Rectum stores the wastes that remain after digestion has taken place. It holds the wastes before they are eliminated as faeces.

Digestion

Meaning of digestion

Digestion is a process whereby complex food substances are broken down into simpler substances that can be absorbed and used by the body. There are two types of digestion:

- Physical digestion
- Chemical digestion

Physical digestion

Teeth in the mouth chews food by physically breaking it down from big pieces that can be swallowed. This process is called **physical digestion.**

Chemical digestion

Once food is swallowed, it may be still in a complex form that cannot be absorbed and used by the cells. It still needs to be broken down further. This complex food is broken down by enzymes. The breaking down process changes the food materials from complex to simple compounds which can be easily dissolved by the human body. This process is known as **chemical digestion.**

The process of digestion

The mouth has teeth and salivary glands. The teeth break food particles into smaller particles providing a large surface area for enzyme activity.

In the mouth therefore both chemical and mechanical digestion takes place.

The mouth opens into a large space or chamber called the **buccal cavity**. The process of taking food into the body through the mouth is called **ingestion**. Once food is taken into the mouth, several things happen to it. The teeth chew and break up the food into smaller particles.

This creates a large surface area for enzyme action.

The tongue, which is a long muscular organ on the floor of the mouth, contains **taste buds** for tasting food. It also moves food around inside the mouth. This allows the food to mix with saliva which is secreted from the salivary glands.

Saliva contains a substance known as **mucin** and an enzyme known as **salivary amylase** or **ptyalin.** Mucin moistens, softens and lubricates food. This makes dry food easy to swallow. The food particles are also able to stick together to form balls called **boluses** (singular: bolus). Mixing enhances contact of all food particles with enzymes. Salivary amylase breaks down starch to maltose.

There are three pairs of salivary glands inside the mouth cavity which secrete saliva into the mouth through **ducts**. They are:

- **Sublingual salivary glands** located below the tongue.
- **Submandibular salivary glands** located below the jaws.
- **Parotid salivary glands** located on each side of the mouth in front and below the ear.

When the food has been chewed enough, the tongue rolls the boluses against the soft palate of the mouth at the back of the throat, or **pharynx**. This starts the process of **swallowing** which forces food into the **oesophagus**. The tube adjacent to the oesophagus is the **trachea** which leads to the lungs.

During swallowing, a flap of tissue above the trachea, called the **epiglottis,** closes and prevents food from entering the trachea.

Swallowing

When a food bolus is in the oesophagus, muscles in the oesophagus walls contract and relax in a wave-like manner to squeeze it along. This process is known as **peristalsis**. The food is swallowed into the stomach.

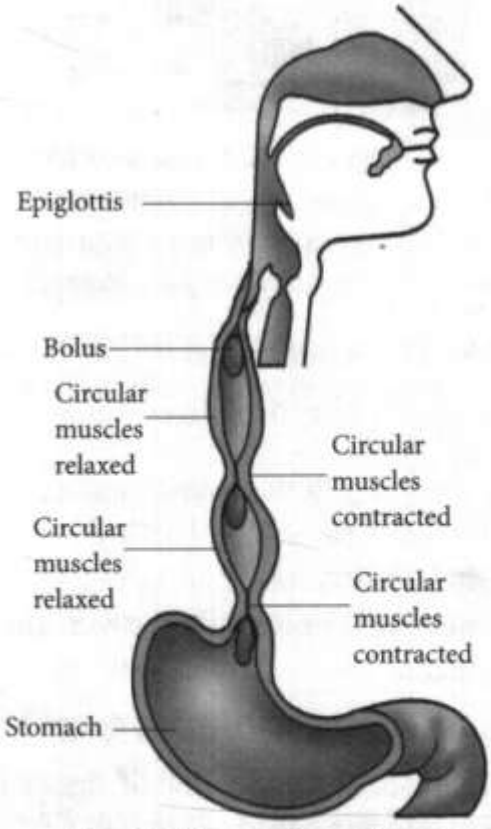


Fig. 6.5: Waves of muscle contraction (peristalsis) down the oesophagus

When food reaches the stomach, the stomach walls begin wave-like contractions similar to peristalsis which **churn** or mix the food. Churning changes the food into a thick semi-liquid form called **chyme**. After 2-6 hours of churning and digestion, the chyme is gradually released in small amounts into the duodenum through the pyloric sphincter muscles which relax at intervals.

In the stomach proteins are broken down by the enzyme pepsin. Renin coagulates milk protein casein to caseinogen.

The stomach juices also contain hydrochloric acid. The acid provides an acidic medium for the action of enzyme pepsin. Hydrochloric acid also kills bacteria that comes in with the food. It also activates pepsinogen into pepsin.

In the duodenum, bile from the liver emulsifies fats. This involves breaking fats into small droplets that can easily be digested by enzymes.

The pancreatic juice contains enzymes that are involved in chemical breakdown of the food substances.

Bile also contains salts. These salts neutralises the acid from the stomach to provide an alkaline condition for the action of pancreatic enzymes.

- Enzyme lipase breaks down lipids,
- Pancreatic amylase breaks down starch.
- Trypsin breaks down proteins.

The food then moves to the ileum.

The walls of ileum produce a juice called **intestinal juice** or *Succus entericus*.

The juice contains enzymes that breaks down the remaining food substances. The enzymes include sucrase, maltase, lactase, peptidase and lipase.

The soluble substances produced are then absorbed into the blood through the walls of the ileum.

The rest of the material moves into the large intestines. Here water is absorbed. This makes the remains of the food material to be semi-solid.

In some animals (ruminants) the caecum has bacteria that produce an enzyme called cellulase. It digests cellulose material in plant tissue into glucose. In humans caecum and appendix are small and do not function.

In the colon there are some bacteria that produce vitamin K. The vitamin is absorbed into the body for use. The waste composed of materials that cannot be digested (indigestible material) and those that were not digested (undigested material) moves to the rectum. It is stored for some time and then eliminated through the anus through a process called **egestion**.

Digestive enzymes

These are chemical substances that break down complex food molecules into simpler molecules that can be absorbed into the body.

Enzymes are produced by glands and then released into the alimentary canal.

Enzymes involved in the digestion of carbohydrates, proteins and lipids

1. In the mouth salivary glands produce saliva. Saliva contains an enzyme called *salivary amylase* or *ptyalin*. Enzyme ptyalin breaks down starch into maltose.

2. The walls of the stomach produces a substance called the gastric juice. It contains the following enzymes:
   (i) *Pepsin* - this is an enzyme that breaks down proteins to peptides.
   (ii) *Renin* - this is an enzyme that breaks milk protein casein to simpler form called caseinogen. This makes it possible for the milk protein to be easily digested by enzyme pepsin.
3. The pancreas produces pancreatic juice. The juice contains the following enzymes:
   (i) *Pancreatic amylase* that contains breakdown of remaining starch to maltose.
   (ii) *Trypsin* that breaks down proteins to peptides.
   (iii) *Pancreatic lipase* that breaks down lipids to fatty acids and glycerol.
4. The walls of intestines produce a juice called intestinal juice. It contains the following enzymes:
   (i) *Sucrase* - it breaks down sucrose to glucose and fructose.
   (ii) *Maltase* - It breaks down maltose to glucose.
   (iii) *Lactase* - It breaks down lactose to glucose and galactose.
   (iv) *Peptidase* - It breaks down peptides to amino acids.
   (v) *Lipase* - It breaks down lipids to fatty acids and glycerol

End products of digestion

During digestion complex food molecules are broken down into simple soluble substances that are easily absorbed into the body for use.

These simple substances are the end products of digestion. They are incorporated into all metabolism by a process called **assimilation**.

Table 6.1: Summary of food substances and their end products

Complex food substance	End products of digestion
1. Carbohydrates: (a) Starch	Glucose
(b) Sucrose	• Glucose and fructose
(c) Lactose	• Glucose and galactose
2. Proteins	• Amino acids
3. Lipids	• Fatty acids and glycerol

Revision Exercise 6

1. Which one of the following is **not** a type of salivary gland?
   A. Sublingual
   B. Submandibular
   C. Parotid
   D. Epiglottis
2. Which one of the following is true about pepsin?
   A. It digests proteins to peptides.
   B. It digests lactose to peptides.
   C. It digests lipids to fatty acids and glycerol.
   D. It is separated in the mouth.
3. State two functions of ileum.
4. List the two types of digestion.
5. Give the function of pancreatic amylase and state where it is secreted from.

Unit 7

Human Circulatory System

Success criteria

By the end of this unit, the student should be able to:

(a) Describe the components of the human circulatory system and their functions.

(b) Explain the consequences of reduction of red blood cells in the body.

Introduction

Animals need a system through which they can move useful substances like nutrients, water and oxygen to reach all cells of the body and also through which all waste substances in the body. They also need a system through which all waste substances in the body can be moved from where they are to sites where they can be eliminated from the body. This system is called the **circulatory system**.

Carry out the following activity.

Activity 7.1:

To examine components of the human circulatory system

Materials

- Models of circulatory system.
- A dissected rabbit showing parts of the circulatory system.
- Charts.
- Pictures.

Procedure

1. Work in groups.
2. Examine the materials provided by your teacher.
3. Note the location of the heart and lungs in the body.
4. Note the shape of the heart.
5. Note blood vessels that take blood from the heart to all other parts. Takes blood back to the heart.
6. Examine using a hand lens fine blood vessels that form a network into all the tissues.
7. Draw and label parts of the human blood circulatory system.

Discussion

From the activity you may have noted that the circulatory system is composed of three main components:

(a) the heart

(b) blood vessels

(c) the blood

Blood vessels are of 3 types: arteries, veins and capillaries.

Let us study the components and their functions.

Parts of the human circulatory system and their functions

The heart

The heart is a muscular organ that lies inside the chest cavity between the

two lungs. Internally, the heart is surrounded by a tough membrane called the **pericardium** which covers and protects it.

