

UNIT 1: INTRODUCTION TO BIOLOGY

Definition: Biology is the study of living things.

OR Biology is the study of life

The word **Biology** comes from two Greek words, '**Bios**' which means **life** and '**logos**' which means **knowledge or study of**.

People who study biology are called **Biologists**.

BRANCHES OF BIOLOGY

There are two main branches of biology;

1. **Botany**. This is the study of plants.
2. **Zoology**. This is the study of animals.

Other branches of biology include;

1. **Taxonomy**. This is the study of classification of organisms.
2. **Cytology**. This is the study of cells.
3. **Ecology**. This is the study of organisms in relation to their environment.
4. **Genetics**. Is the study of inheritance.
5. **Nutrition**. Is the study of food and feeding in organisms.
6. **Anatomy**. Is the study of internal structures of organisms.
7. **Morphology**. Is the study of the external structures of organisms.
8. **Microbiology**. Is the study of microorganisms.
9. **Physiology**. Is the study of functioning of the different body parts.
10. **Bacteriology**. Is the study of bacteria.
11. **Entomology**. Is the study of insects.
12. **Pathology**. Is the study of animals and plant diseases.
13. **Parasitology**. Is the study of parasites.
14. **Nutrition**. This is the study of food and feeding in organisms.
15. **Ethology**. This is the study of behaviors of animals.

Why we study Biology?

The knowledge of biology is useful in the following ways.

1. Leads to career and employment opportunities in areas such as medicine, agriculture, pharmacy, nursing, research, dentistry, etc.
2. To find effective ways of preventing and treating diseases.
3. To develop a practical approach towards scientific problems e.g. analyzing, classifying, observing, recording, etc.
4. To get knowledge to better conserve our environment.
5. Improve our general health standards through the skills acquired in preventing and treating diseases.

6. To understanding and explain the different behaviors of organisms.

LIVING THINGS

Living things are biologically called organisms e.g. Man, cow, pig, frog, bacteria, tree, etc.

CHARACTERISTICS OF LIVING THINGS

There are seven life processes/characteristics which are carried out by all living things. These include;

1. **Respiration.** This is the chemical breakdown of food to release energy in living cells. All living things respire.
2. **Movement.** All living things move. Animals can move from one place to another i.e. they carryout locomotion. Plants cannot move from one place to another only parts of a plant can move. Movement in plants is mainly by growth e. g bending of a shoot towards light.
3. **Growth.** This is the permanent/irreversible increase in size of an organism as a result of increase in the number of body cells. All living things grow.
4. **Reproduction.** This is the giving rise to new organisms by already existing organisms. All living organisms reproduce.
5. **Nutrition/feeding.** Nutrition is the process of obtaining food and make use of the food by the organism. All living organisms carryout nutrition i.e. they all feed.
6. **Excretion.** This is the removal of waste products of metabolism from the body. All living things excrete. Examples of waste products of metabolism; urea, ammonia, uric acid, carbon dioxide, excess water, excess salts, etc.
Note. Faeces is not a waste product of metabolism, it is just undigested food.
7. **Irritability/sensitivity.** This is the ability of an organism to perceive stimuli and respond to them. A stimulus is any change in the organism's environment. All living things are sensitive to stimuli and respond to them.

Note: MRS. GREN can be used to remember the characteristics of living things.

M- Movement

R- Respiration

S- Sensitivity

G- Growth

R- Reproduction

E- Excretion

N- Nutrition

Exercise

1. A car moves, takes oxygen, gives out carbon dioxide, consumes fuel but it is not a living thing. Explain why.
2. Give seven differences between living and non-living things.
3. Give five reasons why animals move.

Differences between plant and animals

Plants	Animals
1. Make their own food by photosynthesis	Cannot make their own food. Depend on already made food.
2. Have chlorophyll.	Do not have chlorophyll
3. They cannot move from one place to another i.e. no locomotion.	Can move from one place to another i.e. they carryout locomotion.
4. Growth occurs throughout the life of a plant (unlimited growth)	Growth stops when animal is mature (limited growth).
5. Plant cells have cell wall made of cellulose.	Animal cells do not have cell wall and do not have cellulose.
6. Store food in form of starch and oils.	Store food in form of glycogen and fats.
7. Response to stimuli is slow and it is usually by growth.	Response to stimuli is fast and does not always cause growth.

Similarities

1. All feed
2. All respire
3. All excrete
4. All reproduce
5. All grow
6. All sense

COMPOSITION OF LIVING ORGANISMS

All living organisms are made up of cells.

THE CELL

Some organisms are made up of only one cell. Such organisms are called **unicellular organisms** e.g. bacteria, amoeba, euglena, etc. organisms which are made up of more than one cell are called multicellular organisms e.g. hen, cow, mushroom, man, etc.

HOW TO STUDY CELLS

Most cells of organisms are very tiny and cannot be seen by a naked eye. Cells are studied by using a microscope.

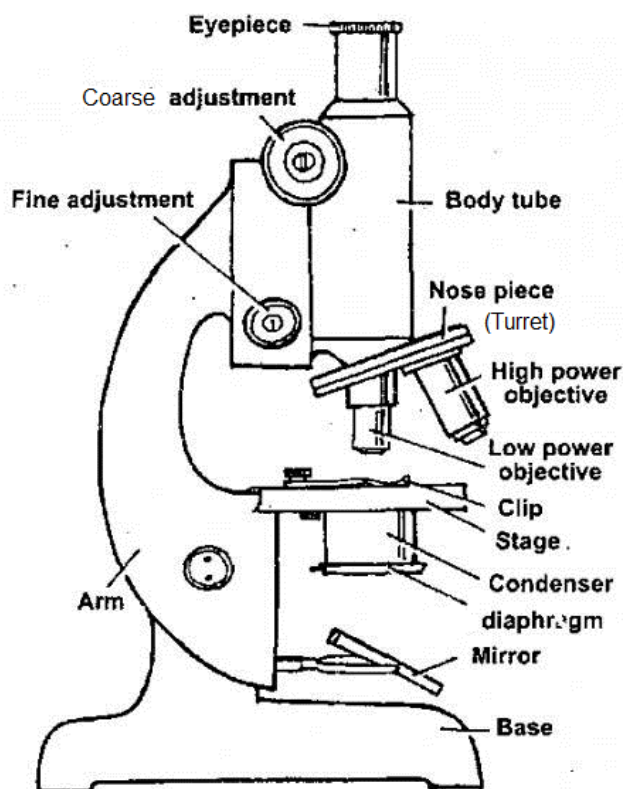
THE MICROSCOPE

A microscope is an instrument which is used to see objects which are too small to be seen by a naked eye or an unaided eye. A microscope magnifies the image of an object/specimen.

THE LIGHT MICROSCOPE

The light microscope uses a beam of light to view the image of an object.

DIAGRAM OF THE LIGHT MICROSCOPE



PARTS OF THE MICROSCOPE AND THEIR FUNCTIONS

Eye piece. It magnifies the image of the object. It is also the part of the microscope where the image of the observed from.

Objective lenses. These magnify the image of the object under study. There are usually three objective lenses on a light microscope. The low power objective lens, with the lowest magnification, the medium power objective lens and the high power objective lens with the highest magnification.

The body tube. This holds the eye piece and objective lenses in position.

The stage. This is the place where the glass slide containing the object is placed for viewing.

Coarse adjustment knob. It is used for focusing the image of the object by moving the body tube upwards or down wards.

Fine adjustment knob. For final focusing of the image of the object. It makes the image appear very clear.

The mirror. This reflects light into the microscope so that the image can be seen.

Condenser. Concentrates light through the object.

Diaphragm. Regulates the amount of light passing through the microscope by reducing or increasing the size of the aperture.

Clips. These hold the glass slide on the stage.

Base. This supports the microscope and enables it to stand properly in one place.

Arm. For carrying the microscope.

Note: The microscope should be emphasized practically. Observe plant and cells.

THE ELECTRON MICROSCOPE

This uses a beam of electrons that is focused on the specimen by powerful electromagnets. The images produced by the electron microscope cannot be detected directly by the naked eye. Instead the electron beam is directed onto a screen from which black and white photographs called photo electron micrographs can be taken.

Advantages of an electron microscope over a light microscope

- Has a high magnification
- Has a high resolution
- Larger part of the specimen is in focus.
- Does not depend on light.

CARE FOR THE LIGHT MICROSCOPE

A microscope is a very expensive instrument and should be handled with great care.

- Carry the microscope using both hands.
- Put down the microscope with care in order not to damage its delicate parts.
- Keep the microscope in upright position.
- Keep the stage dry and clean.
- Clean the lenses by using a soft lens tissue.

HOW TO USE A MICROSCOPE

- Place the microscope on a table or bench with the arm towards you and the stage away from you.
- Place the glass slide containing the object on the stage.
- Fix the glass slide on the stage with the clips.
- Turn the mirror so that it can reflect light through the object.
- Look through the eye piece and lower the objective lens by using the coarse adjustment knob until the image of the object is in focus.
- Focus the image clearly by turning the fine adjustment.

MAGNIFICATION

This is the number of times the image of the object appears bigger than the real object.

Magnification of = Magnification of eye piece X Magnification of objective lens

Example

A senior one student viewed the plant cells by using a microscope of eye piece lens magnification X10 and objective lens magnification X5. What was the magnification of the microscope?

Answer

Magnification = magnification of eye piece X magnification of objective lens

$$= 10 \times 5 = 50$$

$$= \mathbf{X50}$$

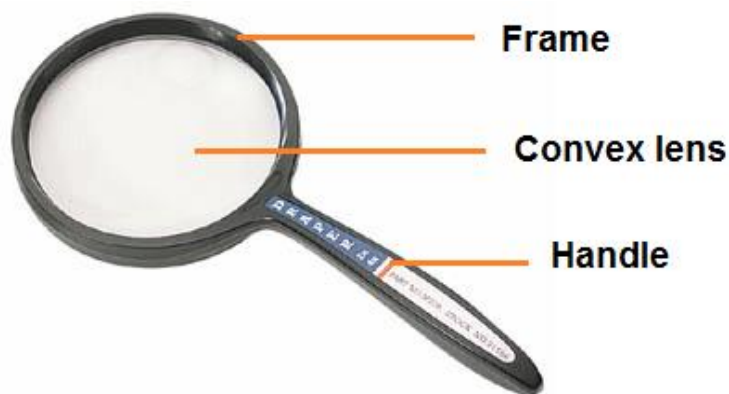
Exercise

1. Fill in the table below

Eye piece lens magnification	Objective lens magnification	Total magnification
i. X10		X200
ii.	X100	X1000
iii. X20	X50	

2. What is the magnification of a microscope fitted with a x5 eyepiece lens and x100 objective lens?
3. What is the objective lens magnification of a microscope with a magnification of x500 and an eyepiece lens magnification of x10?

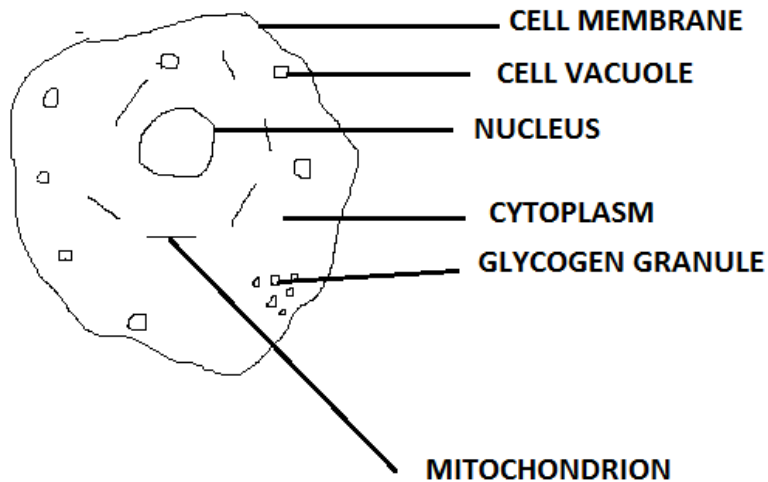
THE HAND LENS. It has got a magnifying lens which magnifies the image of the object.



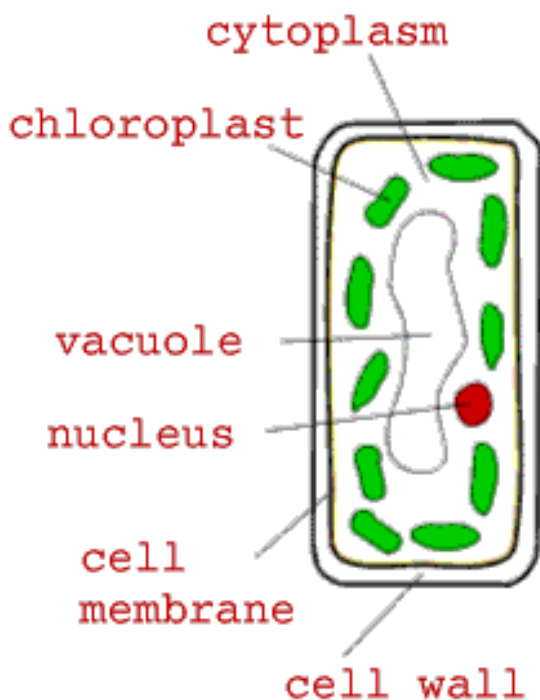
THE CELL

A cell is the smallest basic functional unit of an organism which can carry out life processes.

Structure of the animal cell



Structure of the plant cell



Note: the structures found inside a cell are called cell **organelles** e.g. vacuole, nucleus, etc.

THE PARTS OF THE CELL AND THEIR FUNCTIONS

Cell membrane: It is also called the plasma membrane. The cell membrane is the outer most part of an animal cell. In plant cells it is covered by the cell wall.

Functions

1. It controls movement of substances in and out of the cells.
2. It encloses the inner parts of a cell.
3. It plays a part in cell locomotion in some organisms e.g. amoeba.

4. It is a site for biochemical reactions.

Nucleus

It is surrounded by the nuclear membrane. The fluid inside the nucleus is called nucleoplasm. The nuclear membrane separates the nucleoplasm from the cytoplasm.

Functions

1. It controls all the activities which take place in the cell.
2. It contains the genetic material of the cell.
3. It is responsible for cell division.

Cytoplasm

This is a jellylike substance in which cell organelles are embedded/suspended.

Functions

1. It is a site biochemical reactions e.g. protein synthesis and glycolysis.
2. It contains cell organelles e.g. mitochondria.
3. It stores substances e.g. proteins, starch, fats, etc.
4. It aids movement of materials within the cell by cytoplasmic streaming.

Note: the nucleus together with the cytoplasm are known as **protoplasm**.

Mitochondria (sing. **Mitochondrion**)

They are responsible for release of energy by a process of respiration.

Cell wall. This is the outer most part of a plant cell. It found in plant cells only. It is made up of cellulose.

Functions

1. It gives shape to the cell due to its strength and rigidity.
2. Allows movement of materials in and out of a cell.
3. It provides mechanical strength to the cell.
4. It protects the inner parts from mechanical damage.

Chloroplasts. These are found in plant cells only. They are sites for photosynthesis. They contain a green pigment, chlorophyll which traps sunlight energy for photosynthesis.

Vacuole. Plant cells usually contain one centrally placed vacuole. The vacuole in plants contains cell sap. Animal cells usually lack vacuoles but sometimes they are seen when very small and are temporary e.g. the contractile vacuole in amoeba used for osmoregulation. In plant cells the vacuole is surrounded by a membrane called tonoplast.

Functions

1. For storage of food substances.
2. For temporary storage of waste materials/products.

COMPARISON BETWEEN PLANT AND ANIMAL CELL

Similarities

1. Both have nucleus.
2. Both have cytoplasm.
3. Both have cell membrane.
4. Both have mitochondria.

Differences

Plant cell	Animal cell
1. Has regular shape	Has irregular shape
2. Has a cell wall	Lacks a cell wall
3. Has chloroplasts	No chloroplasts
4. Has a peripheral nucleus	Nucleus centrally located
5. Has middle lamella	Lacks middle lamella
6. Has a small/little cytoplasm	Has much cytoplasm
7. Stores food in form of starch	Stores food in form of cytoplasm
8. Has tonoplast	Lacks tonoplast

ORIGIN OF CELLS

New cells arise from already existing cells by the process of cell division.

Specialized cells

In multicellular organisms cells become specialized to perform particular functions.

TYPES OF SPECIALISED ANIMAL CELLS

1. Red blood cells (erythrocytes). These carry oxygen in the body.
2. White blood cells (leucocytes). These defend the body against diseases.
3. Nerve cells. These transmit impulses in the body.
4. Sperm cell. For sexual reproduction in male animals. Fuses with ovum/egg to form a zygote.
5. Ovum. For sexual reproduction. Fuses with sperm to form a zygote.
6. Osteoblasts. These produce bone.
7. Muscle cells. These cause movement of different parts of the body through contraction.
8. Epithelial cells. These cover surfaces of the body.

SPECIALISED PLANT CELLS

1. Root hair cells. For absorption of water and mineral salts from the soil.
2. Palisade cells. Carryout photosynthesis.
3. Epidermal cells. Protect the inner parts of the plant from mechanical injuries.
4. Parenchyma cells. For storage of food. They also fill the spaces between tissues.

5. Collenchyma cells. This is found in the stem cortex. It provides support and strength.
6. Tracheid and vessels. These together form the xylem. They are responsible for transporting water and mineral salts. The xylem also provides mechanical strength to the plant.
7. Sieve elements. Found in the phloem tissue. They transport food materials in the plant.

Note. The sieve elements are joined end to end to form long tubes called **sieve tubes**.

Guard cells. Found in plant leaves especially in the lower surface of the leaf. They are responsible for opening and closing of stomata.

LEVELS OF ORGANISATION OF ORGANISMS

Organization of cells and formation of organism.

Each organism begins as a single cell. Cells divide, increase in number and are grouped into tissues, organs, systems and then form an organism.

Cells → tissues → organs → systems → organism.

TISSUES. A tissue is a group of cells which are similar, performing a similar function.

Examples of animal tissues.

1. Blood. This is made up of RBC, WBC, platelets in plasma.

Function

Transports various substances in the body and also defends the body against diseases.

2. Nervous tissue. It is made up of nerve cells.

Function: transmit impulses in the body i.e. carries information around the body.

3. Muscular/muscle tissue. This aids movement of the different body parts and the whole organism.
4. Epithelial tissue. This covers surfaces and cavities.

Function: It offers protection.

5. Connective tissue. This binds tissues and organs together.

EXAMPLES OF PLANT TISSUES

1. Epidermal tissue. This is made up of epidermal cells.

Function: it protects the inner parts of the plant from mechanical damage and water loss.

2. Photosynthetic tissue. This is made up of xylem and phloem.

Function: carries out photosynthesis.

3. Vascular tissue. This is made up of xylem and phloem.

Function: transports water, mineral salts and food materials.

4. Mechanical tissue. This is made up of collenchyma and sclerenchyma cells. It provides mechanical strength in plants.

ORGANS. An organ is a group of tissues performing a specific function.

Examples of plant organs: leaves, flowers, stem, roots, fruit

Examples of animal organs

- Kidney. For excretion and osmoregulation.
- Heart. Pumps blood around the body.
- Skin. Protects inner body parts and for excretion.
- Eye. For seeing.
- Ear. For hearing.
- Tongue. For tasting.
- Brain for coordination of body processes.
- Nose. For smelling.

SYSTEM. This is a group of organs performing the same function.

E.g.s of plant systems: the root system and shoot system.

E.g.s of animal systems

- Digestive system- for digestion of food.
- Circulatory system- for transport of materials around the body.
- Excretory system- removing metabolic waste products from the body.
- Reproductive system- for reproduction.
- Endocrine system- for coordination.
- Skeletal system- for movement and support.

ORGANISM. An organism is a group of systems working together efficiently e.g. man.

EXERCISE

1. Which of the following cell structures controls the chemical reactions of a cell?
 - A. Cell wall
 - B. Cell membrane
 - C. **Nucleus**
 - D. Vacuole
2. Which of the following structures is only found in plant cells?
 - A. Nucleus
 - B. **Chloroplast**
 - C. Cytoplasm
 - D. Cell membrane
3. The term protoplasm means,

- A. **Cytoplasm and nucleus**
 - B. Cytoplasm and cell membrane
 - C. Cytoplasm and mitochondria
 - D. Cytoplasm and cell wall
4. Which one of the following parts of a plant cell makes it strong and rigid?
- A. Cell membrane
 - B. Cytoplasm
 - C. **Cell wall**
 - D. Nucleus
5. Which one of the following parts of a cell separates the cytoplasm from the nucleoplasm?
- A. Cell wall
 - B. Tonoplast
 - C. Cell membrane
 - D. **Nuclear membrane**
6. (a) Draw a well labelled diagram of an animal cell.
 (b) State the functions of the parts labelled.
 (c) How does the animal cell differ from a plant cell?
7. (a) Why is a microscope important in the study of cells?
 (b) State four important parts of a microscope.
8. Define the following terms an example in each case.
- (a) Tissue
 - (b) Organ
 - (c) Syste

UNIT 2: CLASSIFICATION OF LIVING THINGS

There are many types of living things, forming a variety of life called biodiversity.

CLASSIFICATION

This is the grouping of organisms according to their similarities and differences. The study of classification is called **taxonomy**.

IMPORTANCE OF CLASSIFYING ORGANISMS

1. To simplify the study of organisms.
2. To bring order out of chaos or confusion.
3. To understand how life originated.
4. To quickly identify organisms belonging the same group.

How organisms are classified

Organisms are classified according to their similarities and differences. They are put into groups called taxa (sing. Taxon).

Taxonomic levels (taxa)

Kingdom
Phylum
Class
Order
Family
Genus
Species

- **Kingdom** is the largest group of classification and species is the smallest. As one moves from kingdom down to the species, the number of organisms decreases but the similarities between/among organisms increase.
- **Species.** This is the group of organisms that can interbreed to produce fertile offspring e.g. all human beings belong to the same species.
- **Genus** (plural. Genera) is a group of organisms that show resemblance. Organisms have several characteristics in common.
- **Family** is made up of several genera having several common characteristics.
- **Order** Is made up of several families
- **Class** is made up of orders with several common features.
- **Phylum** (pl. phyla) is made up of several classes with some common characteristics.
- **Kingdom** is made up of phyla with some similar characteristics. The organisms in a kingdom have few similarities.

Example showing hierarchical system of classification

Taxon	Man	Honey bee	Maize	Cockroach
Kingdom	Animalia	Animalia	Plantae	Animalia
Phylum	Chordata	Arthropoda	angiospermae	Arthropoda
Class	Mammalia	Insecta	monocotyledonae	Insecta
Order	Primates	Hymenoptera	Commelinales	Dictyoptera
Family	Hominidae	Apidae	Poaceae	Blattidae
Genus	Homo	Apis	Zea	Periplaneta
Species	Sapiens	mellifera	Mays	americana

TYPES OF CLASSIFICATION

1. **Artificial classification.** This involves grouping organisms basing on their common characteristics which do not arise from natural relationships e.g. grouping of animals which can fly into one group.
2. **Natural classification.** This involves grouping of organisms basing on natural relationships e.g. ability of the organisms to interbreed and produce fertile offspring.

Advantages of natural classification

It is used to bring order to thousands of animals and plants that have been discovered.

BINOMIAL NOMENCLATURE

Nomenclature means naming.

Binomial nomenclature is the system of naming where an organism is given two names i.e. the generic (genus) name and the specific (species) name. This was invented by Carl Linnaeus.

How to write a scientific name

The scientific name of an organism has two parts. The first part is the generic or genus name and the second part is the specific or species name. The genus name starts with a capital letter while the species name starts with a small letter. The two names are then underlined separately if written by hand or italicized if written using a computer.

Examples

Common name	Genus	Species	Scientific name
Man	Homo	Sapiens	<i>Homo sapiens</i>
Dog	Canis	Familiaris	<i>Canis familiaris</i>
Maize plant	Zea	Mays	<i>Zea mays</i>
Black jack	Bidens	pilosa	<i>Bidens pilosa</i>
Domestic cat	Felis	cattus	<i>Felis cattus</i>
Housefly	Musca	domestica	<i>Musca domestica</i>
Bean plant	Phaseolus	vulgalis	<i>Phaseolus vulgaris</i>

EXERCISE

1. The scientific name of a malaria parasite is Plasmodium falciparum. State the genus and species name to which the malaria parasite belongs.
2. An S.1 student wrote the scientific name of a lion as felis Leo. Did the student write the name correctly? Give a reason for your answer.

THE TWO KINGDOM SYSTEM OF CLASSIFICATION

Originally organisms used to be classified into two kingdoms; the plant and animal kingdoms. However some organisms in any of these two kingdoms e.g. fungi don't have chlorophyll as plants, euglena has chlorophyll and bacteria have no true nucleus.

THE FIVE KINGDOM SYSTEM OF CLASSIFICATION

This system classifies organisms into five kingdoms i.e. monera, protocista, fungi, plantae and Animalia.

KINGDOM MONERA (PROKARYOTAE)

This kingdom consists of bacteria and blue green algae/bacteria.

Characteristics of organisms

1. They are unicellular (single celled) and microscopic organisms.
2. They are prokaryotic organisms i.e. nucleus lacks a nuclear membrane (no true nucleus).
3. Have a cell wall, few organelles and no mitochondria.
4. They have varied types of nutrition. Some are autotrophs and others are heterotrophs.
5. They reproduce asexually, mainly by binary fission and occasionally by conjugation.
6. Some bacteria respire aerobically while others respire anaerobically.
7. Most of them move by use of flagella.

ECONOMIC IMPORTANCE OF BACTERIA

1. The nitrogen fixing bacteria fix nitrogen into nitrates in the soil. The nitrates are needed by plants in protein synthesis.
2. Some bacteria decompose the dead organic matter adding humus to soil. Bacteria therefore bring about recycling of nutrients in nature.
3. Bacteria are used in sewage treatment.
4. Some bacteria are used in industries to make yoghurt, cheese, insulin, vitamin B₁₂ and K.
5. Some bacteria are used in the manufacture of antibiotics e.g. streptomycin and Chloromycetin.
6. Bacteria in ruminant animals help in cellulose digestion. They produce the enzyme cellulase which digests cellulose.
7. Some bacteria cause diseases to humans e.g. cholera, tuberculosis, typhoid fever, syphilis, gonorrhea, brucellosis, whooping cough, tetanus, diphtheria, diarrhoea, leprosy, etc.
8. Some bacteria spoil food.

VIRUSES

Viruses are very small living particles that have some characteristics of life. They are the smallest living organisms. Viruses are not classified in any of the five kingdoms because they do not have all the seven characteristics of living things. E.g. they do not grow, they do not reproduce outside living cells, and they do not respond to stimuli.

Characteristics of viruses

1. They can only reproduce when inside living cells.
2. They are not made up of cells i.e. have no cellular structure (acellular).
3. They are the smallest living organisms.
4. They are at the boundary between living and nonliving things.
5. They have a simple structure
6. They have genetic material composed of either DNA or RNA and protein.
7. They cause diseases to living organisms.