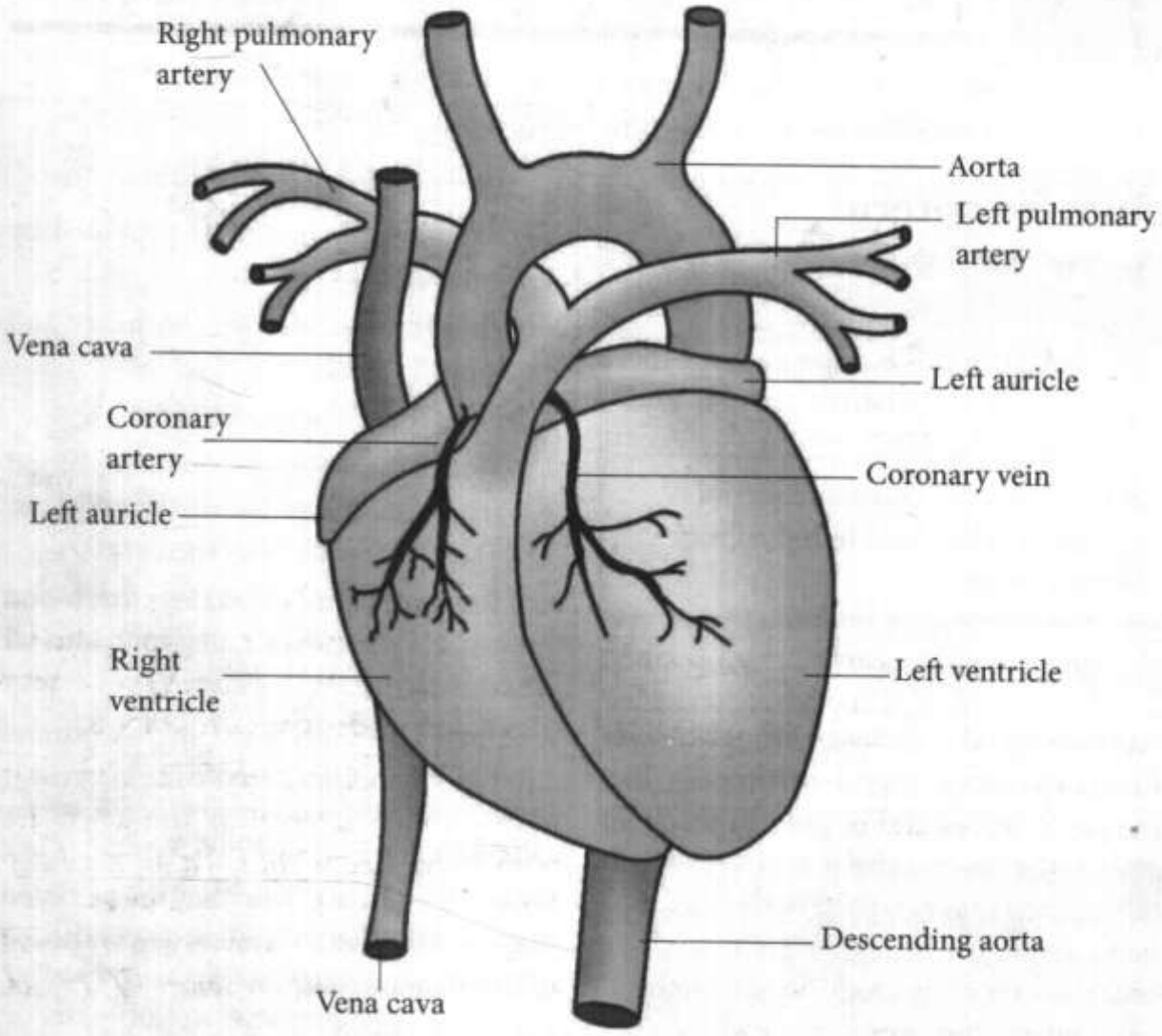


Fig. 7.1: External structure of the human heart

The heart is divided into two sides, the left and the right side which are completely separated by a wall called the **septum**. The septum prevents blood on the right side from mixing with that on the left side. Each side consists of a small upper chamber called the **atrium** (plural atria) or auricle and a larger lower chamber called the **ventricle**. This makes the mammalian heart a four-chamber organ.

The atria (also called *auricles*) are thin walled and receive blood into the heart which they pump to the ventricles. The left ventricle is more muscular than the right ventricle because it pumps blood to all parts of the body, farther from the heart with high pressure.

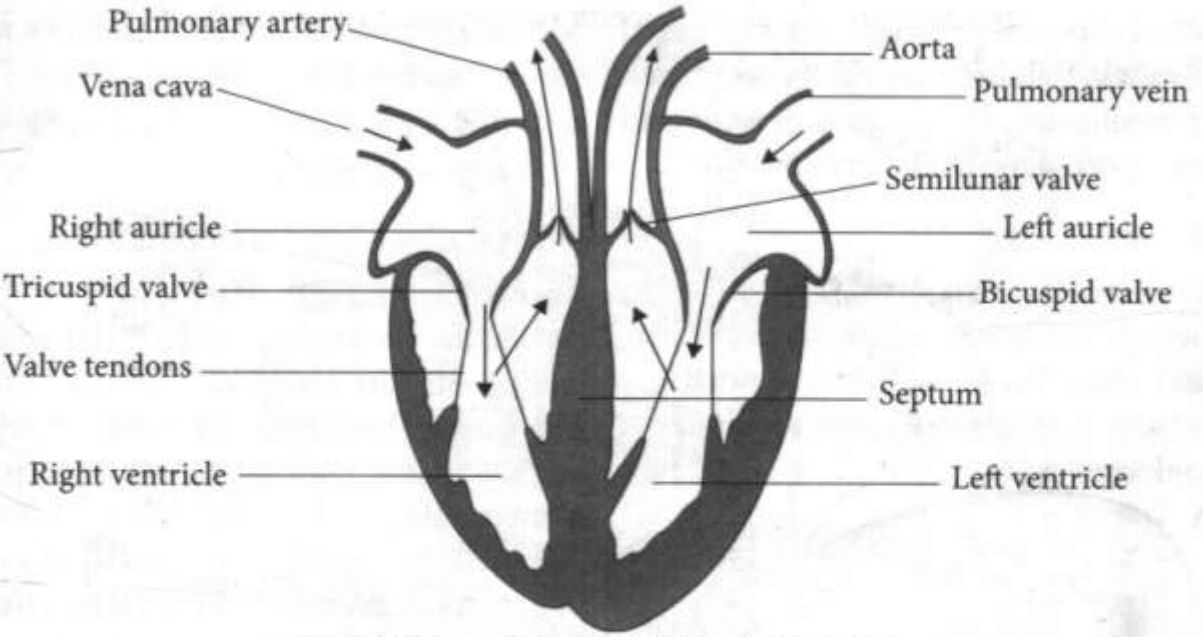


Fig. 7.2: Internal structure of the human heart

Functions of the heart

The function of the heart is to pump blood to all body parts through the arteries. This ensures that blood transports substances to all tissues and at the same time it removes waste substances from all the tissues.

Blood vessels

There are three types of blood vessels. They include arteries, veins and capillaries.

1. Arteries

The heart pumps blood into vessels called **arteries**. Arteries carry blood to various parts of the body. Due to the pumping action of the heart, blood from the heart enters the arteries at high pressure. Therefore, the structure of the arteries enables them to withstand the high pressure of blood flowing in them. They have thicker muscular walls with narrow lumen and elastic walls.

Most arteries are located deep within our bodies. It is this pressure which makes blood in arteries to flow in only one direction. All arteries carry **oxygenated blood** except the pulmonary artery which carries deoxygenated blood.

Arteries branch out to form narrower vessels called **arterioles**. The arterioles branch further within the tissues into finer vessels called **capillaries**. The function of arteries is to transport blood from the heart to all the other body parts.

2. Veins

Veins carry blood under low pressure from the tissues towards the heart. They have thin walls which are composed of a thin outer fibrous coat and a thin middle layer of muscle. They have valves that allow blood in them to flow in one direction only. Veins are also located along skeletal muscles. As they contract they get squeezed.

Veins carry **deoxygenated** blood except the pulmonary vein which carries oxygenated blood from the lungs into left side of the heart.

Veins branch into fine vessels called **venules**. Venules form branches joined to **capillaries**. The function of veins is to transport blood back to the heart.

3. Capillaries

These are fine vessels that form a network in tissues joining arterioles and veins. The figure below shows the relationship between veins, capillaries and arteries.

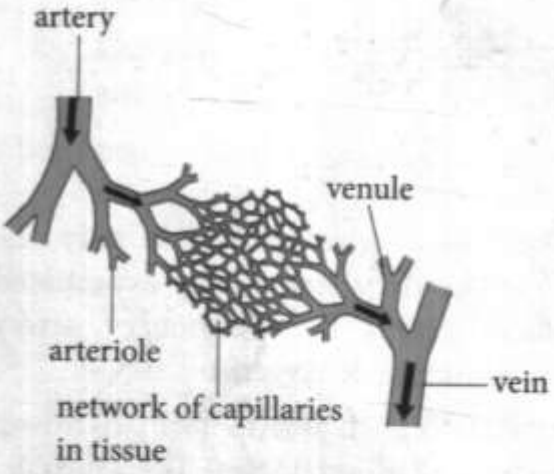


Fig. 7.3: Relationship between arteries, capillaries and veins

Capillaries are made up of very thin walls. These walls allow for exchange of substances between the capillaries and tissues.

The functions of capillaries

They allow oxygen and nutrients to flow from the blood to the tissues and carbon dioxide and wastes to move from the tissue to the blood for elimination.

Blood

Blood is the liquid which transports materials in mammals. It is a liquid tissue that contains suspended substances as well as dissolved substances. Blood has three major functions:

- A medium of transport of materials to and from other tissues.
- Regulation of body temperature and of materials in the body.
- Protection against disease causing microorganisms.

Blood circulation in the body

Blood flows through all parts of the body in vessels. The vessels form a continuous system so that blood circulates within the body. Blood flows in blood vessels always in the same direction. **Arteries** convey blood from the heart to the body tissues. Veins return blood to the heart from the body tissues. **Capillaries** provide a link between the arteries and veins within the tissues.

Blood leaves the heart through the aorta. This is the main artery that branches to take blood to the upper parts and also to the lower parts.

The aorta branches into arteries.

There is an artery that supplies blood to every body part.

For instance renal artery takes blood to the kidney. Mesenteric artery takes blood to the alimentary canal.

Blood in the aorta is rich in oxygen.

The arteries branch into arterioles. Arterioles branch into capillaries. In the capillaries exchange of substances takes place.

Blood from capillaries then flows to the venules. Venules join to form veins.

Veins from each organ transport blood to the main vein called the venacava. Venacava takes blood back to the heart to the chamber called right atrium.

For blood to obtain oxygen it is transported by a vessel called pulmonary artery from the right ventricle to the lungs. After oxygenation it is returned

back from the lungs to the left side of the heart by a vessel called pulmonary vein. This is called **pulmonary circulation** while circulation to the rest of the body is called **systemic circulation**.

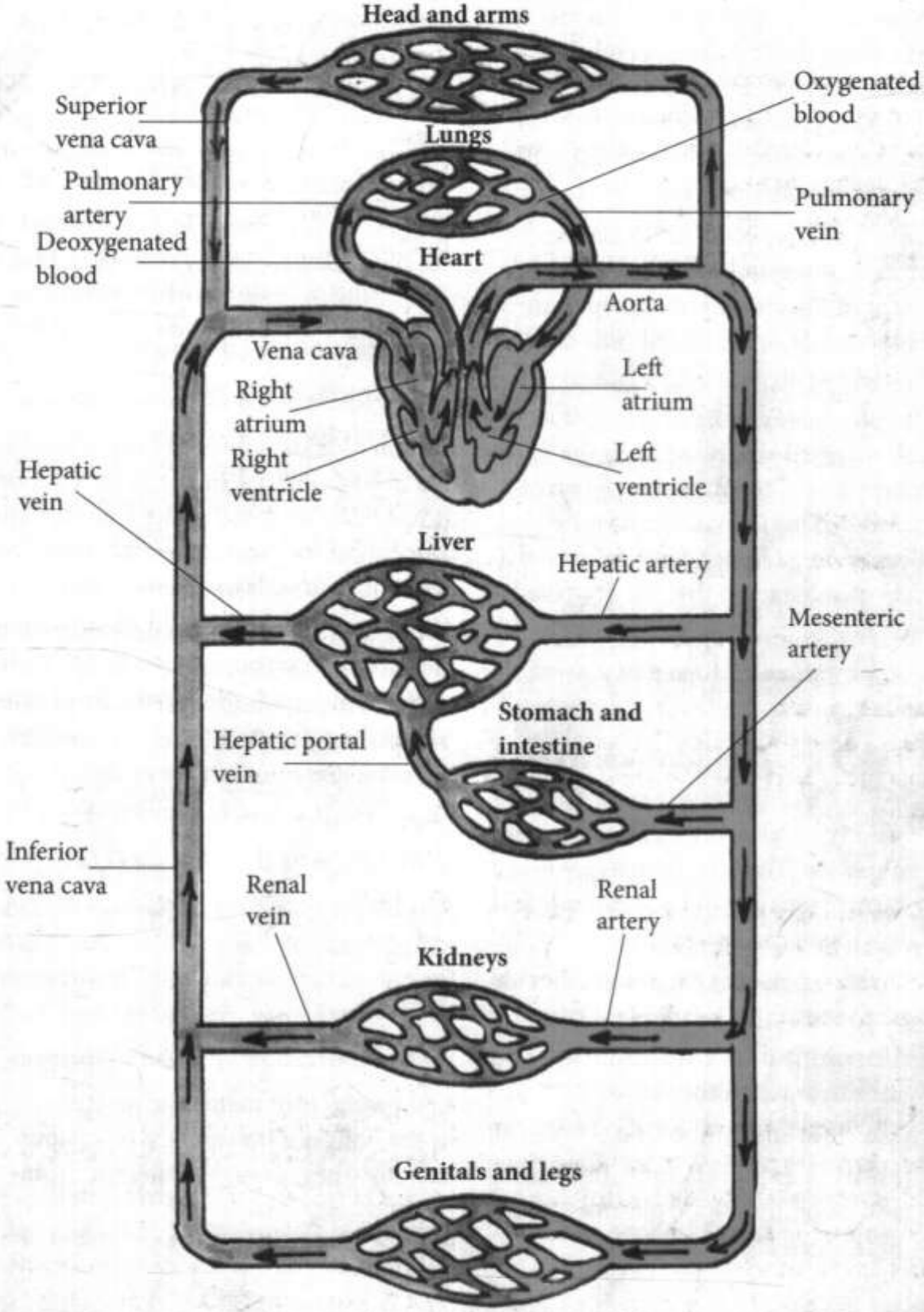


Fig. 7.4: The circulatory system in humans

Composition of blood

The mammalian blood is composed of **cellular components** suspended in a pale yellow watery medium known as **plasma**. The cellular components of blood are the **blood cells** and the **platelets**. There are two main types of blood cells: **red blood cells** also known erythrocytes and the **white blood cells** also known as leucocytes.