Examples of viral diseases: Ebola, polio, influenza, mumps, measles, pneumonia, common cold, hepatitis, etc.

KINGDOM PROTOCTISTA

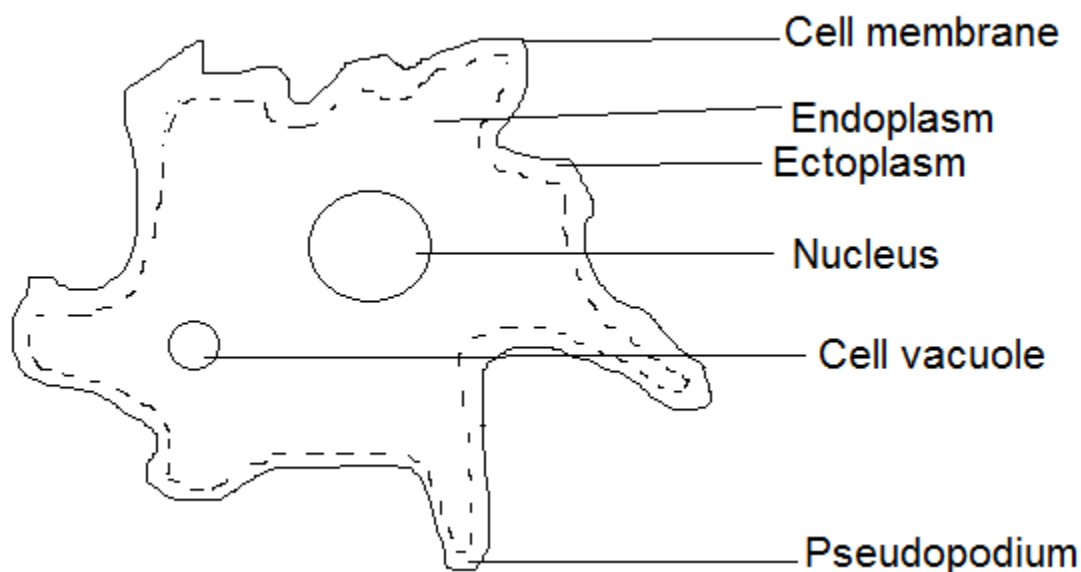
Examples. Protozoans e.g. plasmodium, amoeba, paramecium, euglena, etc., and algae e.g. spirogyra, brown algae, etc.

Characteristics of protists

1. Most are unicellular.
2. They are eukaryotic i.e. the nucleus is membrane bound.
3. They have different types of nutrition. Some are autotrophs and others are heterotrophs.
4. They are aquatic organisms i.e. live in water.
5. Reproduction is mainly asexual by binary fission, fragmentation or sporulation. A few reproduce sexually by conjugation.
6. They are mostly mobile, moving by pseudopodia, cilia or flagella. A few are sessile.

Note: Protozoa is the main phylum of kingdom protista.

Structure of amoeba

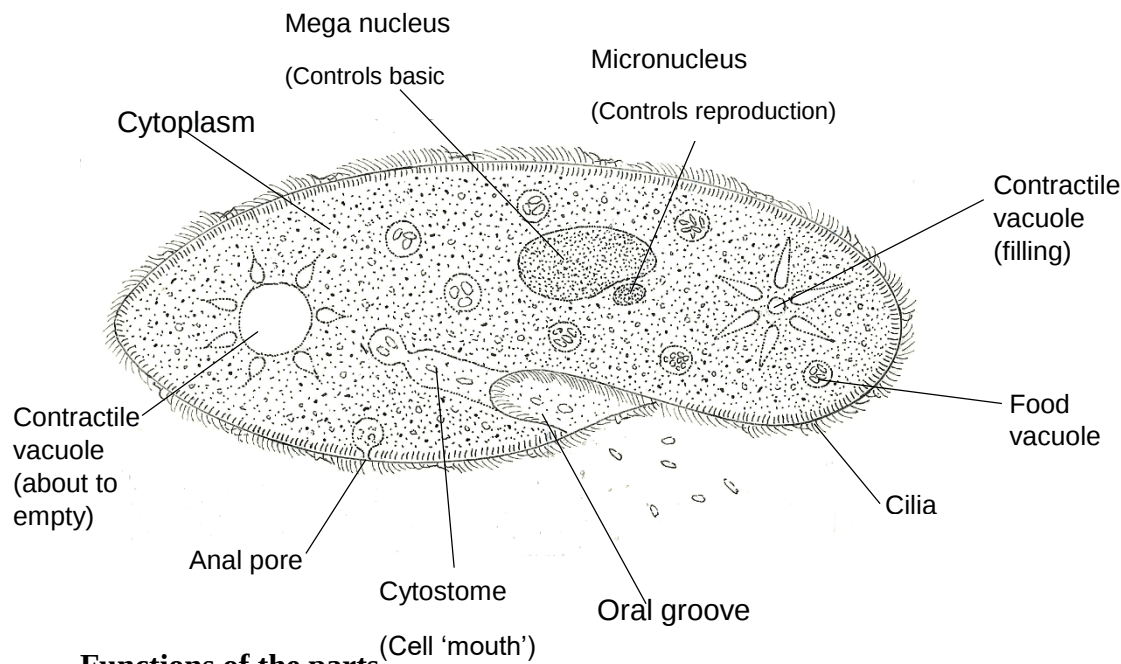


Note. Amoeba has no regular shape.

Functions of the parts of amoeba

1. Nucleus. Controls all the activities of the cell.
2. Contractile vacuole. For osmoregulation i.e. it regulates the amount of water in the body.
3. Pseudopodia. For movement and engulfing food particles during feeding.
4. Food vacuole. Is where digestion of food occurs.

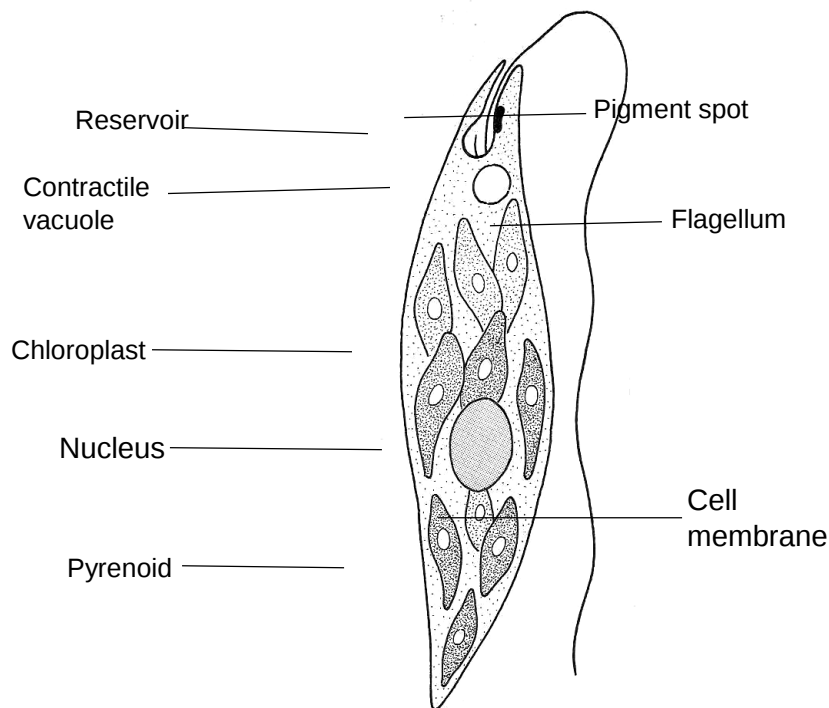
Structure of paramecium



Functions of the parts

1. Mega nucleus/macronucleus. Controls metabolic activities of the organism.
2. Micronucleus. Controls reproduction and formation of new macronuclei.
3. Cilia. For locomotion.
4. Contractile vacuule. For osmoregulation.
5. Food vacuole. Where digestion of food occurs.

Structure of euglena



EXERCISE

1. Euglena can be considered as an animal or a plant. State the characteristics that make it;

- (i) An animal
 - (ii) A plant
2. State the differences between amoeba and paramecium.

Other protozoans

- Plasmodium-causes malaria in humans.
- *Entamoeba histolytica*-causes amoebic dysentery.
- Trypanosome-causes trypanosomiasis (sleeping sickness).

ALGAE

This is found under kingdom protocista. E.g. spirogyra.

Characteristics

1. Have cell wall.
2. Have chloroplasts hence carry out photosynthesis.
3. Are aquatic organisms.

Structure of spirogyra

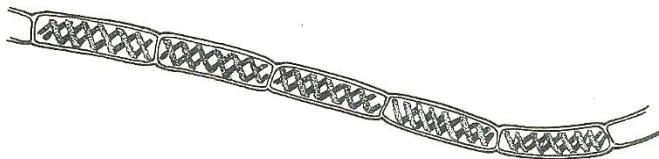
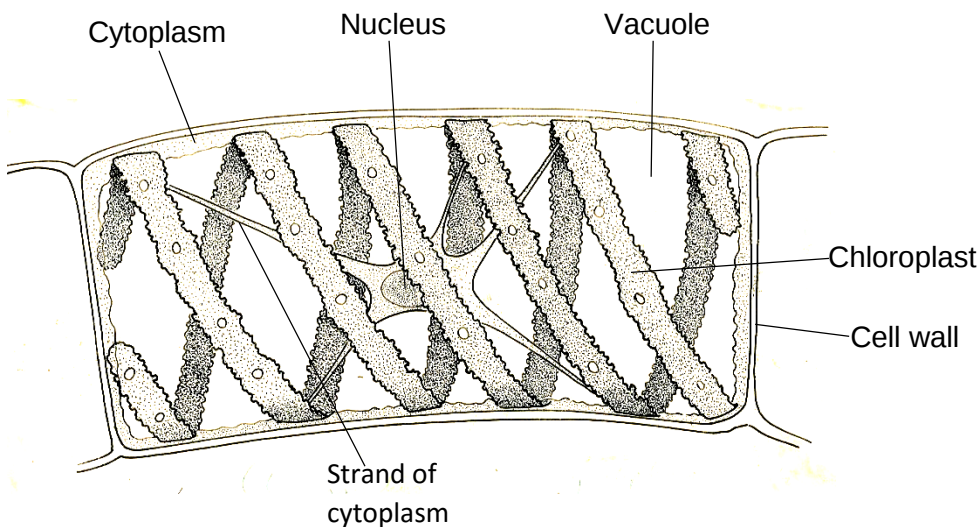


Diagram of one cell of spirogyra



ECONOMIC IMPORTANCE OF ALGAE

1. They are a source of food for some aquatic organisms e.g. small fish.

2. They reduce the concentration of carbon dioxide in the atmosphere by using it for photosynthesis.
3. They produce oxygen for aquatic organisms.
4. They cause eutrophication as a result of pollution.

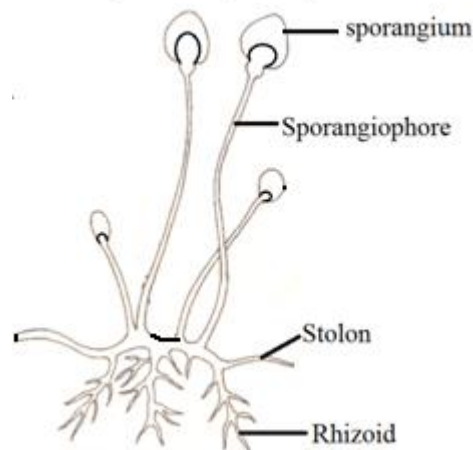
KINGDOM FUNGI

Characteristics of fungi

1. They are multicellular organisms.
2. They are eukaryotic organisms i.e. have a true nucleus.
3. They lack chlorophyll.
4. Have a cell wall made of chitin.
5. The body is a mycelium made of threadlike structures called hyphae.
6. Fungi reproduce sexually through spores or budding, and asexually by conjugation.
7. Have varied types of nutrition. Some are parasites while others are saprophytes (saprotrophs) i.e. feed on dead organic matter.

Examples of fungi; mushroom, rhizopus (common bread mould), mucor, *Penicillium*, yeast, toad stool, etc.

Drawing showing rhizopus/bread mould



ECONOMIC IMPORTANCE OF FUNGI

1. Some fungi e.g. mushrooms are used as food by man.
2. The saprophytic fungi decomposes dead organic matter and bring about recycling of nutrients.
3. Some fungi are used in the manufacture of antibiotics e.g. penicillin is made from *Penicillium*.
4. Yeast is used in brewing industry in the production of alcoholic drinks e.g. beer.
5. Yeast is used in baking industry in bread making.
6. The parasitic fungi cause diseases in plants e.g. potato blight, wheat rust, and in humans e.g. ring worms, candidiasis, etc.
7. Yeast is a source of vitamins e.g. B₁ and B₂.
8. Some fungi, such as the bread mould spoil food.

Differences between plants and fungi

Plants	Fungi
1. Food is stored in form of starch	Food is stored in form oil droplets or glycogen.
2. Have chlorophyll	Lack chlorophyll.
3. The wall hypha consists of mainly chitin	Cell wall consists of cellulose.
4. The basic unit of a fungus is a hypha	The basic unit of a plant is a cell.

KINGDOM ANIMALIA

Examples of animals: Humans, insects, fish, amphibians, reptiles, etc.

CHARACTERISTICS OF ANIMALS

1. They are multicellular organisms.
2. They are eukaryotic organisms.
3. Most carry out locomotion but a few are sessile.
4. They carry out sexual reproduction.
5. They feed heterotrophically i.e. feed on other organisms.
6. Body has a definite shape.

The phyla in kingdom Animalia include;

- Phylum Porifera e.g. sponges
- Phylum Coelenterate/cnidarian e.g. hydra
- Phylum Platyhelminthes (flatworms)
- Phylum Nematoda (Round worms)
- Phylum Annelida (segmented round worms)
- Phylum Mollusca e.g. snails
- Phylum Echinodermata e.g. starfish
- Phylum Arthropoda
- Phylum Chordata (vertebrata)

Phylum Porifera (sponges)

1. Adults do not carry out locomotion but attached on rocks (sessile).
2. They are all marine animals.
3. They are hermaphrodites.
4. Have a hollow central cavity called spongocoel e.g. sycon.

Phylum coelenterate (cnidarian)

1. They are multicellular animals
2. Body wall consists of two layers of cells thick
3. They are aquatic organisms
4. They have a sac-like intensive with only one opening, one mouth.

5. Have tentacles used for locomotion
6. Body has specialized cells e.g. stinging cells

Examples: Hydra, sea anemones, Jelly fish, corals

Diagram of hydra

Phylum Platyhelminthes (Flatworms)

Examples: Tapeworm, planaria, liver fluke (Fasciola)

Characteristics

1. Have flat bodies
2. All are hermaphrodites
3. Have un segmented bodies, except cestodes
4. Many are parasites e.g. Tapeworms and flukes. The parasitic one cause diseases in animals. The blood fluke schistosomiasis (bilharzia) in man and the liver fluke causes liver rot in sheep.
5. Have mouth but no anus.
6. Have bilateral symmetry

Classes of phylum Platyhelminthes

Class Tubellaria e.g. planaria

Class Trematoda e.g. liver fluke (fasciola), Schistosoma (blood fluke).

Class Cestoda e.g. Taenia (Tapeworm)

Characteristics of Cestodes

1. They are endoparasites. They live in the gut of man and muscles of cattle and pig.
2. Body is segmented into proglottids
3. Have suckers and hooks for attachments to the host.

Examples of cestodes

Taenia solium in pork, *Taenia sarginata* in beef

Structure of a Tapeworm

Phylum Echinodermata

Examples: Star fish, sea urchin, sea cucumbers

Characteristics of Nematodes

1. Have a star shaped bodies with five “arms”.
2. They are aquatic.
3. Body covered with spines.
4. Radially symmetrical.

Phylum Nematoda (un segmented round worms)

Characteristics of Nematodes

1. Have round bodies.
2. Body is pointed at both ends.
3. They lack segments.
4. Have mouth and anus.
5. Some are parasites and others are free living.

Examples of nematodes

1. *Ascaris lumbricoides*. These live in the large intestines of humans.
2. Hook worms. These are parasites and live in the wall of intestines and suck blood.
3. Filarial worms. These are parasites of animals. They are found in the lymphatic vessels of the host. Filarial worms block the lymph vessels and cause a disease called elephantiasis. Filarial worms also cause river blindness.

Diagram of a round worm

Phylum Annelida (segmented round worms also called True worms)

Examples: Earthworms, leeches, rag worms (marine worms, lugworms)

Characteristics

1. Have cylindrical segmented bodies.
2. They are hermaphrodites.
3. They use nephridia for excretion.
4. They have well developed nervous system.
5. Have a digestive system running from the mouth to the anus.
6. Have Bilateral symmetry.
7. They have considerable powers of repairing injuries.
8. Body covered with a cuticle.

Drawing of earthworm

Economic importance of earthworms

1. They improve on soil aeration by burrowing, making tunnels in the soil.
2. They add humus (organic matter) to the soil when they die.

Phylum Mollusca

Examples: Snails, slugs, octopus, squids

Characteristics

1. They have soft non segmented bodies.
2. Some have a shell for protection.
3. Have open circulatory system.
4. They have well developed respiratory, excretory, digestive, reproductive and nervous systems.

Phylum Chordata (also called phylum vertebrata or craniate)

Vertebrates are animals which have back bones or a vertebral column.

Examples: Humans, cow, fish, frog, snake, Hen, etc.

Characteristics of vertebrates

1. They have an internal skeleton called endoskeleton.
2. They have a vertebral column (back bones).
3. Have closed circulatory system.
4. Have a brain case, cranium in which the brain is found.
5. They have well developed sense organs e.g. eyes.
6. Have two pairs of limbs.
7. They have bilateral symmetry.
8. Have ventral hearts.

Phylum chordate/vertebrata is divided into five classes. These include;

Class	Mammalia
Class	Amphibia
Class	Reptilia
Class	Aves
Class	Pisces

CLASS MAMMALIA

This class consists of organisms called mammals.

Examples of mammals include; Elephant, whale, kangaroo, bat, goats, cow, etc.

Characteristics of mammals

1. Have mammary glands.
2. Have parental care. They care for their young ones.
3. They are endothermic animals.
4. Have well developed brain.
5. Have external ear lobes called Pinnae.

6. Carryout internal fertilization.
7. Breathing is by lungs.
8. Have heterodont teeth i.e. have teeth of different types and carryout different functions.
9. Have a diaphragm which separates the thoracic cavity from the abdominal cavity.
10. They produce young ones alive.
11. Body is covered with hair that is; have hairy bodies.

CLASS AMPHIBIA

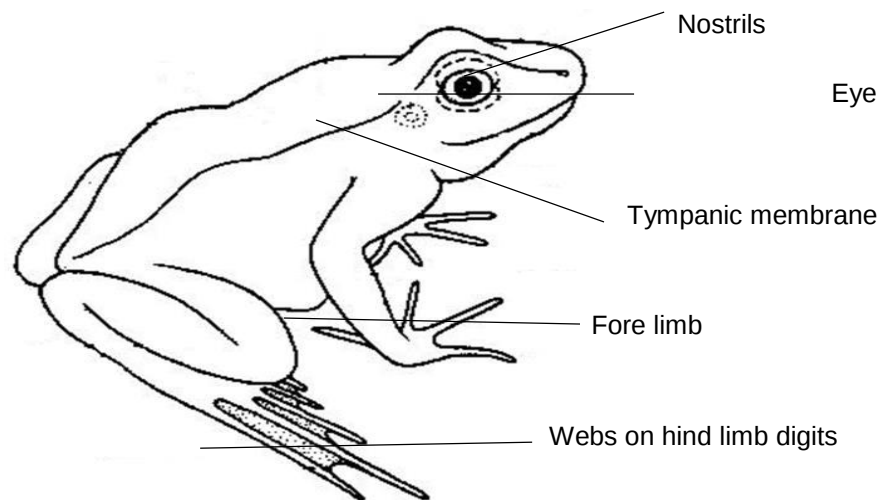
The word amphibian means able to live on both land and in water.

Characteristics

1. They are ectothermic of amphibians.
2. Fertilization is external.
3. Have moist skin without scales.
4. Have two pairs of limbs.
5. Body is divided into a head and trunk. There is no neck.
6. Live both on land and in water.
7. Young ones (tadpoles) use gills and adults use lungs for breathing.
8. Have homodont teeth.

Examples of amphibians: Toads, frogs, newts and salamanders.

Drawing of a toad



CLASS REPTILIA

Characteristics

1. They are ectothermic reptiles.
2. Fertilization is internal.
3. Breathing is by lungs.
4. Have homodont teeth. That is; teeth are similar and serve the same function.
5. Have dry scaly skin with horny scales.
6. Have no pairs of limbs except snakes.

7. Have a four chambered heart except snakes.
8. Lay eggs enclosed in a shell.

Examples of reptiles: Lizards, tortoise, chameleon, crocodile, snakes, geckoes, alligators, etc.

CLASS AVES

This is the class to which birds belong.

Characteristics of birds

1. They are endothermic animals.
2. Body covered with feathers.
3. Have horny beaks.
4. Fertilization is internal.
5. Lay eggs enclosed in a shell.
6. Breathing is by lungs.
7. Their feet are covered with scales.
8. Fore limbs are modified into wings.
9. Have parental care.
10. Have a four chambered heart.

Examples of birds: Hen, duck, ostrich, owl, eagle, hove, vulture, hawk, weaver bird.

CLASS PISCES

This is the class to which fish belong.

Characteristics of fish

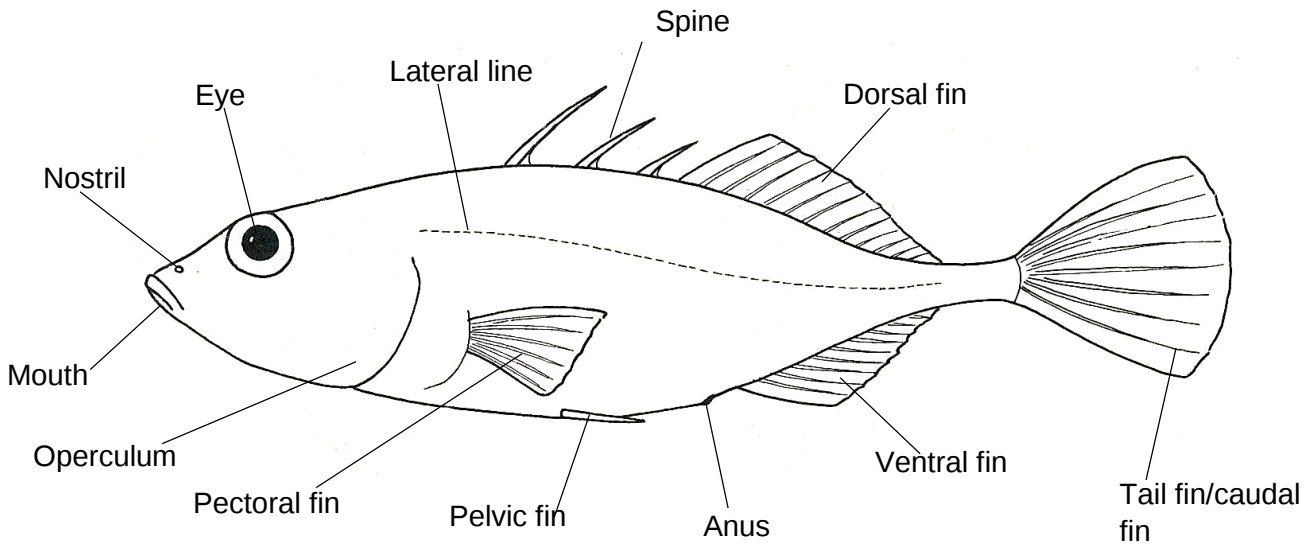
1. In most fish the body is covered with scales.
2. Have homodont teeth.
3. Use gills for breathing.
4. Fertilization is external.
5. They are aquatic.
6. They are ectothermic animals.
7. Limbs are present as paired fins.

Some fish e.g. shark, lack bones but contain cartilage. These fish are called **cartilaginous fish**.

While other fish have bones and they are called **bony** fish e.g. Tilapia.

Examples of fish: Tilapia, Nile Perch, mud fish, etc.

Drawing showing the external features of a bony fish



Parts of the fish and their functions

Nostrils – For smelling.

Lateral line – for detection of sound vibrations.

Operculum – protects the gills from mechanical injuries.

Scales – protect inner body parts from mechanical damage.

Dorsal fin – for protection against enemies.

Pelvic fin/pectoral fin/Tail fin – for locomotion.

Eye – for seeing.

Mouth – for ingestion of food and water.

PHYLUM ARTHROPODA

Phylum arthropoda is the largest phylum in the animal kingdom.

The organisms in this phylum are called arthropods.

Arthropods are invertebrate animals which have jointed legs and segmented bodies.

Characteristics of arthropods

1. Have segmented bodies.
2. Have jointed legs/have jointed appendages.
3. Body covered by an exoskeleton/cuticle.

Functions of the skeleton

1. For attachment of muscles.
2. Protects inner body parts from mechanical damage and water loss.
3. Provides shape and support to the animals.

Note: Arthropods have an open circulatory system.

Phylum arthropoda is divided into five classes. These include;

Class Insecta

Class	Arachnida
Class	Chilopoda
Class	Diplopoda
Class	Crustacea

CLASS ARACHNIDA

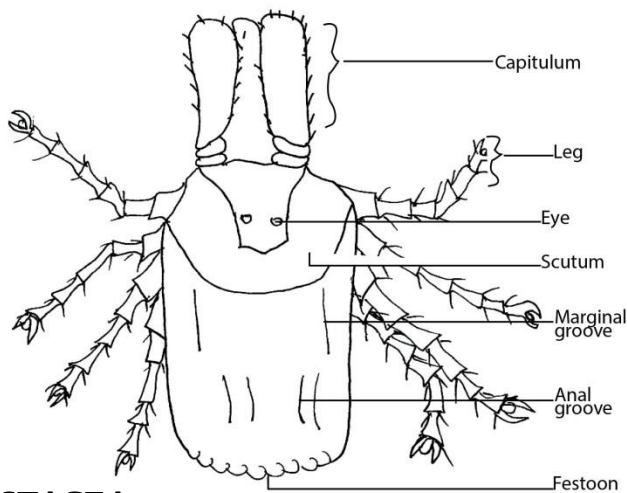
Examples: Ticks, spiders, scorpions, etc.

Characteristics

1. Have four pairs of arachnids.
2. Have two main body parts that is; the cephalothorax and abdomen.
3. Have simple eyes.

Note: Arachnids do not have antennae.

Drawing of a tick



CLASS CRUSTACEA

Examples: Crabs, lobsters, woodlice, Cray fish, prawns, and shrimps.

Characteristics

1. They have two pairs of antennae.
2. Body divided into two main body parts i.e. the cephalothorax and abdomen.
3. Have five or main pairs of jointed legs.
4. Cephalothorax covered with a hard carapace shell.
5. Have a hard exoskeleton because it contains chitin and chalk.
6. Have a pair of compound eyes at the end of movable stalks.
7. Majority are aquatic.