Plasma makes up about 55 percent of the total volume of blood. The other 45 per cent of the blood is made up of the red blood cells, white blood cells and the platelets.

Blood plasma is clear and pale yellow in colour when separated from the cellular parts of blood. Ninety percent of blood plasma is made up of water. The remaining ten per cent consists of a variety of substances that are dissolved in water.

These substances dissolved in plasma include:

- Food substances like glucose, amino acids and fatty acids.
- Vitamins and mineral salts from digestion. The mineral salts are in the form of ions like sodium chloride and hydrogen carbonate ions.
- Waste substances like carbon dioxide and urea.
- Hormones like adrenaline and insulin among others.
- Enzymes and antibodies.
- Proteins such as albumin, fibrinogen and globulins. Blood plasma without fibrinogen is called **serum**.

Water	**92%**
Blood proteins • Fibrinogen • Albumin • Globulin	7%
Nutrients and urea	0.136%
Ions like chloride, sodium, potassium	0.931%

Table 7.1: Composition of plasma

Functions of blood plasma

(i) Transportation of carbon dioxide

Carbon dioxide is formed from reactions that release energy in the cells. Carbon dioxide can be toxic to the cells at high concentrations and must be removed before it accumulates.

About 5 to 10% of carbon dioxide from the tissue is transported in solution form as **carbonic acid**. The water in plasma acts as the solvent.

$$\text{Carbon dioxide} \longrightarrow \text{Water} + \text{Carbonic acid}$$

$$CO_{2(g)} + H_2O_{(l)} \longrightarrow H_2CO_{3(aq)}$$

Red blood cells convert carbon dioxide to hydrogen carbonate. This makes it easy for the carbon dioxide to be transported by plasma.

(ii) Transportation of waste substances

End products of metabolic reactions in the body are transported to various excretory organs for elimination from the body.

(iii) Distribution of heat in the body

Transport of heat by the blood helps to distribute it evenly within the body tissues. Most of the heat originates from an organ like the liver in which many heat producing chemical reactions occur. It is then transported to all parts of the body.

(iv) Transportation of hormones

The blood plasma serves as a medium in which hormones are transported from the glands that produce them to specific target organs on which they act.

(v) Transportation of antibodies

Antibodies are chemical substances that protect the body against disease causing micro-oganisms. They are transported in the plasma.

(vi) Transportation of nutrients

Many of the products of digestion such as glucose and amino acids are dissolved in the plasma before they are transported from the small intestines to the liver either for storage or for further transport to cells in body organs.

Blood cells

Carry out the following activity.

Activity 7.2 :

To examine various blood cells

Materials

- Microscopes
- Slides
- Blood stain
- Fresh blood from a small mammal like a rat or a rabbit (avoid use of human blood)
- Prepared slides of blood samples

Procedure

1. Place a drop of fresh blood on a slide.
2. Using another slide touch the end of the drop and then slide it over the slide at an angle. The 2nd slide will spread or smear the blood over the slide surface.
3. Cover the smear with a stain.
4. Dip the slide into methyl alcohol for 3-5 minutes. Alcohol fixes the cells to make sure they do not burst.
5. Allow the smear to dry.
6. Stain the smear to make the cells more visible. Staining is done by placing a drop of eosin or methylene blue on the smear.
7. Allow the smear to stain for about 20 minutes.
8. Rinse it with distilled water and allow it to dry.
9. Place a coverslip on the slide.
10. Observe the smear using a microscope.
11. Note the following;
    (a) The cells that are numerous. These are the red blood cells. These cells are disc shaped.
    (b) Large few cells with a large dark area inside them. These are the white blood cells.
    (c) Tiny disc-like fragments scattered all over the smear. These are the platelets.
12. Draw each of the cells.

Discussion

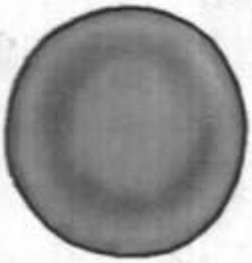
There are three types of blood cells. These are red blood cells, white blood cells and platelets.

1. Red blood cells

These are very tiny cells. They are **disc shaped** and **biconcave** and appear as discs which are thinner in the centre and thicker around the edges.

The small size of red blood cells increases their surface area to volume ratio for the diffusion of oxygen. Their cytoplasm contains a red iron-containing pigment called **haemoglobin.**

(i) Red blood cell cut in half to expose its biconcave shape



(ii) Disc shape of a red blood cell observed from the top

Fig. 7.5: Structure of red blood cell

Red blood cells have no nucleus. This creates space for more cytoplasm and therefore more haemoglobin in them. Red blood cells are also very many in number. There are about five million red blood cells in every cubic millimetre (mm^3) of human blood. However, the number of red blood cells varies depending on any of the following factors:

(a) **Altitude:** the higher the altitude the more they will be.

(b) **The state of health of a person:** People with severe anaemia or malaria have fewer red blood cells in their blood.

Red blood cells are made in the red bone marrow of the bones of the sternum and ribs. They stay alive for four months and are destroyed in the liver and spleen.

Iron from destroyed cells is re-used in the body to make haemoglobin in new red blood cells.

Functions of the red blood cells

The main function of the red blood cells is to transport oxygen from the lungs to the body tissues. The haemoglobin found in these cells readily combines with oxygen when the blood passes through the lungs to form **oxyhaemoglobin**.

When the blood reaches a region with low oxygen levels like in the tissues, the oxyhaemoglobin readily gives up the oxygen it was carrying. It then reverts back to haemoglobin. The cells take up the oxygen and while haemoglobin is free to be used again to carry more oxygen.

$$\text{Haemoglobin + oxygen} \underset{\text{tissues}}{\overset{\text{lungs}}{\rightleftharpoons}} \text{Oxyhaemoglobin}$$

Haemoglobin can combine even more readily with carbon monoxide gas than with oxygen to form **carboxyhaemoglobin**. However, carboxyhaemoglobin does not split readily to release haemoglobin. This prevents adequate oxygen from being supplied to the tissues. This makes carbon monoxide a dangerous gas

because a person who has inhaled even small quantities of it, especially in a room with poor ventilation can die of suffocation.

2. White blood cells

The white blood cells are larger than red blood cells, they are colourless and are fewer in number. There are about 6000 per cm^3 of blood. This number increases during infections but reduces in the case of HIV infection. White blood cells have a nucleus.

Functions of white blood cells

There are two main types of white blood cells namely **lymphocytes** and **phagocytes.** White blood cells fight disease causing germs in the body.

Phagocytes

Phagocytes are a type of white blood cells that have a large lobed nucleus and a cytoplasm containing granules.

They can change their shape as they actively **seek, engulf** and **digest** disease causing germs therefore protecting the body from infection.

They can squeeze through capillary walls in order to reach infected tissues. They are made in the bone marrow of long bones.

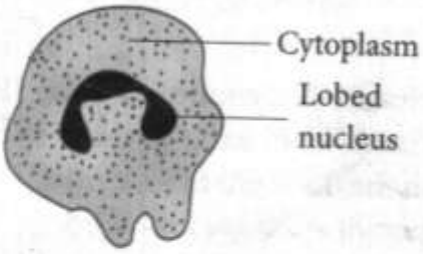


Fig 7.6: A phagocyte

Lymphocytes

Lymphocytes have large rounded nucleus.

Lymphocytes protect the body by producing chemical substances called **antibodies** to destroy disease causing organisms.

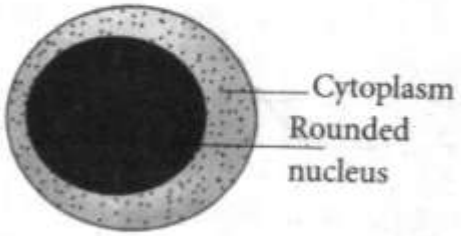


Fig 7.7: A lymphocyte

Platelets

Blood platelets are also known as **thrombocytes.** They are fragments from larger cells. They are small and have no nucleus as shown below.

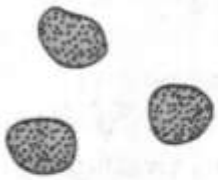


Fig. 7.8: Platelets

Functions of platelets

Platelets are involved in blood clotting when an injury occurs on the skin.

Anaemia

Read the following story.

"Ndolo comes from Kachere village in the lake region of Malawi. Last year while in form one he contracted malaria and was admitted at Kachere health centre for one month. Upon recovery, Ndolo returned home to the joy of his parents and friends. But though Ndolo was healed and did not have headaches and fever, he still felt weak. Ndolo went back to school assuming that the weakness of his body would end. In school he realised that he often felt tired after doing small tasks. He also felt like fainting especially when

he tried to walk hurriedly when obeying school bells.

His friends kept asking him what happened to his skin because he looked pale and he often got mild headaches. His lips and eyes were also very dry.

Ndolo was noticed by his biology teacher Mrs. Phiri who advised him to go to hospital again because he looked as if he was suffering from anaemia. Ndolo wondered how he could suffer from a second disease after having been treated of malaria. The teacher explained to him that when he was sick with malaria, the malaria destroyed very many red blood cells making him to suffer a condition called anaemia.

Questions

1. From the story what caused Ndolo to suffer from anaemia?
2. How did the teacher know that Ndolo was suffering from anaemia?
3. Why do you think Ndolo was feeling tired and fatigued?

Discussion

From the story, you may have learnt that the teacher examined the face of Ndolo and noticed signs of anaemia. Due to presence of few red blood cells, Ndolo's body would not get enough oxygen hence the body produced less energy. It made him to feel tired when doing exercises.

Meaning of anaemia

This is a condition whereby the blood does not contain enough healthy red blood cells. This results to less oxygen being transported to the tissues.

Symptoms of anaemia

1. The person feels tired and fatigued even after slight activity.
2. The face looks pale and the mucous membranes are dry and dark coloured.
3. The patient may experience mild headaches and may sometimes feel like fainting.

Causes of anaemia

(a) Heavy or excessive bleeding due to injuries and accidents.

(b) Heavy bleeding in adult females due to menstruation.

(c) Diseases which lead to reduced blood production.
Such diseases include:
   (i) Malaria – malaria parasites hack and destroys red blood cells.
   (ii) Leukemia - cancer of blood.
   (iii) Diseases of the liver and kidney.

(d) Infestation by worms such as hookworms and bilharzia worm.
   - These worms suck a lot of blood.
   - They also cause injuries in the alimentary canal leading to serious bleeding.

(e) Poor nutrition. Formation of red blood cells require proteins, vitamin C and iron. Lack of these nutrients in the diet lead to anaemia.

(f) Hereditary defects such as sickle cell anaemia and haemophillia. Haemophillia is a condition whereby blood takes too long to clot after an injury. This leads to excessive blood loss, incase of an injury.

Prevention of anaemia

Anaemia can be prevented by:

(a) Eating food rich in iron and vitamins for example leafy vegetables like spinach and liver.

(b) Controlling of worms by taking dewormers regularly.

(c) Maintaining hygiene to prevent worm infestation.

(d) Providing foods rich in iron.

Ways of treating anaemia

A patient with anaemia can be treated by:

(a) Giving mineral supplements. These includes:
   (i) iron tablets
   (ii) folic acid tablets

(b) Having blood transfusion. Addition of blood to increase the number of red blood cells.

Types of bleeding

There are three types of bleeding, depending on the type of vessel that is injured. The type of bleeding can usually be identified by how the blood flows.

1. Capillary bleeding

This type of bleeding occurs within seconds to minutes. A good example of capillary bleeding is a nose bleeding.

A nosebleed occurs from blood vessels that line the nose are broken. To stop nosebleeds of this nature, sit or stand upright, then pinch your nose with your thumb and index finger for 5 to 10 minutes or less until the bleeding stops. If it does not stop within a reasonable time frame, it is best to seek medical care.

2. Venous bleeding

Veins are found under the skin nearer to the body surface. Cuts on the skin have the potential to cut open veins. A cut vein typically results in a steady but slow flow of dark red blood. The best way to stop most cases of venous bleeding is to put direct pressure on the wound.

3. Arterial bleeding

This is the least common and most dangerous type of bleeding. It occurs when one gets deep cuts. It involves bright red blood that comes out in large volume and in spurts that correspond with each beat of your heart.

In most cases of arterial bleeding, apply firm pressure on the wound to stop the bleeding. If direct pressure is not applied, a severe arterial wound can cause you to bleed to death within a few minutes.

First aid to a bleeding patient

1. If possible, have the bleeding person lie down and position his or her head so that it is lightly lower than the trunk. Also, try to elevate his or her legs. Taking these measures will help to increase blood flow to the brain, which will decrease the chance of fainting.
2. If possible, elevate the body part that is bleeding. Doing so will reduce blood loss because the heart will have to work against gravity to pump blood to the injured area.
3. Remove large chunks of dirt and other debris from the wound, but if there is an impaled object, do not remove it.
4. Apply firm and direct pressure to the wound. Then use sterile bandage, a

clean cloth, clothing or your hand to apply pressure.

5. Do not stop applying firm and direct pressure to the wound until the bleeding stops.

First aid for minor cuts

1. The best treatment for a minor cut or scrape is to wash it thoroughly with water and plain soap. If possible, apply aloe or an antibiotic ointment onto the wound, and then cover with a bandage to keep it clean.
2. If a cut does not stop on its own with direct pressure for a few minutes, or it is clear that it is more serious than a minor cut or scrape, be sure to have a doctor look at it as soon as possible. Don't forget to do your best to stop the bleeding before you can do anything else.
3. In the case of a puncture wound, stop the bleeding, if necessary, and visit your doctor or the hospital right away. Even if a puncture doesn't appear to be serious, it is important to take preventive measure to reduce your chance of experiencing an infection.
4. In the case of a blow to the head, especially either side of the head in the temple region, even if there is no bleeding, it is important to seek medical care immediately and to let the attending physician know where you were hit. Internal bleeding in the head region can be dangerous.

Revision Exercise 7

1. Which one of the following is **not** a type of blood vessel?
   A. The heart
   B. Artery
   C. Vein
   D. Capillary
2. Which one of the following transports oxygen?
   A. Capillary
   B. Red blood cell
   C. White blood cell
   D. Platelets.
3. In which form is oxygen transported in blood?
   A. Oxyhaemoglobin
   B. Carboxyhaemoglobin
   C. Carbonic acid
   D. Dissolved carbon dioxide
4. List any **three** symptoms of anaemia.
5. Give **two** types of bleeding.

Unit 8

Worm Infestation

Success criteria

By the end of this unit, students must be able to:

(a) Describe the signs and symptoms of worm infestation in humans.

(b) Explain modes of transmission, prevention and control of worm infestations in humans.

Introduction

Worms are parasites that are found in the alimentary canal of an animal. Worms obtain food and shelter from the body of the animal. This causes harm to the human body. When worm infestation is high, the body of an individual becomes affected as signs and symptoms of worm infestation appear.

1. Roundworms (*Ascaris lumbricoides*)

This is the common roundworm. It is 15 – 20 cm long.

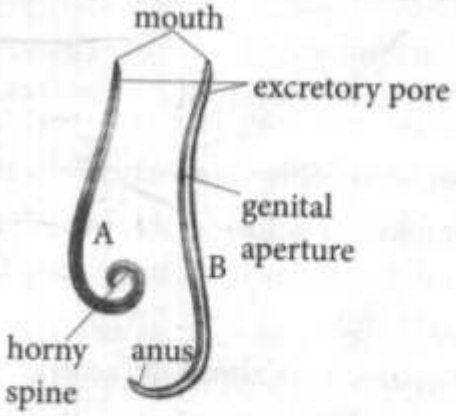


Fig. 8.1: Male (A) and female (B) Ascaris (Ascaris lumbricoides)

Life cycles of a roundworm

Eggs of *Ascaris lumbricoides* are taken into the body with contaminated food especially salads and lettuce which are eaten uncooked.

Once the eggs get into the body, they hatch into embryos which migrate to the lungs.

After some time they find their way to the trachea and back into the intestines where they gradually develop into adult roundworms.

They then produce eggs which are passed out in faeces.

Symptoms or effects of the parasites on the hosts

Adult worms feed on digested food substances in the small intestine, competing for the food nutrients with the host. This often causes malnutrition.

In heavy infestation, the large numbers of worms can cause the blockage of the intestine. Due to crowding, they move about in the gut, sometimes getting into and blocking the pancreatic and bile ducts.

Adaptive characteristics of the parasites

They are able to respire anaerobically. As a result, they can survive in the gut which has low oxygen levels.

Large numbers of eggs are produced. This ensures that some of the offspring that hatch out from the eggs will survive even if there are hazards in the environment of the parasite.

Control and prevention of diseases associated with the parasites

- Washing hands after visiting the toilet or latrine.
- Having a safe water supply.
- Proper disposal of faeces in a hygienic way that is, use of toilet or pit latrine.
- Thorough washing of vegetables.
- Thorough cooking of food if it is suspected to be contaminated with eggs of the worms.
- Proper treatment.

Life cycle of roundworms

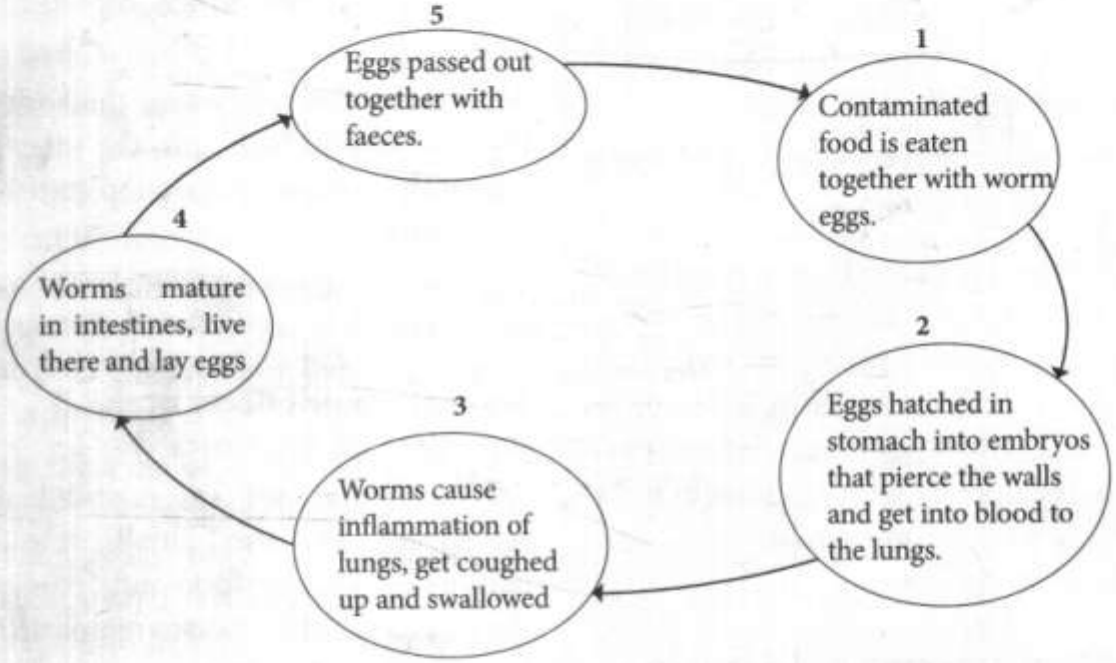


Fig. 8.2: Life cycle of roundworms

2. Hookworms

These are small worms measuring about 10 cm in length.

Structure of a hookworm

Like the other round worms, a hookworm is made of a round unsegmented body.

The body is pointed on two ends. One end is the anus and the other end is the mouth. The worms are usually red in colour.

On the mouths, they have tiny spines or hooks that attach them onto the intestinal walls.

They use the mouth to suck digested food substances and blood in the intestines.

Life cycle of a hookworm

Adult hookworms live in the intestines. Male and female worms mate and the female lays eggs.

Eggs are passed out through faeces.

In damp conditions or in water, the eggs hatch into larva. The larva has spines or hooks at their mouths.

The larva uses the spines to pierce through the skin of an individual who walks or swims in the water.

It enters into the bloodstream and is transported by blood to the lungs.

In the lungs, they continue to develop and enter into the bronchi then to the trachea.

The larva is then coughed out and then swallowed together with mucus.

In the intestines, the larva develops into an adult worm.

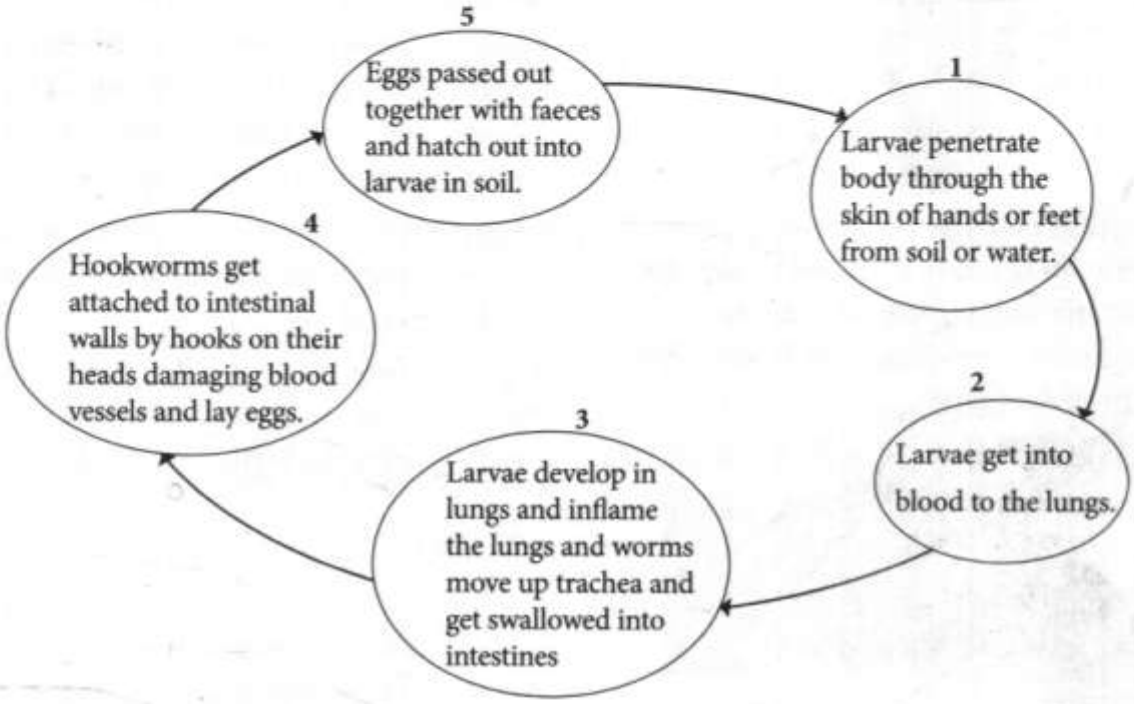


Fig. 8.3: Life cycle of hookworm

Exercise

Discuss the following questions with your group members.