CLASS CHILOPODA

Example: centipedes

Characteristics

1. Have long segmented flattened bodies.

2. Each body segment has one pair of jointed legs.
3. Have one pair of antennae.
4. Have simple eyes.
5. They are carnivores.
6. They are terrestrial animals i.e. live on land.

Drawing of a centipede

CLASS DIPLOPODA

Example: millipedes

Characteristics

1. Have long cylindrical bodies.
2. Have one pair of antennae.
3. Each body segment has two pairs of jointed legs.
4. Have simple eyes.
5. They are terrestrial animals that is; live on land.
6. They are herbivores.

Drawing of a millipede

CLASS INSECTA

This class consists of animals called insects.

Examples of insects: Housefly, cockroach, termite, grasshopper, butterfly, ants, etc.

Characteristics of insects only

1. Body divided into three main body parts that is; head, thorax and abdomen.
2. Have three pairs of jointed legs.
3. Thorax divided into three thoracic segments that is pro-thorax, meso-thorax and meta-thorax.

Other characteristics of insects

1. All insects have one pair of antennae.
2. Some have compound eyes e.g. housefly.
3. Some have one or two pairs of wings but some insects have no wings e.g. termite.
4. They use spiracles for breathing.

MOULTING (ECDYSIS)

This is the process by which arthropods shed off (remove) the skeleton in order to allow growth to take place.

The exoskeleton (cuticle) limits the size of the arthropod, in order for the growth to take place, the exoskeleton must be removed, a process called moulting (ecdysis).

Moulting takes place during the larva and pupa stage.

METAMORPHOSIS

This is the change in form and structure of an organism from the young stage to the adult stage during its life cycle.

Types of metamorphosis

There are two types of metamorphosis

1. Complete metamorphosis

This is the type of metamorphosis where an organism undergoes through four stages of development during its life cycle i.e. Adult – Egg – Larva – Pupa.

Examples of insects which undergo complete metamorphosis: Butterfly, bee, housefly, mosquito, wasps, ants, beetles, tsetse fly.

2. Incomplete metamorphosis

This is the type of metamorphosis where an organism undergoes three stages of development during its life cycle i.e.

Examples of insects which undergo incomplete metamorphosis: Cockroach, grasshopper, termite, locust, aphids, bugs.

Differences between complete and incomplete metamorphosis

Complete	Incomplete
1. Four stages of development that is; egg, larva, pupa and adult	Three stages of development that is; egg, nymph and adult.
2. Larval stage present	Larval stage not present
3. No nymph	Nymph present
4. Pupal stage present	No pupal stage
5. Young ones do not resemble adults	Young ones resemble adults.

Similarities between complete and incomplete metamorphosis

1. Both have adult stage
2. Both have egg stage

Note: Metamorphosis is shown by insects and amphibians.

UNIT 3: SOME INSECTS OF ECONOMIC IMPORTANCE

THE HOUSEFLY

Classification of a housefly

Kingdom	-	Animalia
Phylum	-	Arthropoda
Class	-	Insecta
Order	-	Diptera
Genus	-	Musca
Species	-	domestica

Exercise

1. Write the scientific name of a housefly.
2. Give three reasons why a housefly belongs to phylum arthropoda.
3. Give three reasons why a housefly belongs to class insect.

Note: A housefly belongs to order diptera because it has two wings.

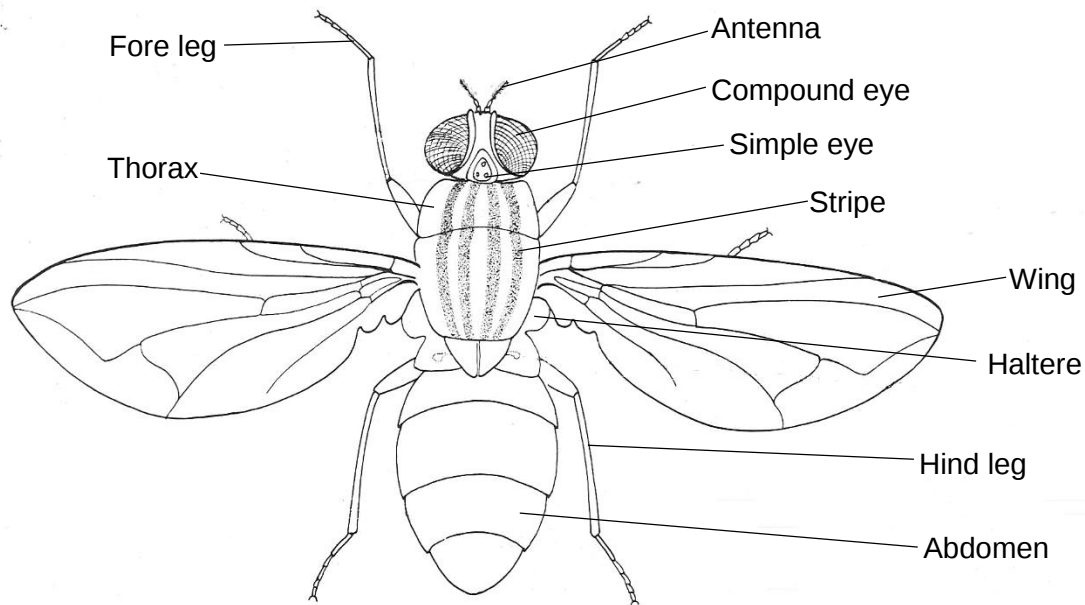
Characteristics of insects in order diptera

- Have two wings i.e. one pair of wings.
- Have all legs of the same size.

- Have sucking mouth parts.

Habitat. A habitat is a place where an organism lives. Houseflies live in dirty moist places such as dustbins, toilets, rotting organic matter, etc.

Drawing of the dorsal view of a housefly showing its external features

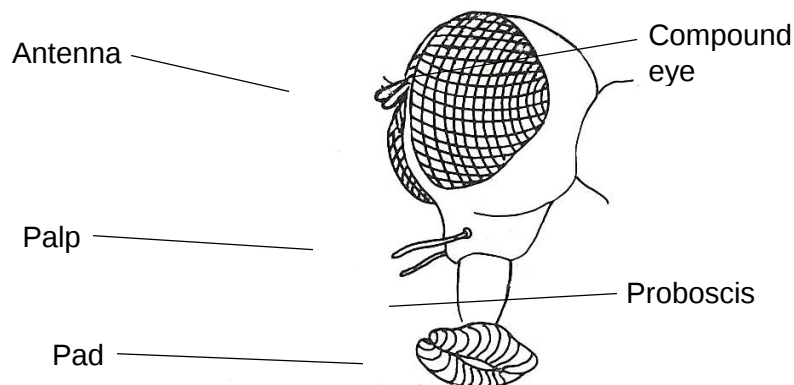


EXTERNAL FEATURES OF A HOUSEFLY

Features of the head

- Has one pair of large compound eyes for vision.
- One pair of short hairy antennae for sensitivity.
- Three simple eyes (ocelli).
- Has a proboscis for sucking liquids.

Drawing of the lateral view of the head of a housefly



Features on the thorax

- The thorax is divided into three segments. Prothorax, mesothorax and metathorax.
- Each thoracic segment has one pair of hairy jointed legs.
- All the six legs are of the same size.
- The mesothorax has a pair of transparent membranous wings for flight.
- The metathorax has a pair of small knobbed projections called halteres or balancers. These are used for body balance during flight.

Drawing of the leg of a housefly**Features on the abdomen**

- It is hairy.
- It is segmented.
- Has spiracles for breathing.

Note: The body of a housefly is hairy.

LIFE CYCLE OF A HOUSEFLY

A housefly undergoes **complete metamorphosis**.

After mating, a mature female housefly lays eggs in batches of 100 – 150 eggs.

The eggs are laid in rotting organic matter or warm moist place.

After about 8 – 24 hours the eggs hatch into larvae called maggots.

A maggot has a small head. The head has a mouth used for feeding.

A maggot has got spongy pads for movement.

The maggot moults about two times and after 4 – 5 days it changes to the pupa.

The cuticle becomes hard and dark brown in colour.

The pupa does not feed or move but it undergoes internal development.

The pupa has spiracles for breathing.

After 8 – 10 days the pupal case bursts open and an adult housefly emerges (comes out).

Illustration

Economic importance of a housefly

1. Houseflies are vectors of many diseases. They spread diseases like cholera, diarrhea, dysentery, Trachoma, Tuberculosis, etc.
2. Houseflies are a source of food for some organisms e.g. chameleon.

Features which enable a housefly to spread diseases (Adaptations as an insect vector)

1. Has a hairy body on which germs are attached and transmitted when the insect walks on food, the germs are dropped.
2. Has a proboscis which is used to pass out saliva containing germs (pathogens) on to the food.

Methods of controlling houseflies and prevention of the spread of diseases

1. Spraying the houseflies with insecticides e.g. DDT to kill them.
2. Covering holes of pit latrines to prevent houseflies from picking germs from the latrine.
3. Covering all the food to prevent houseflies from walking on it.
4. Boiling drinking water and milk to kill the germs.
5. Foods eaten in raw form e.g. fruits should be properly washed to remove the germs.
6. Proper disposal of wastes so that houseflies cannot reach them e.g. by burning, covering them in dustbins, etc.
7. Washing hands with soap and clean water after visiting the latrine and before eating food.
8. Improving sanitation through proper disposal of sewage and other waste materials.

THE TSETSE FLY

A tsetse fly is a vector. It carries protozoans called trypanosomes which cause trypanosomiasis (sleeping sickness) in man and nagana in cattle.

A tsetse fly does not lay eggs during its life cycle. The eggs develop from inside the mother fly, it produces young ones which have reached an advanced stage of development, the larval stage.

THE MOSQUITO

Classification

Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Order	Diptera

The common genera are; Anopheles, Culex and Aedes.

TYPES OF MOSQUITOES

There are three common types of mosquitoes

Type of mosquito (vector)	Disease spread	Cause of the disease
Anopheles	malaria	Plasmodium parasites
Culex	Elephantiasis	Filarial worms
Aedes	Yellow fever	Virus

HABITAT

Adult mosquitoes live in cool dark places e.g. in the bush while the larvae live in stagnant water.

EXTERNAL FEATURES OF A MOSQUITO

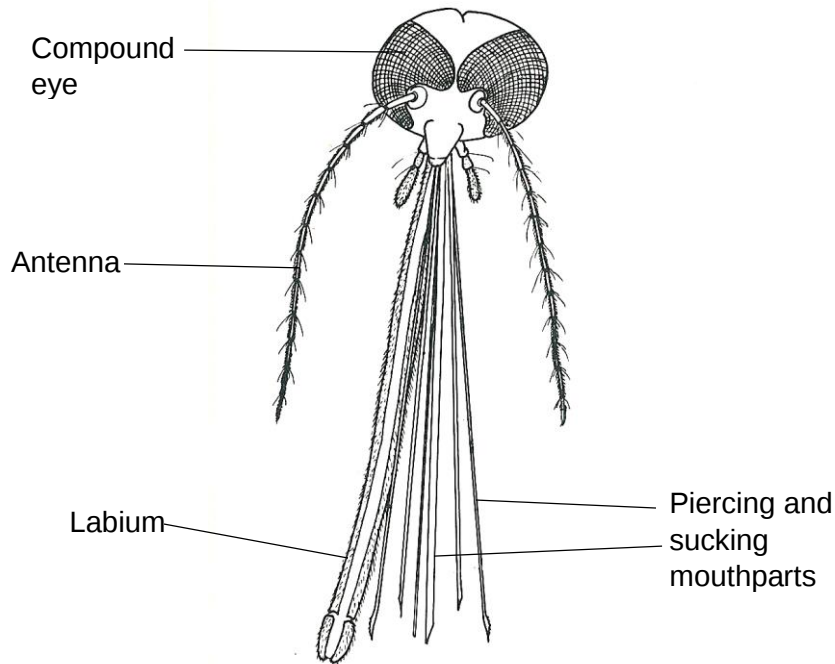
Features on the head

The head is small, with a pair of large compound eyes.

A pair of hairy antennae.

A long pointed proboscis for sucking liquids.

Drawing of the anterior view of the head of a mosquito



Features on the thorax

- It has three thoracic segments
- The middle segment, mesothorax wings pair of membranous transparent wings.
- The metathorax has a pair of halteres.
- The thorax also has three pairs of long jointed legs.

Features on the abdomen

The abdomen is elongated and slender. It is also segmented.

LIFE CYCLE OF THE MOSQUITO

A mosquito undergoes **complete metamorphosis**.

Life cycle of anopheles mosquito

After mating, the female adult mosquito lays eggs in stagnant water. The eggs are boat shaped and they are laid singly. Each egg has an air float after 2 to 3 days the eggs hatch into larvae.

The larva hangs from the water surface by a breathing trumpet. The larva gets air through this trumpet. The larva has a pair of eyes and mouth brushes used for feeding. The larva lies parallel to the water surface and breathes through spiracles. The larva undergoes four moults.

After 10 days the larva changes to the pupa. The pupa also hangs from the water surface by two breathing tubes. After 1 to 2 days the pupa changes to the adult mosquito.

Illustration

Life cycle of a culex mosquito

After mating the adult female mosquito lays eggs in stagnant water. The eggs stick together a raft.

After 2 to 3 days the eggs hatch into larvae.

The larvae hang from the water surface by the breathing trumpet and breathe through the siphon.

The larva lies at an angle to the water surface. The larva moults four times and after 10 days it changes to the pupa.