(a) How are hookworms transmitted?

(b) How are hookworms controlled and prevented?

Symptoms of hookworm infections

Heavily hookworm infestation results to:

- Pain in the abdomen.
- Weight loss.
- Itching or pain in some points after swimming or passing through water. This is due to piercing of larva as it enters into the skin.
- Coughing.
- Anaemia.

Control of hookworms

- Avoid walking bare foot in water or on land.
- Deworming using drugs.
- Proper disposal of faeces.

3. Tapeworms

Tapeworms are worms that have flat segmented bodies resembling a tape.

The worm has two hosts, the adult worm is found in the body of humans while its larva lives in the body of either pigs or cows. The tapeworm requires the two hosts to complete its lifecycle.

Structure of a tapeworm

The tapeworm is made up of a head called scolex. The scolex has hooks and suckers, as shown below.

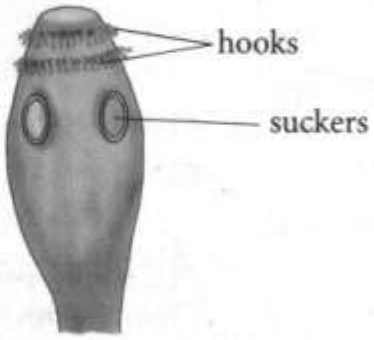


Fig. 8.4: Tapeworm head (scolex)

The body is made up of many flattened segments called proglottids. The proglottids are joined end to end like sections in a tape.

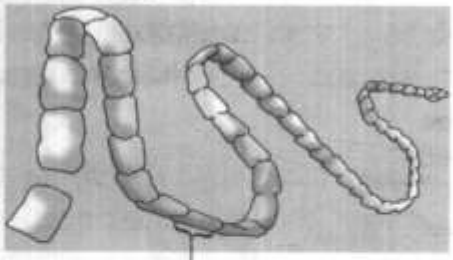


Fig. 8.5: Strobila

The suckers and the hooks attach the worm onto the walls of the alimentary canal. A mature tapeworm lives in the intestines of a human. It feeds by absorbing digested food substances in the intestines.

Lifecycle of a tapeworm

Eggs are formed inside the segments. A mature proglotid is usually full of eggs. It breaks off at the end of the body and eliminated together with faeces.

If proglottids are eaten by cattle or pigs, the eggs enter the digestive system and hatch into embryos.

The embryos have hooks that enable them to bore and enter into the blood capillaries on the walls of intestines.

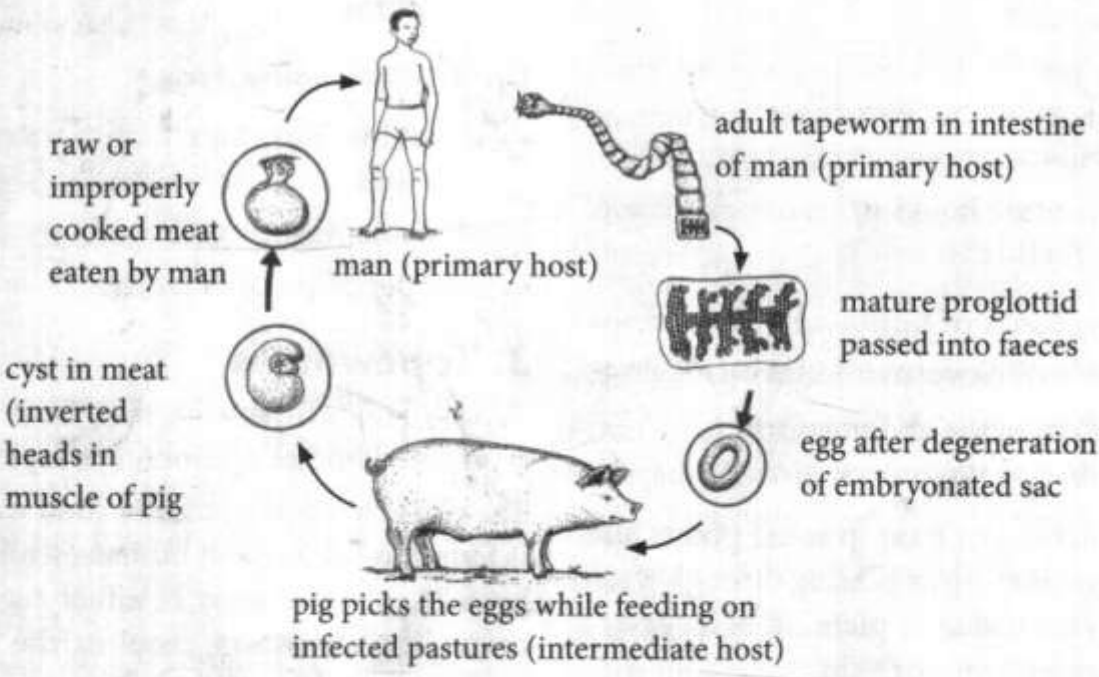


Fig. 8.6: Life cycle of pig tapeworm (Taenia solium)

They are then transported by blood to the muscles. In the muscles, the embryos develop into a bladderworm.

The bladderworm has a head surrounded by a fluid filled cavity.

- The bladderworm lives in the muscles
- If the cattle or the pig is slaughtered and the meat in not well cooked, the bladderworm is ingested into the alimentary canal.
- In the intestine of the human, the bladderworm develops into the adult tapeworm.

Symptoms of tapeworm infection

When a person is heavily infected with tapeworms, the following signs are noted:

- Presence of segments of worms in faeces.
- Abdominal pains.
- Obstruction of intestines by heavy infestation.
- Loss of body weight.

How tapeworms are spread

- Eating meat that is not well cooked.
- Eating food or drinking water contaminated with tapeworm eggs.

Control and prevention of tapeworms

- Proper cooking of meat before eating.
- Drinking boiled or treated water.
- Proper disposal of faeces by use of toilets and pit latrines.

4. Threadworms

These are tiny white worms that usually affect children. They resemble hookworms.

Life cycle of threadworms

The worm lives in the large intestines. The female lay eggs which are passed out through faeces.

Eggs are swallowed through contaminated food or water.

The eggs also attach onto the fingers as children scratch the anus due to itching. They then swallow the eggs as they feed using unwashed hands.

In the alimentary canal, the eggs hatch into larva. Larva migrates to the large intestines and develops into an adult worm.

The worm feeds by absorbing food substances in the large intestines.

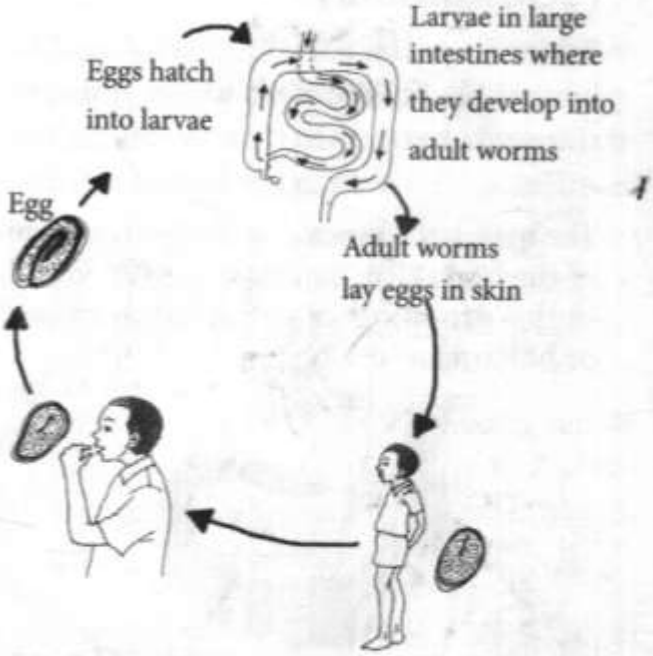


Fig 8.7: Lifecycle of threadworm

How threadworms are spread

- Through contaminated food.
- Through contaminated water.

Signs of threadworm infections

- Presence of worms in faeces.
- Itching of the anus.
- Sores or small wounds around the anus.
- Swelling around the anus in heavy infestation. This is because female thread worms lay eggs around the anus.

Control of threadworms

- Washing of hands with soap and water before eating.
- Proper disposal of faeces
- Use of dewormers.

5. Bilharzia worm (*Schistosoma*)

Schistosoma is a parasitic fluke found in human blood. The adult worms are very thin and can be up to 2 cm in length. The males are larger than the female worms.

The male has a groove along the front side of the body. The female is usually found in this groove. It causes schistosomiasis or bilharzia.

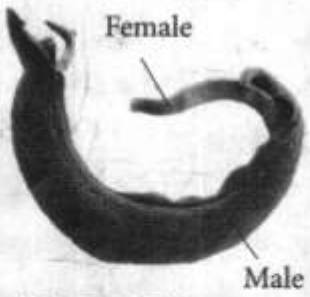


Fig. 8.8: Schistosoma

Mode of transmission

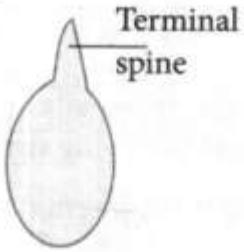
Certain larval stages of the *Schistosoma* are released into water by snails which act as hosts.

Types of Bilharziasis (*Schistosomiasis*)

1. Urinary bilharzia

It affects urinary bladder of infected person.

It is caused by *Schistosoma haematobium*; a parasite which lives in water snails of *Bulinus spp.* which lay eggs with a terminal spine.

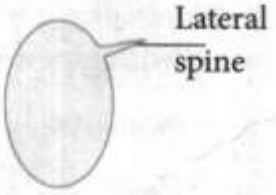


2. Intestinal bilharzia

It affects the large intestines of an infected person.

It is caused by *Schistosoma mansoni.*

The parasite lives in water snails of *Biomphalaria spp.* which lays eggs with lateral spine.