The pupa also hangs from the water surface by two breathing tubes. After 1 to 2 days the pupa changes to the adult.

Illustration

Differences between anopheles and culex life cycles

Anopheles	Culex
1. Eggs are laid singly	Eggs stick together
2. Eggs have air floats	Eggs have no air floats
3. Larva hangs parallel to the water surface	Larva hangs at an angle to the water surface
4. Larva breathes through spiracles	Larva breathes through a siphon
5. Adults rests with body inclined at an angle to the resting surface.	Adult rests with body parallel to the resting surface.

Control of mosquitoes and prevention of the spread of diseases by mosquitoes

1. Draining of all stagnant water to prevent mosquitoes from laying eggs.
2. Clearing away all the bush around the house to destroy their hiding places.
3. Spraying oil on top of stagnant water to suffocate and kill the larvae and pupae.

The oil prevents the larvae and pupae from breathing to get oxygen.

4. By using biological control method. This involves introducing organisms in water such as small fish which can feed on mosquito larvae and pupae.
5. Spraying the mosquitoes with insecticides to kill them e.g. DDT (Dichloro-Diphenyl Trichloroethene), BHC (Benzene hexachloride, doom, etc.)
6. Taking anti-malarial drugs regularly to prevent the development of the parasites. This also prevents the spread of malaria from already infected people to healthy ones. These drugs include; chloroquine, fansider, coartem, quinine, artemether, primaquine, etc.
7. Sleeping under mosquito nets to prevent mosquito bites.
8. Smearing the body with mosquito repellants to repel mosquitoes to avoid mosquito bites.
9. Burning of mosquito coils in the house at night to repel the mosquitoes/to prevent mosquitoes from entering in the house.
10. Preventing mosquitoes from breeding by destroying their breeding places. This includes; removing all empty containers, empty tins, broken pots, etc. in which water can collect.
11. Using charged electronic trap by moving it around the house to trap and kill the mosquitoes.

ECONOMIC IMPORTANCE OF MOSQUITOES

1. Adult female mosquitoes are vectors of human diseases e.g. the female anopheles mosquito spreads malaria.
2. The larvae, pupae and adult mosquitoes are eaten as food by some organisms e.g. small fish.

Note: Adult female mosquitoes suck blood because blood contains materials essential for egg production.

Exercise

1. State the three common types of mosquitoes.
2. Give three diseases which spread by mosquitoes. In each case, state the mosquito which spreads the disease.
3. Describe the life cycle of a culex mosquito.
4. Give five ways in which the spread of diseases by mosquitoes can be controlled.

BUTTERFLIES

Classification

Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Order	Lepidoptera
Family	Papilionidae
Genus	Papilio
Species	demodocus

Note: A butterfly belongs to order Lepidoptera because it has scales on its wings.

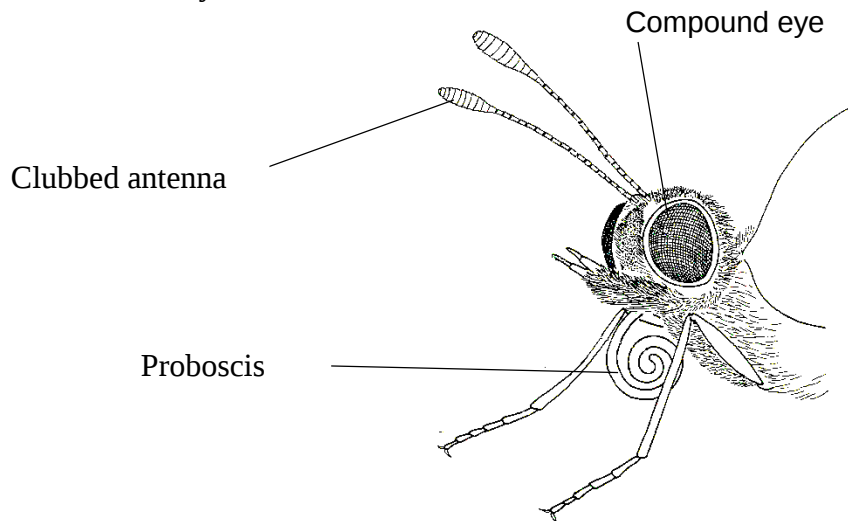
EXTERNAL FEATURES OF A BUTTERFLY

Features on the head

- A pair of large compound eyes.
- A pair of long dubbed antennae.

- A long coiled proboscis for sucking juices/nectar.
- The head is covered with hairs.

Drawing of head of a butterfly



Features on the thorax

- The thorax consists of three segments. Each segment has a pair of jointed legs.
- Has two pairs of wings covered with scales.
- The thorax is hairy.

Features on the abdomen

It is hairy and segmented.

Life cycle of a butterfly

A butterfly undergoes **complete metamorphosis**.

An adult female butterfly lays eggs after mating. The eggs are laid on the underside of a young leaf to protect them from the sun and rain. After 2 to 4 days the eggs hatch into larvae called caterpillars.

A caterpillar has a head, thorax and abdomen. The head has a pair of toothed mandibles for cutting leaves. The head also has simple eyes (ocelli) for seeing.

The caterpillar moults four times and after 7 to 10 days it changes to the pupa also called chrysalis.

The pupa does not feed or move but it undergoes internal development.

After 7 to 10 days, the adult butterfly emerges from the pupa.

Illustration

CATERPILLARS

A caterpillar is the larval stage of a butterfly.

Its body is divided into three main parts i.e. the head, thorax and abdomen.

The head has a pair of toothed mandibles and simple eyes (ocelli).

The thorax is divided into three thoracic segment has one pair of jointed legs called true legs.

The abdominal segments have fleshy projections called pro-legs.

The last abdominal segment has a pair of fleshy projections called claspers.

ECONOMIC IMPORTANCE OF BUTTERFLIES

1. They pollinate flowers.
2. Caterpillars are plant pests. They feed on plant leaves destroying the plants.
3. Some caterpillars are beneficial at some stage e.g. the silk worms produce silk wires used for making silk clothes.
4. Some butterflies can be used by artists as decorations because of their beautiful colours.
5. They are a source of food for some organisms e.g. birds eat some caterpillars.

Note: A butterfly is both economically useful and destructive to man. This is because it pollinates and destroys man's crops.

Exercise

1. A butterfly belongs to order.
A. Diptera B. orthoptera C. Lepidoptera D. hymenoptera
2. Which one of the following insects is both economically useful and destructive to man?
A. Housefly B. cockroach C. Bee D. butterfly
3. A long, coiled mouth part for sucking nectar is known as;
A. Palp B. proboscis C. mandible D. maxilla
4. The larval stage of a butterfly is known as;
A. Chrysalis B. maggot C. imago D. caterpillar
5. Give one way in which butterflies are useful to people
6. How does a butterfly feed?
7. Describe the life cycle of a butterfly

THE COCKROACH

Classification

Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Order	Dictyoptera (has straight wings)
Family	Blattidae
Genus	Periplaneta
Species	americana

HABITAT

Cockroaches live in dark narrow places such as cracks in walls.

Note: A cockroach is able to live in narrow places such as cracks in walls because it has a dorso-ventrally flattened body shape. It is dark brown in colour for camouflage.

Mode of life

Cockroaches live in dark warm places. They are nocturnal animals that is; they are most active at night.

EXTERNAL FEATURES OF A COCKROACH

Features on the head

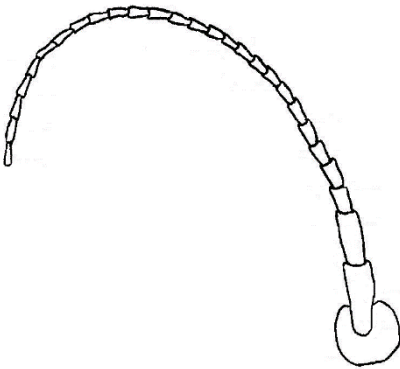
A pair of long segmented antennae used for sensitivity.

A pair of large compound eyes for vision/seeing

A pair of strong serrated mandibles for cutting food.

A pair of long jointed hairy maxillary palps for holding food.

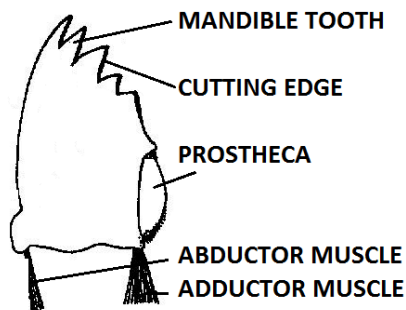
Drawing of the antenna of a cockroach



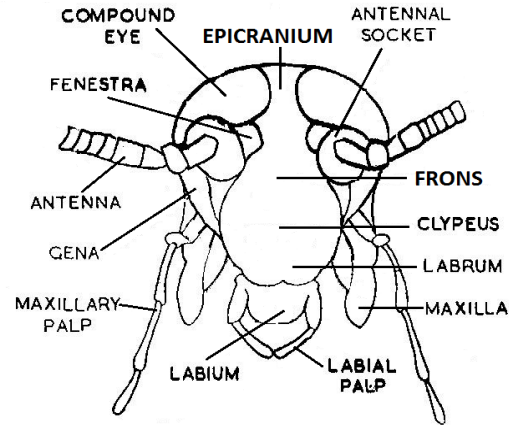
Note: The antenna is long, segmented and tapers towards the distal end.

Drawing of the mandible of a cockroach

DRAWING OF MANDIBLE OF COCKROACH



DRAWING OF ANTERIOR VIEW OF A COCKROACH HEAD



Features on the thorax

- The thorax has three thoracic segments that is; prothorax, mesothorax and metathorax.
- Has three pairs of jointed legs
- The outer (fore) wings are attached on the mesothorax.
- The inner (hind) wings are attached on the metathorax.

The outer (fore) wings

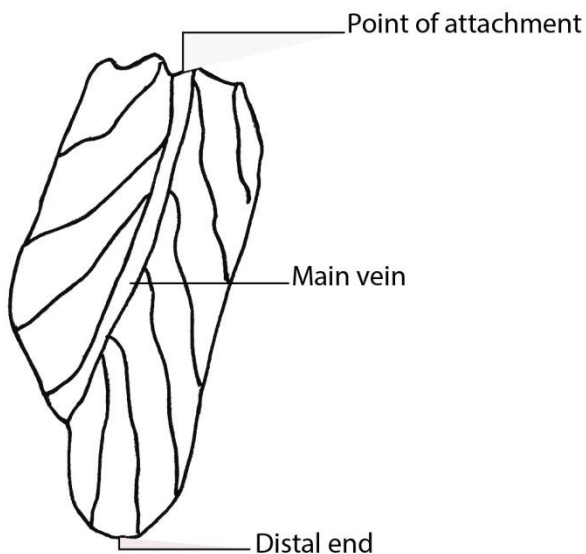
Functions

1. Protect inner body parts from mechanical damages.
2. For camouflage to avoid predation

Adaptations to function

1. Dark brown in colour for camouflage
2. They are thick and stiff to protect the inner body parts from mechanical damage.

Drawing of the outer wing of a cockroach

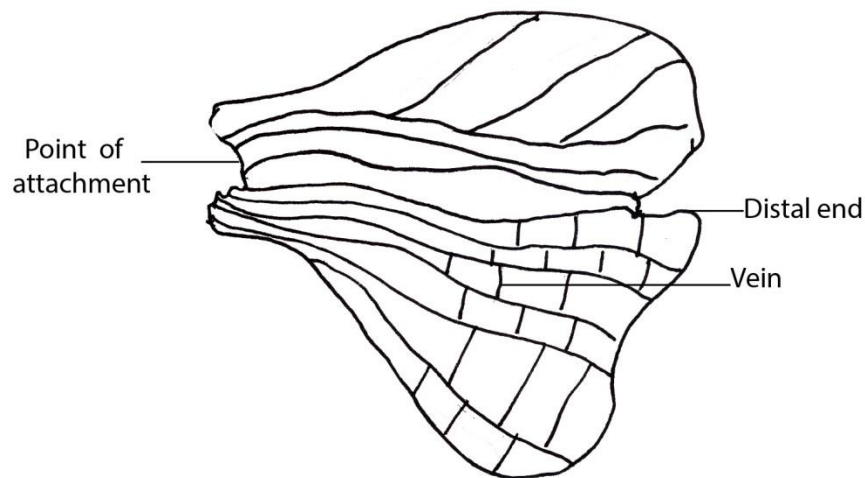


The inner (hind) wings

Function: used for flight

The inner wings are thin, broad membranous for flight.

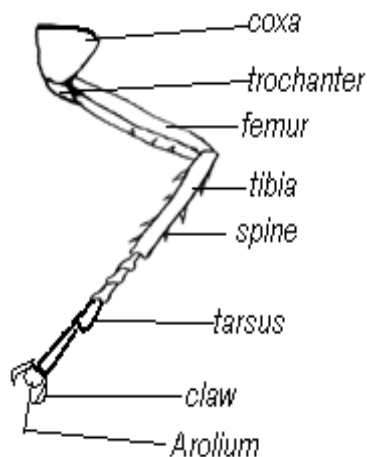
Drawing of the inner wing of a cockroach



Differences between the outer and inner wings of a cockroach

Outer wing	Inner wing
1. Thick	Thin
2. Narrow	Broad
3. Not folded	Folded

Drawing of a leg of a cockroach



Functions of the legs

- used for locomotion
- used for protection against enemies

Adaptations to functions

1. Has spines for protection against enemies
2. Jointed for flexibility during locomotion.
3. Has claws for attachments onto surfaces.

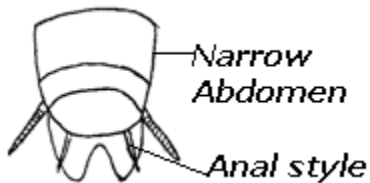
4. Has a glandular pad which is rough for walking on slippery/smooth surfaces.

Features on the abdomen

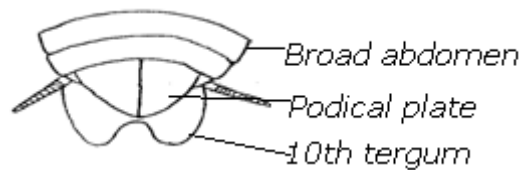
- The end of the abdomen has a pair of anal cerci (singular: cercus).
- In males, there is another pair of anal styles.
- The females have a pair of podical plates for holding the egg case.
- The abdomen is segmented and it is dorso-ventrally flattened.

Drawing of the end of the abdomen (posterior part) of a cockroach

MALE



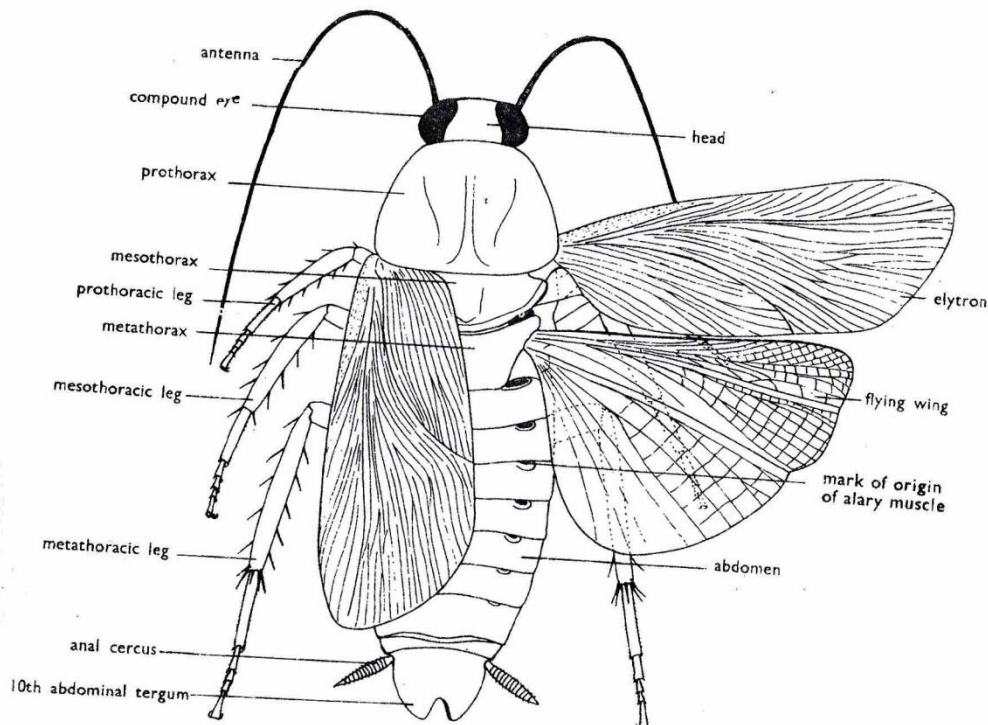
FEMALE



Differences between male and female cockroach

Male	Female
1. Has anal styles	No anal styles
2. Has narrow abdomen	Has broad abdomen
3. Lacks podical plates	Has podical plates

Drawing of the dorsal view of a cockroach



Life cycle of a cockroach

A cockroach undergoes **incomplete metamorphosis**.

After mating the eggs are fertilized and then enclosed in an egg case called the **ootheca**.

The ootheca is deposited in a warm, dry place.

After 40 to 50 days the eggs hatch into **nymphs**.

The nymphs look like adults, but they are small in size and have no wings.

The nymphs moult six to seven times and grow after 11 to 14 days the nymphs reach the adult stage.

Illustration

ECONOMIC IMPORTANCE OF COCKROACHES

1. The spread of diseases. They carry diseases causing micro-organisms such as bacteria.
2. They destroy man's properties such as books and clothes.
3. They are used as biological specimens for study.
4. They are a source of food for some organisms such as lizards.

EXERCISE

1. Define the term metamorphosis
2. (a) State the two types of metamorphosis
(b) Give five examples of insects which undergo each type of metamorphosis.
3. Explain why a grasshopper belongs to;
(a) Class insect
(b) Phylum arthropoda
4. Give a reason why a cockroach is able to live in narrow places such as cracks in walls.
5. (a) Many grasshoppers are green in colour. Explain the importance of this colour in the life of the grasshopper.
(b) Describe the life cycle of a locust/grasshopper
(c) Draw and label the hind limb of a grasshopper.
6. Write the scientific name of a cockroach.

THE HONEY BEE

Classification

Kingdom	Animalia
Phylum	arthropoda
Class	Insecta
Order	Hymenoptera
Family	Apidae
Genus	Apis
Species	mellifera

Mode of life. Bees are social insects that live together in a colony in a beehive.

Types of bees

There are three types of bees called castes.

A caste is a group of organisms of the same species specialized in performing particular functions.

The types of bees include;

- (i) **The queen.** There is usually one queen and it is the only fertilized female. Its work is to lay eggs.
- (ii) **Drones.** These are the male bees. Their work is to mate with the queen and fertilize the eggs.

Note: Drones do not have a sting.

- (iii) **The workers.** These are sterile females that is; they do not lay eggs.

The duties of the workers include;

1. Building the hive.
2. Collecting nectar and pollen from flowers.
3. They guard the hive.
4. Feed the queen, drones and larvae.
5. Clean the hive.
6. Build cells of the comb where eggs are laid.

Note: The hind limbs of workers have a pollen basket where pollen is collected.

EXTERNAL FEATURES OF THE HONEY BEE

Features on the head

- A pair of large compound eyes for vision.
- Has a proboscis for sucking nectar.
- A pair of short, segmented antennae for sensitivity.

Features on the thorax

- Two pairs of membranous wings for flight.
- Three pairs of hairy jointed legs for locomotion.

Features on the abdomen

- Has a wax gland on the underside for producing wax for making the comb.
- The last abdominal segment has a sting for defense.
- The abdomen is segmented.

Note: A bee has got a hairy body.

Drawing of the hind limb of a worker bee

Drawing of the middle limb of a worker bee

Prong – for removing pollen from the pollen basket.

Pollen comb – for cleaning off pollen grains from the head and abdomen

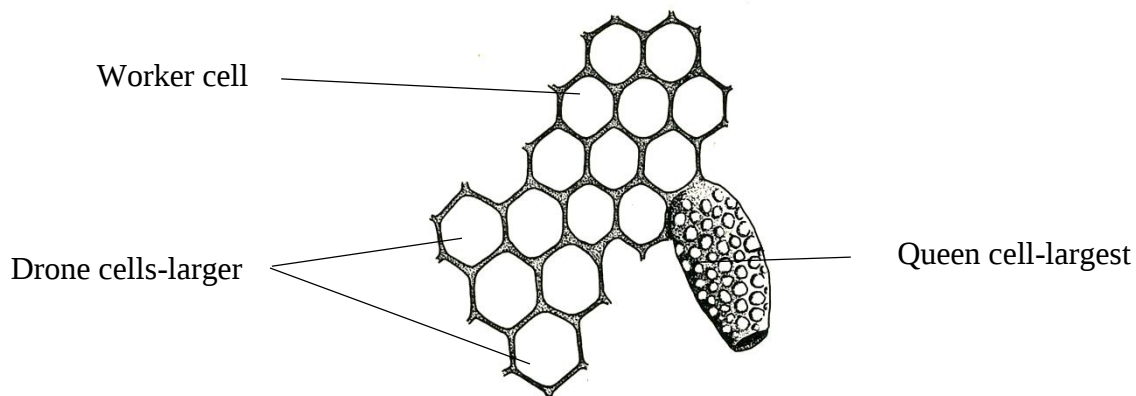
Pollen basket – for carrying pollen collected from flowers

LIFE CYCLE OF THE HONEY BEE

A bee undergoes **complete metamorphosis**.

The queen lays eggs in the cells of the comb. It lays fertilized and unfertilized eggs. One egg is laid in each cell.

Drawing showing cells of a honey bee



After three days the eggs hatch into larvae.

After 6 days the larvae change into pupae. After 7 to 15 days the adult bee emerges out of the pupa.

Illustration

Note: The life cycles of the three types of bees differ in the length of time after the larval stage.

Nakibinge Alex0783412882 @2017edition

Life cycle of the queen bee

A queen bee takes 16 days to complete its life cycle.

The queen bees develops from fertilized eggs and the larvae are fed on royal jelly only.

Royal jelly also called bees milk is a secretion of the worker's salivary glands.

After 6 days the eggs hatch into larvae the larvae change to pupae after 6 days.

After 7 days the pupa changes to the adult.

Life cycle of the worker bee

The worker bee takes 21 days to complete its life cycle.

Worker bees develop from fertilized eggs.

After 3 days the eggs hatch into larvae.

The larvae are fed on royal jelly first and then on a mixture of honey and pollen.

After 6 days the larvae change into pupae.

After 12 days the pupa changes to the adult.

Life cycle of the drone (male bee)

Drones develop from unfertilized eggs

The drone takes about 24 days to complete its life cycle.

After 3 days the eggs hatch into larvae. The larvae are fed on royal jelly first and then later on a mixture of honey and pollen.

After 6 days the larvae changes into pupae.

After 15 days the pupa changes to the adult.

ECONOMIC IMPORTANCE OF BEES

1. They pollinate flowers.
2. They produce honey which is used as food for some organisms.
3. They produce wax which can be used in industries to manufacture shoe polish, candles, varnish, etc.
4. They honey produced is used for sweetening syrups.
5. Honey can be used as medicine.

EXERCISE

1. Why are bees important to man?
2. Give the structural differences between a cockroach and a worker bee
3. Describe the life cycle of a honey bee
4. Draw and label the hind limb of a worker bee.

Other insects include

Praying mantis, moths, locusts, aphids, beetles, weevils, ants, wasps, stick insects, etc.

SUCCESS OF INSECTS

Insects are the most successful animals on earth. They are found in almost all habitats.

REASONS WHY INSECTS ARE THE MOST SUCCESSFUL ANIMALS ON EARTH

1. Have an exoskeleton made of chitin which protects the insect from water loss. Hence conserving water.

2. They excrete their nitrogenous wastes in form of uric acid which requires very little water for its removal hence conserving water.
3. Have an efficient tracheal system for efficient gaseous exchange. This allows swift locomotion.
4. They undergo different stages of development to reduce on competition for resources.
5. They have a variety of colours for camouflage to avoid predation.
6. They are small in size to enable them feed on little food and be able to reach many places.
7. Some have wings which enable them to fly, thus easily escape from predators.

ECONOMIC IMPORTANCE OF INSECTS

1. Some pollinate flowers e.g. bees, butterflies, etc.
2. Some are vectors e.g. mosquitoes.
3. Some are parasites e.g. bed bugs.
4. Some are pests that destroy crops e.g. caterpillars
5. Some improve soil aeration e.g. termites.
6. Some insects are sources of food for some organisms e.g. birds eat most of them.
7. Some insects are used by artists for decorations because of their beautiful colours e.g. butterfly.
8. They are used as biological specimens for study.
9. Many insects are nuisance to man and destroy his property such as clothes and stationary.

DICHOTOMOUS KEY

(Identification key. Sometimes called biological key)

This is a key used to identify organisms.

A dichotomous key involves the use of alternative statements that describe external features of the organisms.

When constructing a dichotomous key, external observable features (characteristics) of organisms are used.

One feature is chosen at a time and used as a basis to divide all organisms into two groups. Then in each of these groups characteristics are chosen to divide the members into two smaller groups. This process continues until each organism is identified that is; remains single.

Note: Some characteristics are not used when constructing a dichotomous key. These include **colour** and size i.e. big or small.

When constructing a dichotomous key, one can begin with a flow chart also called **flow diagram**.

Examples

You are provided with the following organisms or specimens

Grasshopper, housefly, centipede, termite;

- (a) Construct a table of characteristics to identify the above organisms.
- (b) Use the table of characteristics you have made to construct a dichotomous key of the organisms.

Solution

- (a) A table of characteristics to identify the grasshopper, housefly, centipede, and termite.

Insect	Number of wings	Body surface	Legs	Mouth parts
Grass hopper	4 wings/2 pair	Smooth	6 long, spiny legs	Mandibles, maxillae and labrum
Housefly	2 wings/1 pair	Hairy	6 short, hairy legs	Proboscis

Centipede	No wings	Smooth	Many short legs	Mandibles
Termite	No wings	Smooth	6 short legs	Mandibles

Dichotomous key to identify specimens

- 1(a) have wings.....2
 (b) Have no wings.....3
 2 (a) has four wings..... grass hopper
 Has two wings..... housefly
 3 (a) has six legs.....termite
 Has more than six legs.....centipede

Note: you can also teach learners how to draw a flow chart.

Exercise

- You are provided with the following organisms; Butterfly (A) worker bee (B) cockroach (C) termite (D) and housefly (E). Construct a dichotomous key to identify the organisms.
- You are provided with the following specimens. Cockroach (A), housefly (B), spider (C), worker bee (D) and millipede (E). Construct a dichotomous key to identify the specimens.

KINGDOM PLANTAE

Characteristics of plants

- They are multicellular organisms.
- They have chlorophyll.
- Cells have cell wall made of cellulose.

The plant kingdom is divided into the following phyla also known as **divisions**.