Life cycles of bilharzia worms

The larvae can enter into a human through the following ways:

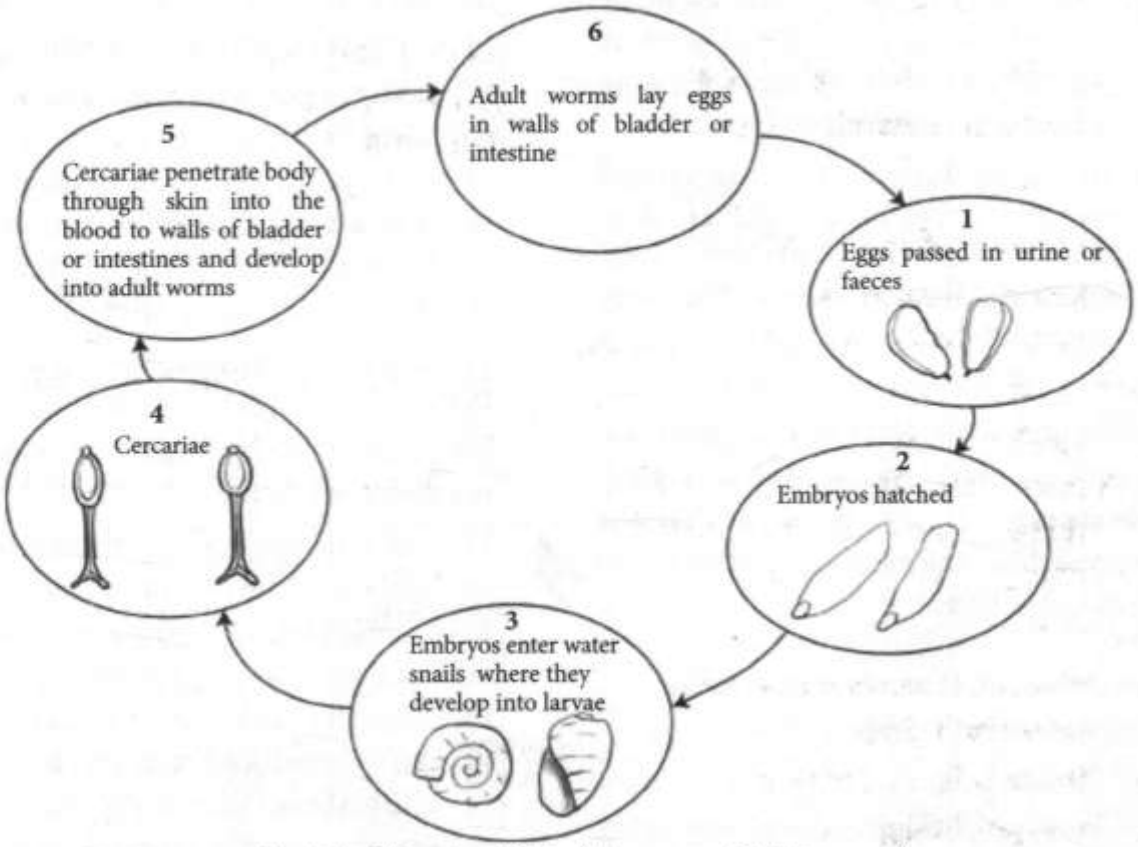


Fig. 8.9: Lifecycle of Bilhalzia worms (Schistosoma)

- They penetrate the skin of a person coming into contact with the water. They then enter into the blood stream.
- They can be consumed in contaminated water. They penetrate through the gut and enter into the blood stream.

Once in the bloodstream, the larvae develop into adults and lay eggs in blood.

Blood vessels in the bladder and intestines rupture to release the eggs, which leave the body through faeces or urine. If they get into water, they develop into a form that penetrates into the tissues of certain fresh water snails which acts as hosts.

Symptoms of schistosome infection

Schistosoma damages blood vessels around the bladder and blood appears in the urine. The victim eventually develops anaemia.

Pain is felt during urination. Very often the urinary passage become narrow and eventually the bladder is unable to contract. This makes urination difficult.

Large numbers of eggs are trapped in the thickened walls. The thickening of the intestinal walls interferes with the absorption of food.

Their presence in the intestines causes diarrhoea, abdominal pains and some liver tenderness and in some cases blood-like mucus appears in stool.

Adaptive characteristics of the parasite

(a) The eggs have a hook-like structure (spine) which raptures the walls of the intestines or bladder.

(b) The *Schistosoma* produces large numbers of eggs to ensure its survival.

(c) The larvae have a tail for swimming in water in search of a host.

(d) The larvae have a sucker that is used for attachment on the human skin. They then produce enzymes which digest the human skin so that they can enter the body.

There is prolonged association of the female and male worms. The male has a canal in which the female is carried. This ensures that successful fertilisation occurs before the eggs are released into the blood vessels.

Control and prevention of diseases associated with *Schistosoma*

- Treating drinking and washing water. Filtration followed by chlorination kills the larvae. Boiling also destroys larvae in water.
- Preventing the eggs from reaching fresh water through proper disposal of sewage and proper use of latrines and toilets.
- Educate the people: People living in infected areas should be educated always to use latrines. Children should be warned about the hazards of playing in snail infested water and be taught about the need for hygienic behaviour. This is necessary since they often play in and out of water, exposing themselves to the risk of infection.
- Larvae can be prevented from reaching the skin either by keeping out of water or by wearing protective boots.
- Destruction of snails that serve as intermediate hosts by use of appropriate chemicals in water.
- Clearing vegetation in ditches. Building bridges and culverts over streams and ditches is also helpful. A rapid flow with few obstructions discourages the growth of water-weeds on which the snail feed.
- Cutting off water in rice paddy fields to allow ditches to dry out periodically leads to death of large numbers of snails.
- Use of the natural predators of snails such as the guppy or rainbow fish. These fish eat the eggs of snails that act as secondary hosts of the schistosomes. As a result, the number of snails is reduced and the larvae of schistosomes eventually die due to lack of a host for survival. This is a biological way of controlling the schistosomes.

6. Filarial worms (*Wuchereria bancrofti*)

Wuchereria bancrofi is a parasitic worm which causes elephantiasis.

Life cycles of filarial worms

It has five stages.

The male and female worms mate and the female gives birth to many small filarial worms.

The small filarial worms are taken by the vector insect (female mosquito or black flies) during a blood meal.

In the vector, they moult and develop.

The vector injects the infectious larvae into the dermis layer of the skin.

After one year, the larvae moults through two more stages into the adult worms.

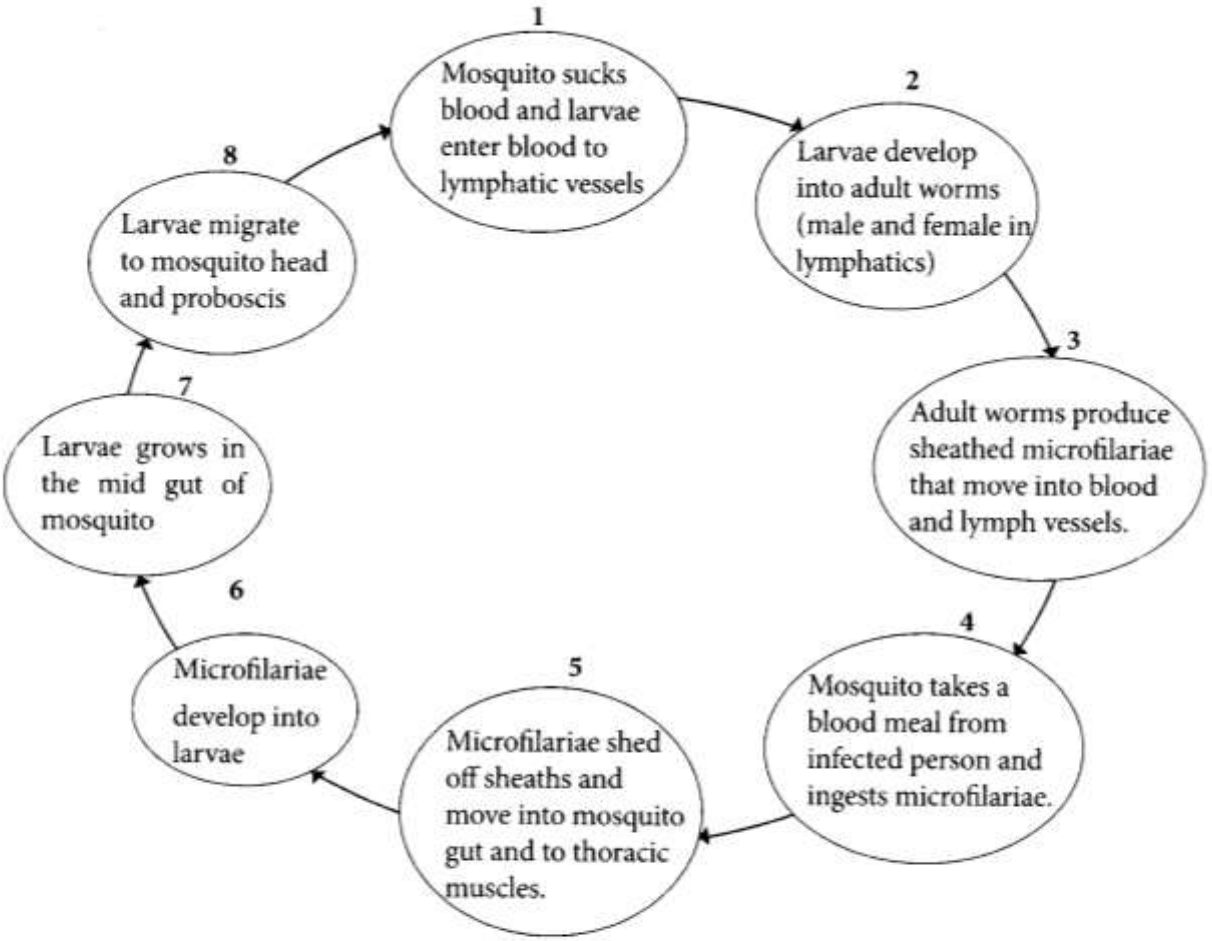


Fig. 8.10: Lifecycle of Wuchereria bancrofti (Elephantiasis worms)

Acute symptoms

- Fever
- Pain in the testicles
- Pain above the testicles
- Enlarged groin lymph nodes

Chronic symptoms

- Blocked lymph vessels.
- Massively swollen legs, genitalia and breasts.
- White urinary discharge
- Swollen liver
- Swollen spleen.

- Control mosquito population.
- Administer medicine to kill microscopic worms.

Revision Exercise 8

1. Which one of the following is not a control measure for tapeworms?
   A. Proper cooking of meat before eating.
   B. Proper disposal of faeces by use of toilets and pit latrines.
   C. Eating contaminated food.
   D. Drinking boiled or treated water.

2. Which of the following is not a sign and symptom of worm infection?
   A. Eggs in faeces.
   B. Worms in the stool.
   C. Blood capillaries weaken.
   D. Blockage of lymph vessels.
3. How are some worms transmitted from animals to humans?
   A. Poorly cooked meat.
   B. Anaemia.
   C. Diarrhoea.
   D. Constipation.
4. Which of the following habits would prevent spread of worm infestation among humans?
   A. Proper use of latrines.
   B. Proper disposal of garbage.
   C. Disinfecting our houses.
   D. Slashing grass.
5. (a) Briefly describe the symptoms of tapeworm infection.
   (b) What are the adaptive characteristics of :
      (i) *Ascaris lumbricoides?*
      (ii) *Schistosomes?*
6. State measures that can be used to control schistosomes.
7. How are hookworms transmitted?
8. Outline the control measures for hookworm infestation.

Model Test Paper

Section A: Multiple choice questions: 30 marks

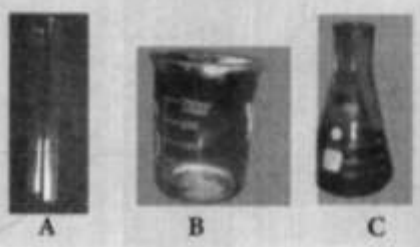
Instructions:

Answer all questions in this section.

Encircle the letter corresponding to the correct answer.

1. When fire breaks out in the lab, which one of the following should you not do?
   A. Scream and run to any direction
   B. Call the teacher for assistance
   C. Press the fire alarm on the wall of the lab.
   D. Move out quietly and seek help
2. Why are plants said to be producers?
   A. They produce oxygen during the day and carbon dioxide at night.
   B. They produce food for other organisms.
   C. They use simple substances in their environment to manufacture complex food substances for their use and for use by other organisms.
   D. They produce leaves and stems for use by man.
3. Which one is the correct order of hierarchy in classification of organisms?
   A. Kingdom- Genus-Species-Phylum-Class-Order-Family
   B. Kingdom-Phylum-Class-Family-Order-Genus-Species
   C. Kingdom-Class-Phylum-Order-Family-Genus-Species
   D. Kingdom-Phylum-Class-Order-Family-Genus-Species
4. Name the deficiency diseases that occur when the body of a child lacks enough calcium.
   A. Rickets
   B. Marasmus
   C. Kwashiorkor
   D. Anaemia
5. Which one among the following does not take place during chemical digestion?
   A. Enzymes are produced
   B. Food is broken into smaller pieces
   C. Complex food molecules are broken into simpler molecules
   D. Enzymes work on specific food substances
6. Name an enzyme that is not involved in digestion of carbohydrates.
   A. Salivary amylase
   B. Lactase
   C. Peptidase
   D. Maltase
7. Which blood cell is involved in blood clotting?
   A. Blood platelets
   B. Red blood cells
   C. White blood cell
   D. Leukocyte

The figures below illustrate various laboratory apparatus. Use them to answer questions 8 and 9.



A B C

8. What name is given to apparatus marked A?
   A. Beaker
   B. Conical flask
   C. Test tube
   D. Bottle

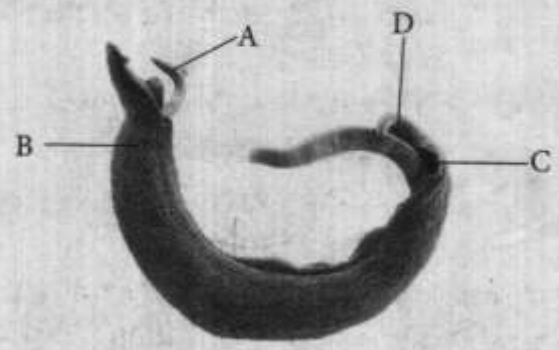
9. What is the use of apparatus labelled C?
   A. For heating and mixing reagents
   B. For storing chemicals
   C. For filtering substances
   D. For measuring liquids

A student was carrying out a field study in a garden. He measured the garden and found out that it had a length of 12 m and a width of 11 m. He also found out that in the garden there were 100 caterpillars feeding on 25 cabbage plants planted in the garden. Use the information above to answer the following questions.

10. Calculate the area of the garden that the student was carrying out the study in
    A. 132 m
    B. 46 cm^2
    C. 23 cm^2
    D. 132 m^2

11. What was the average number of caterpillars paper every cabbage plant?
    A. 3
    B. 4
    C. 5
    D. 6

The figure below illustrates a pair of a particular worm that infests human beings. Use the figure to answer the questions that follow.



12. Name the worms.
    A. Bilharzias worms
    B. Roundworms
    C. Tapeworms
    D. Hookworms

13. Which among the marked pairs represents the female worm?
    A. A
    B. B
    C. C
    D. D

14. In which class of group of organisms does a housefly belong?
    A. Crustaceans
    B. Arachnids
    C. Nematodes
    D. Insects

The scientific name of a housefly is Musca domestica.

15. Which statement among the ones listed below shows the name written correctly using the rules of binomial nomenclature?
    A. *Musca Domestica*
    B. *Musca domestica*
    C. *Musca domestica*
    D. Musca domestica

16. What is constipation?
    A. Disorder where one passes out hard faeces frequently.
    B. Disorder where an individual takes too long to empty the bowels.
    C. Disorder where one passes out faeces with blood.
    D. Disorder where food is not digested rapidly.

In a given habitat a student observed that a grasshopper feeds on grass, a spider feeds on a grasshopper and bird feeds on the spider and the grasshopper. Use the above information to answer the questions that follow.

17. Which food chain among the ones listed below is not correctly made?
    A. Grass →grasshopper → spider → bird
    B. Grass → grasshopper → bird
    C. Grasshopper → spider → bird
    D. Grass → grasshopper→ spider

18. Name the primary consumer in the above habitat.
    A. Bird
    B. Spider
    C. Grass
    D. Grasshopper.

19. Which one of the following organisms is not a vertebrate?
    A. Beetle
    B. Fish
    C. Woodpecker
    D. Antelope

The figures below show various types of micro-organisms.

K

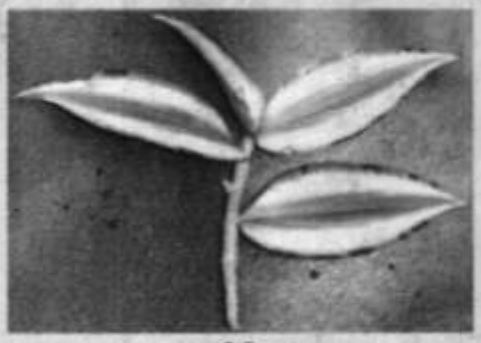
L

20. Which group of organisms does the organism labelled K belong to?
    A. Annelida
    B. Arthropoda
    C. Insecta
    D. Crustacea

21. Explain why the above two organisms are said to be invertebrates.
    A. They are small in size
    B. They can move
    C. They stay in the soil
    D. They have no backbone.

22. Which one is not a function of blood plasma?
    A. Clotting of blood
    B. Transport of oxygen
    C. Dissolving soluble food substances
    D. Transport of food substances

The figures below show various leaf arrangements in plants.



M

N

23. What type of arrangement is represented by leaf marked M?
    A. Whorl B. Alternate
    C. Opposite D. Joined.

24. State the main function of leaves in a plant.
    A. To make food
    B. To produce oxygen
    C. To obtain sunlight
    D. To absorb heat.

25. Which one is not a non-flowering plant?
    A. Conifer B. Moss
    C. Liverwort D. Beans

26. Which one is not a characteristic of a dicotyledonous plant?
    A. Their leaves have network venation.
    B. Their seeds have two cotyledons.
    C. Their root system has taproots.
    D. Their seeds contain a lot of stored foods.

27. Vitamins are in abundant in the following food substances except
    A. maize grains B. vegetables
    C. fish D. liver.

28. Which parts of the body are strengthened by eating foods rich in calcium and potassium?
    A. Liver
    B. Teeth and bones
    C. Teeth and hair
    D. Heart.

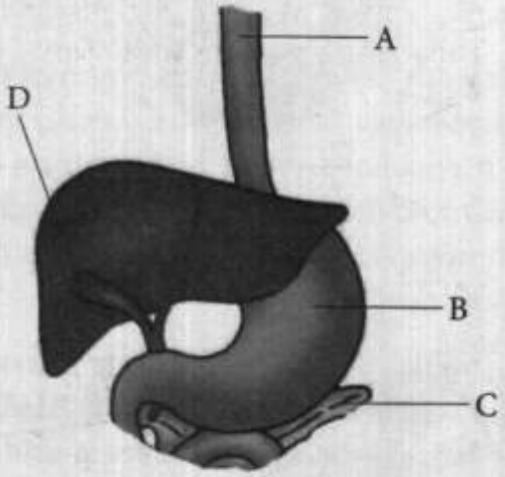
29. Name the vitamin that is involved in blood clotting.
    A. Vitamin K B. Vitamin E
    C. Vitamin A D. Vitamin B12

30. The figure below illustrates a given organism. What group does it belong to?

    A. Algae
    B. Fungi
    C. Protozoa
    D. Virus

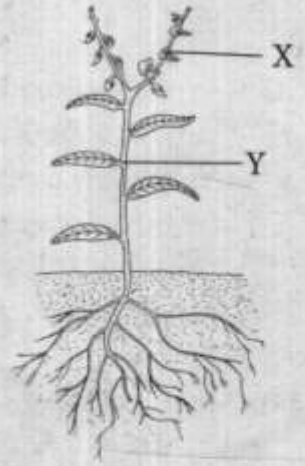
Section B: Structured questions: 30 marks

31. The figure below illustrates a human digestive system.



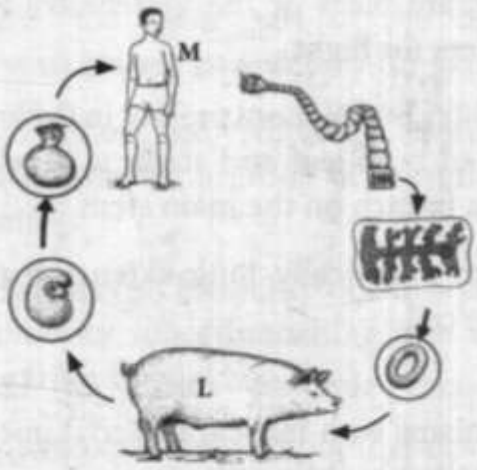
    (a) Name the parts marked A, B, C, and D. (4 marks)
    (b) Name two enzymes produced at part labelled B. (2 marks)
    (c) Name two enzymes produced at part labelled C. (2 marks)
    (d) Explain why part B has an acidic pH. (1 mark)

32. The figure below illustrates parts of a flowering plant.



(a) Name the part labelled X and Y. (2 marks)
(b) What type of root system does the plant possess? (1 mark)
(c) What role does part labelled X play in the plant? (1 mark)
(d) Giving two reasons state whether the above pant is a monocot or a dicot. (3 marks)

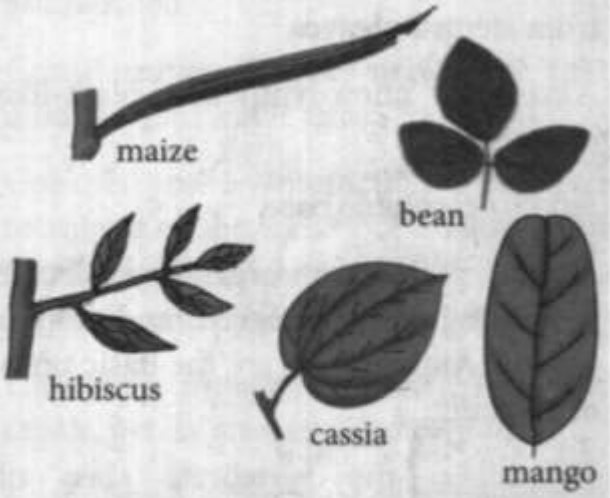
33. The figure below shows a lifecycle of a given worm.



(a) Name the worm. (1 mark)
(b) The worm infects two hosts marked L and M. What type of host is L and M? (2 marks)
(c) State four methods that can be used to control the above worm when in animal marked L. (4 marks)

34. During breathing in one takes in air that contains 79% nitrogen, 20.9 % oxygen, 0.03 % carbon dioxide and the remaining part 0.07% is made of other gases. During breathing out however, the air contains 79% nitrogen 16% oxygen and 4 % carbon dioxide. The rest is composed of other gases.
(a) Read the above passage again and make a table on composition of gases in air that is breathed in and air that is breathed out. (7 marks)
(b) From the table calculate the amount of oxygen retained in the body after breathing in. (2 marks)
(c) Calculate the amount of carbon dioxide released by the body during breathing out. (2 marks)

35. Study the leaf specimens below and use them to make a simple dichotomous key. The first part of the dichotomous key has already been made for you. (6 marks)



1a Leaf simple.....go to 2
b. Leaf compound.....go to 3
2a.....
b.....
3a.....
b.....
4a.....
b.....

Section C: Essays: 30 marks

Answer all questions in this section.

36. Describe the characteristics of living things. (10marks)
37. Describe the various causes of anaemia. (10marks)

Glossary

Absorption: the movement of water and dissolved substances into a cell, tissue, or organism.

Acid: a substance that increases the hydrogen ion concentration in a solution.

Adaptation: a modification of structure, physiology, or behaviour that aids the organism in its environment.

Adventitious: a structure arising from an unusual place, such as roots growing from stems or leaves.

Algae: a photosynthetic, plant-like organism.

Alkaline: soluble base.

Amino acid: an organic molecule possessing both carboxyl and amino groups. Amino acids are the basic units of proteins.

Amphibia: the vertebrate class of amphibians, represented by frogs and salamanders.

Antennae: long, paired sensory structures on the head of many arthropods.

Anterior: referring to the head end of an animal.

Anther: part of flower which produce male gametes.

Aorta: the major artery in blood circulatory systems; the aorta transports blood to the other body tissues.

Artery: a vessel that carries blood away from the heart to other organs.

Asexual reproduction: reproduction where the whole body of an organism or part of an organism body develops a new individual on its own.

Atom: the smallest unit of matter.

Atrium: chamber that receives blood returning to the heart.

Aves: are birds or the vertebrates with feathers for flight.

Axillary bud: a shoot present in the angle formed by a leaf and stem; it develops into a branch on the main stem.

Axon: a typically long extension of a nerve cell.

Bacteria: simplest forms of living organisms with nuclear material instead of nucleus in their cells.

Base: an alkaline solution.

Behaviour: all of the acts an organism performs, for example, seeking a suitable habitat, obtaining food, avoiding predators, seeking a mate and reproducing.

Bilateral symmetry: a body form which can be divided longitudinally into two equal but opposite halves.

Bile: a yellow secretion of the liver, temporarily stored in the gallbladder and composed of organic salts that emulsify fats in the small intestine.

Binary fission: the type of cell division by which some organisms use to reproduce; each cell divides into two similar daughter cells.

Binomial: the two-part Latinized name of a species, consisting of genus and specific names.

Blade: the broad, expanded part of a leaf.

Blood: the liquid tissue in animals composed of blood cells and plasma.

Blood pressure: the force that blood exerts against the wall of a vessel.

Botany: the study of plants.

Brain: the main part of the central nervous system enclosed by the skull.

Bryophyte: the mosses, liverworts, and hornworts; a group of nonvascular plants.

Bronchus (pl. bronchi): one of a pair of respiratory tubes branching into either lung from the trachea.

Bud: young form of shoot that develops into leaves, new stem and flowers.

Calyx: the sepals of a flower.

Capillary: a microscopic blood vessel that penetrates the tissues.

Cilia: a short hair-like microscopic structure on the surface of a cell for locomotion.

Class: a taxonomic grouping of related, similar orders; it is the category above Order and below Phylum.

Coenzyme: an organic molecule or a vitamin that supports metabolic reactions.

Cofactor: any non-protein molecule or ion that is required for the proper functioning of an enzyme.

Cohesion: the binding together of like molecules.

Collagen: a protein of animal cells that forms strong fibres found in connective tissue and bone.

Collenchyma cell: a flexible plant cell type that occurs in strands or cylinders that support young parts of the plant without restraining growth.

Colony: a group of organisms of the same species living together in close association.

Commensalism: a symbiotic relationship in which the symbiot benefits but the host is neither helped nor harmed.

Community: all the organisms that inhabit a particular area.

Competition: interaction between members of the same population or of two or more populations using the same resource, often present in limited supply.

Complete flower: a flower that has sepals, petals, stamens and carpels.

Compound: a chemical combination, in a fixed ratio, of two or more elements.

Compound eye: an eye in insects and crustaceans consisting of up to several thousand light-detecting cells.

Concentration gradient: difference in concentration of a substance separated by a wall.

Conifer: a gymnosperm whose reproductive structure is the cone. Conifers include pines, firs, redwoods, and other large trees.

Connective tissues: animal tissue that functions mainly to bind and support other tissues

Corolla: petals in a flower.

Corpus callosum: in the vertebrate brain, a tightly packed mass of nerve fibres connecting the two sides of the brain; the left and the right hemispheres.

Cortex: the outer, as opposed to the inner part of an organ, as in the adrenal gland.

Cotyledon: the seed leaves of a seed.

Cuticle: a waxy covering on the surface of stems and leaves.

Cytoplasm: the entire liquid contents of the cell.

Development: increase in complexity in an organism's body to enable it perform various functions.

Dicot: a subdivision of flowering plants whose members possess two seed leaves, or cotyledons.

Digestion: the process of breaking down food into molecules small enough for the body to absorb.

Disaccharide: a double sugar, consisting of two monosaccharaides.

Division: a taxonomic grouping of related, similar classes of algae, fungi, and plants.

Dorsal: to the back; opposite of ventral.

Duodenum: the first section of the small intestines.

Energy: the capacity to do work by moving matter against an opposing force.

Enzyme: a class of proteins serving as catalysts, chemical agents that change the rate of a reaction without being consumed by the reaction.

Epidermis: the outer tissue in plants.

Epithelial tissue: outer tissue in body organs.

Eukaryote: an organism whose cells contain membrane-bound organelles and whose cells has nucleus.

Excretion: the disposal of nitrogen-containing waste products from the body.

Exoskeleton: a hard encasement on the surface of an animal, such as the shells of molluscs or the cuticles of arthropods, that provides protection and points of attachment for muscles.

Family: a taxonomic grouping of related, similar genera; the category below Order and above Genus.

Fat: a biological compound consisting of three fatty acids linked to one glycerol molecule.

Fatty acid: a long carbon chain forming a fat molecule.

Flagellum: a long whip-like structure for movement in cells.

Food chain: the pathway along which food is transferred from trophic level to trophic level, beginning with producers.

Food web: the elaborate, interconnected feeding relationships in an ecosystem.

Fruit: a mature ovary of a flower that protects seeds and aids in their dispersal.

Function: characteristic role or action of a structure or process.

Gastric: pertaining to the stomach.

Gastrin: a digestive hormone, secreted by the stomach, that stimulates the secretion of gastric juice.

Genus: a taxonomic category above the species level.

Gill: a structure for gaseous exchange in fish.

Kingdom: a taxonomic category, the largest group in classification.

Lacteal: a tiny lymph vessel extending into the core of an intestinal villus and serving as the destination for absorbed fats.

Lamella: layer, thin sheet.

Larva: a free-living, sexually immature form in animal life cycles that may differ from the adult.

Leaf: the main site of photosynthesis in a plant; consists of a flattened blade and a stalk (petiole) that joins it to the stem.

Lipid: fats and lipids. A group of organic compounds that are fatty acids and are insoluble in water but soluble in organic solvents.

Lumen: the cavity of a tubular structure, such as endoplasmic reticulum or a blood vessel.

Lymph: the colourless fluid, derived from tissue fluid, in the lymphatic system of vertebrate animals.

Lymph node: a mass of spongy tissues, separated into compartments; located throughout the lymphatic system. Lymph nodes remove dead cells, debris, and foreign particles from the circulation; also are sites for production of lymphocytes to fight diseases.

Lymphatic system: a system of vessels and lymph nodes, separate from the circulatory system, that returns fluid to the blood.

Lymphocyte: a white blood cell produced by lymph nodes to fight diseases.

Mammalia: the vertebrate class of mammals, characterised by body hair and mammary glands that produce milk to nourish the young.

Mantle: a heavy fold of tissue in molluscs that secretes a shell.

Mesophyll: the ground tissue of a leaf, sandwiched between the upper and lower epidermis.

Mineral: elements, other than carbon, hydrogen, oxygen, and nitrogen, that an organism requires for proper body functioning.

Molecule: two or more atoms held together by covalent bonds.

Monocot: a subdivision of flowering plants whose members possess one cotyledon.

Monosaccharide: the simplest carbohydrate.

Node: a point along the stem of a plant at which leaves are attached.

Nucleus: the chromosome-containing organelle of a cell.

Omnivore: a heterotrophic animal that consumes both meat and plant material.

Organelle: a structure in a cell cytoplasm that performs specific functions.

Organic compound: a chemical compound containing the element carbon and usually synthesized by cells.

Organism: an individual living thing, such as a bacterium, fungus, protist, plant or animal.

Osmosis: the movement of water molecules from a dilute solution to a concentrated solution through a semi permeable membrane.

Pancreas: a small complex gland located between the stomach and the duodenum, which produces digestive enzymes and the hormones insulin and glucagon.

Peristalsis: rhythmic waves of contraction of smooth muscle that push food along the digestive tract.

Petiole: the stalk of a leaf, which joins the leaf to a node of the stem.

Pharynx: an area in the vertebrate throat where air and food passes.

Phylum: a taxonomic category; Phyla are divided into Classes.

Plankton: mostly microscopic organisms that drift passively or swim weakly near the surface of oceans, ponds, and lakes.

Plasma: the liquid matrix of blood in which the cells are suspended.

Plasma membrane/ cell membrane: the membrane at the boundary of every cell that acts as a selective barrier, thereby regulating the cell's chemical composition.

Platelets: a small blood cell important in blood clotting; derived from large cells in the bone marrow.

Polysaccharide: a complex sugar made of many monosaccharide molecules.

Posterior: to the rear, or tail end.

Predation: an interaction between species in which one species, the predator, eats the other, the prey.

Predator: an organism that kills and eats other living organisms.

Prey: an organism that is killed and eaten by another organism.

Primary consumer: an herbivore; an organism in the trophic level of an ecosystem that eats plants or algae.

Prokaryotic cell: the type of cell lacking a membrane-enclosed nucleus and membrane-enclosed organelles; found only in the bacteria.

Protein: complex nitrogenous organic compound composed of 20 different amino acids.

Protozoa: a microscopic organism that lives primarily by ingesting food like an animal and is capable of movement.

Reptiles: the vertebrate class of reptiles, represented by lizards, snakes, turtles, and crocodiles.

Respiration: breakdown of food substances to release energy.

Root: the descending axis of a plant, normally below ground and serving both to anchor the plant and to take up and conduct water and dissolved minerals.

Root cap: a cone of cells at the tip of a plant root that protects the apical meristem.

Root hair: a tiny projection growing just behind the root tips of plants, increasing surface area for the absorption of water and minerals.

Secondary consumer: a member of the trophic level of an ecosystem consisting of carnivores that eat herbivores.

Sexual reproduction: a type of reproduction in which two parents give rise to offspring that have unique combinations of genes inherited from the gametes of the two parents.

Species: a particular kind of organism; members possess similar characteristics and have the ability to interbreed.

Starch: a complex polysaccharide stored in plants consisting entirely of glucose.

Stem: the part of plant above ground.

Sucrose: cane sugar; a common disaccharide found in many plants; a molecule made of glucose and fructose.

Sugar: any monosaccharide or disaccharide.

Taxon: the group or unit at any given level of classification.

Taxonomy: the branch of biology concerned with naming and classifying the diverse forms of life.

Tertiary consumer: a member of a trophic level of an ecosystem consisting of carnivores that eat mainly other carnivores.

Trophic level: feeding level in an ecosystem.

Vascular: vessels that conduct fluid in a cell.

Vascular bundle: in plants, a group of longitudinal supporting and conducting tissues of xylem and phloem.

Vascular plants: plants with vascular tissue.

Vein: a vessel that returns blood to the heart.

Vena cava: a large vein that brings blood from the tissues to the right atrium of the four-chambered mammalian heart.

Ventral: to the front surface of an animal or towards its belly.

Ventricle: a muscular chamber of the heart that receives blood from an atrium and pumps blood out of the heart, either to the lungs or to the body tissues.

Venule: a very small vein.

Vertebral column: the backbone; in nearly all vertebrates; it forms the supporting axis of the body and protects the spinal cord.

Vertebrate: a chordate animal with a backbone; the mammals, birds, reptiles, amphibians, and various classes of fishes.

Villi: in vertebrates, one of the minute, finger-like projections lining the small intestine that serve to increase the surface area of the intestine for absorption.

Virus: a microscopic, non-cellular particle that reproduces only within a host cell.

Vitamin: an organic molecule required in the diet in very small amounts to stimulate various body processes.

Yeast: a unicellular fungus that is involved in fermentation of sugar.

Zoology: the study of animals.

Zooplankton: a collective term for the non-photosynthetic organisms freely swimming in water.

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