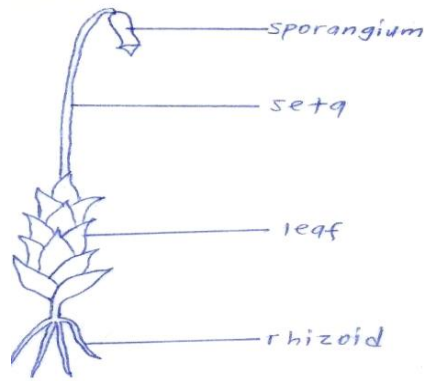
Phylum (division) BRYOPHYTA

This division contains the mosses and liverworts.

Characteristics of bryophytes

- They are flowerless plants.
- Live in damp/moist places.
- Have no vascular tissues.
- Have rhizoids for anchorage and absorption of nutrients. Have no roots.
- Reproduction is both asexual and sexual. Asexual reproduction is by means of spores.

Drawing of a moss plant



Note: Mosses belong to class musci

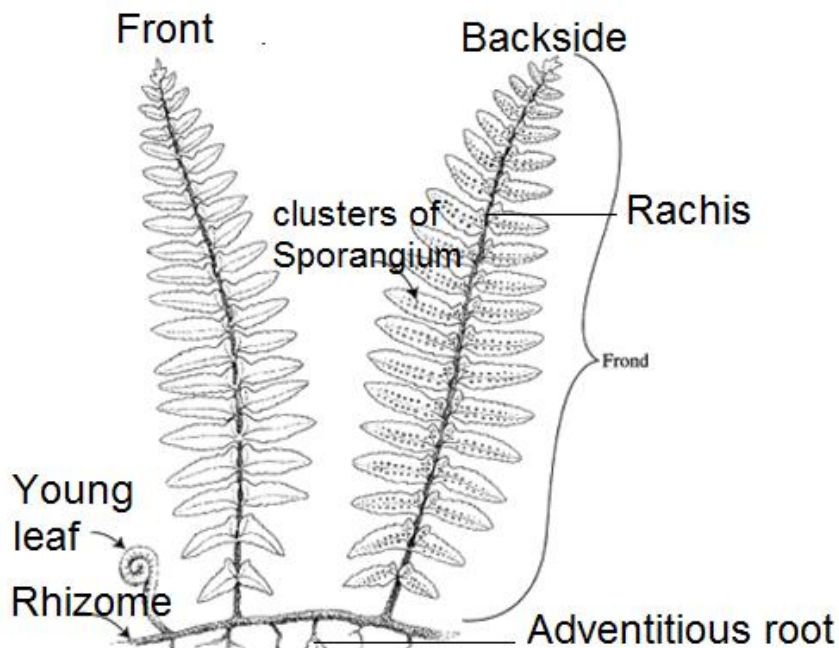
PHYLUM (DIVISION) PTERIDOPHYTA/FILICINOPHYTA

This division contains the ferns, club mosses and horsetails.

Characteristics of Pteridophytes

1. They are vascular plants.
2. They have roots, stems and leaves but in most terms the stem is a rhizome.
3. Reproduction is both sexual and asexual. Asexual reproduction is by spore formation.
4. The size mostly terrestrial plants and live mostly in damp shady places.
5. Leaves are large and they are called fronds. The spores are found in clusters called sori (singular sorus) on the lower surface of the mature fronds.

Note: Each frond (leaf) has a broad lamina. Lamina is divided into leaflets also called pinnae. Each pinna is further divided into small subdivisions called **pinnules**.



Phylum/division spermatophyta

This phylum contains the seed bearing plants.

Spermatophytes are divided into two groups namely; **gymnosperms** and **angiosperms**.

Phylum gymnospermophyta (coniferophyta)

This phylum contains conifers, cycads, pines.

Characteristics of gymnosperms

1. They are non-flowering gymnosperms.
2. They are seed producing plants.
3. They are vascular plants.
4. Seeds are produced in cones and ovules are unprotected.
5. They have roots, stems and leaves which are needle-like.

Phylum ANGIOSPERMOPHYTA

This phylum contains flowering plants. Flowering plants are called **angiosperms**.

Characteristics of angiosperms

1. Their reproductive structures are in flowers. That is; seeds arise from flowers.
2. Ovules are protected within the ovary.
3. Have roots, stems and leaves.
4. After fertilization, the ovary develops into a fruit.
5. They are vascular plants.

Angiosperms are divided into two classes; **monocotyledoneae** and **dicotyledoneae**.

Class monocotyledoneae (Monocotyledons)

These are plants whose seeds have one cotyledon.

Characteristics of monocotyledons

1. Seeds have one cotyledon.
2. Have parallel venation.
3. Vascular bundles are scattered.
4. Have no cambium tissue and therefore no secondary growth.
5. Have fibrous root system.
6. Leaves usually have narrow lamina.
7. Leaves have a leaf sheath.

Examples of monocots: Grasses, reeds, cereals.

Class dicotyledoneae (Dicotyledons)

These are plants whose seeds have two cotyledons.

Characteristics of dicotyledons

1. Seeds have no cotyledons.
2. Have network venation.
3. Vascular bundles are arranged in a ring.
4. Have cambium tissue and therefore undergo secondary growth.
5. Have tap root system.

6. Leaves usually have broad lamina.
7. The petiole is not sheathed.

Examples of dicots: Shrubs e.g. hibiscus, Deciduous trees, Evergreen trees e.g. mango.

Exercise

1. Give seven differences between monocots and dicots.
2. State the similarities and differences between a fern and a moss.
3. What are the survival advantages of a fern over a moss for life on land?
4. (a) What are angiosperms. (b) Give the two main groups of angiosperms.

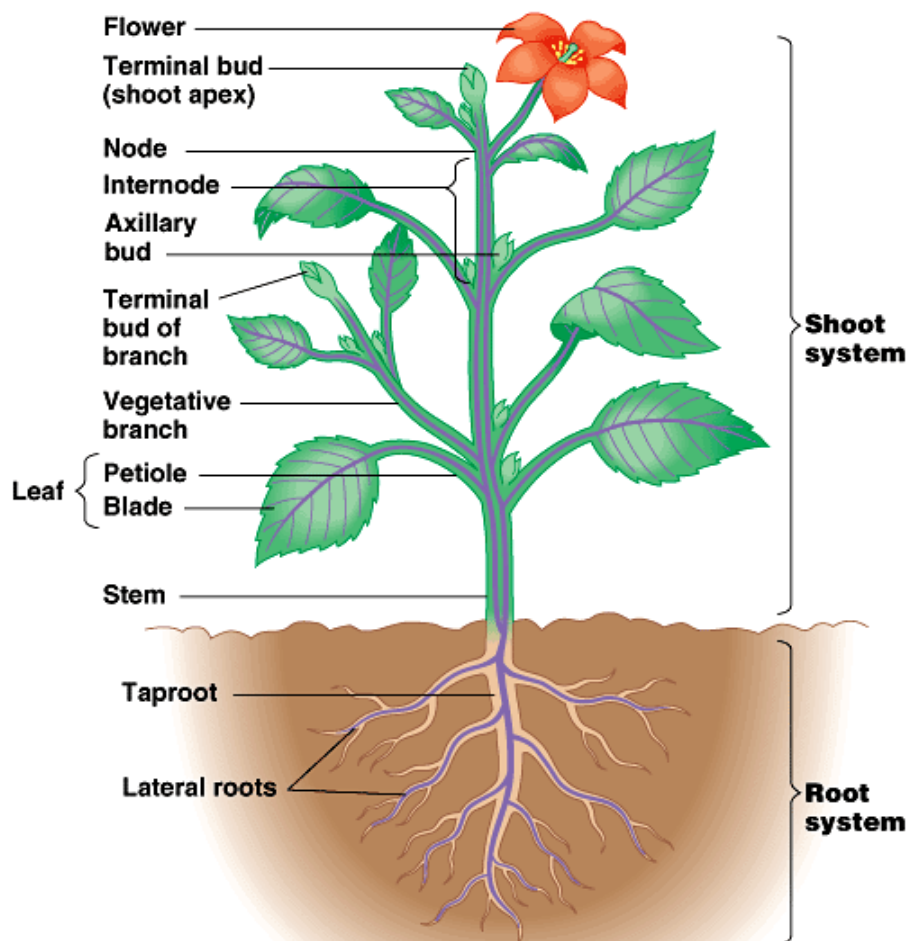
UNIT 4: STRUCTURE OF THE FLOWERING PLANT

A flowering plant has two systems. These are;

- (i) The root system
- (ii) The shoot system

A flowering plant has four main organs. These include; leaves, flowers, stem and roots.

Drawing of a generalized structure of a flowering plant



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Note: A node is the part of stem where a leaf is attached.

An internode is the distance between two successive nodes.

THE ROOT SYSTEM

A root is the descending portion of the axis of the plant. It develops from the radical of the seed during seed germination.

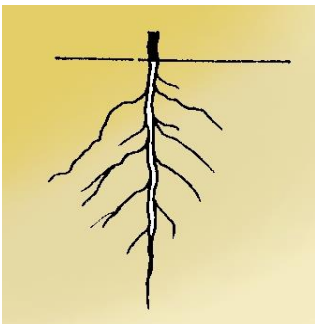
Roots have root hairs which absorb water and mineral salts from the soil.

Types of root systems

There are basically two types of root.

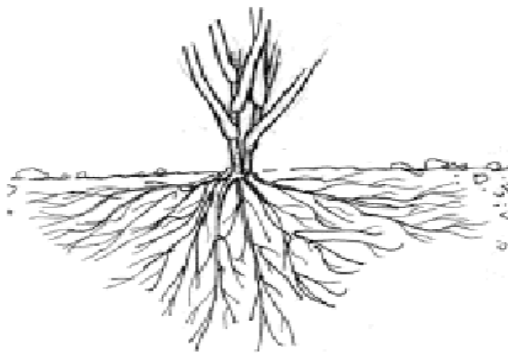
1. Tap root system

This consists of a main root growing straight downwards from the radicle. It gives rise to side to roots called lateral roots. Tap root system is a characteristic of dicotyledonous plants.



2. Fibrous root system

This is the root system without a main root and all roots arise from the same point of the base of the stem. The roots are almost of the same size and a characteristic of monocotyledonous plants.



Adventitious roots

These are roots which develop directly from the stem e.g. in bulbs or from the nodes on the stem e.g. in rhizomes.

MODIFIED ROOTS

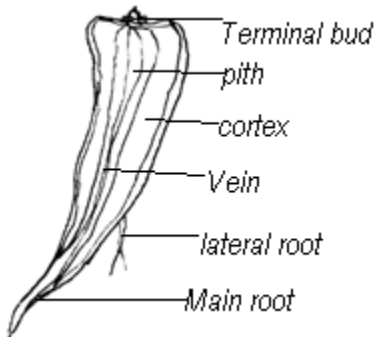
These are roots which are modified to carry out special functions. These root modifications include;

Storage roots. These are thick fleshy and succulent roots. *They contain stored food like sugar and starch. The roots are modified as root tubers* e.g. *carrots, cassava and sweet potato roots.*

Storage roots include;

- (i) **Swollen tap roots.** These are tap roots which are thick and fleshy. Examples of swollen tap roots include; carrots, sugar beet, etc. A carrot is a swollen tap root with a very short stem at the top.

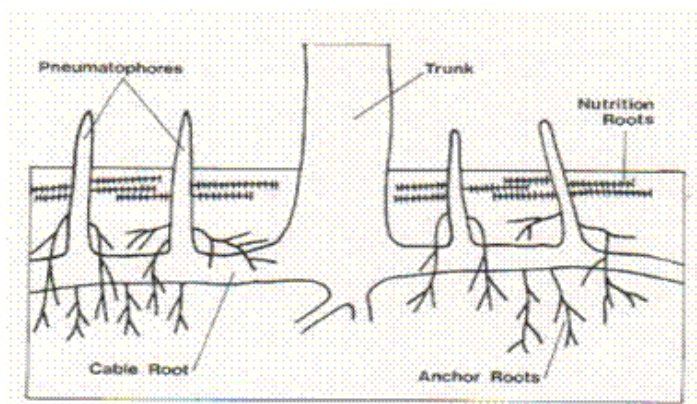
Drawing of a longitudinal section of a carrot



- (ii) **Root tubers.** These are swollen roots that are and fleshy. They store food for the plant. Examples of root tubers; cassava, sweet potatoes

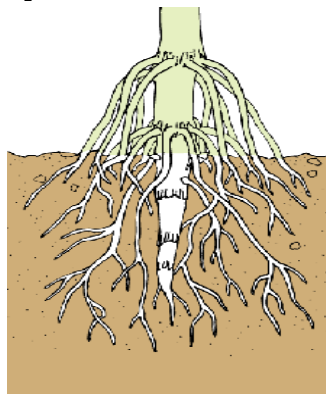
- (iii) **Breathing roots.** These are roots which grow through the mud into the air. They are found in some plants which grow in swampy areas e.g. white mangrove.

Function. Breathing roots are used for gaseous exchange. This is because the plant cannot obtain enough air from the mud of mangrove swamp due to water logging in the mud.



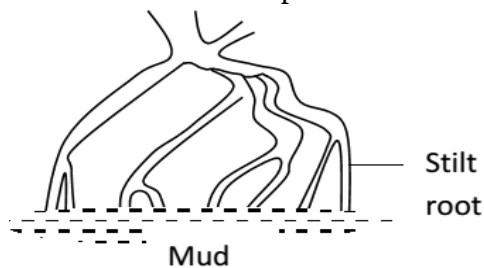
Prop roots. These are roots which grow nodes of the stem close to the soil surface e.g. in maize, sorghum and sugar cane.

Function. They provide extra support to the plant.

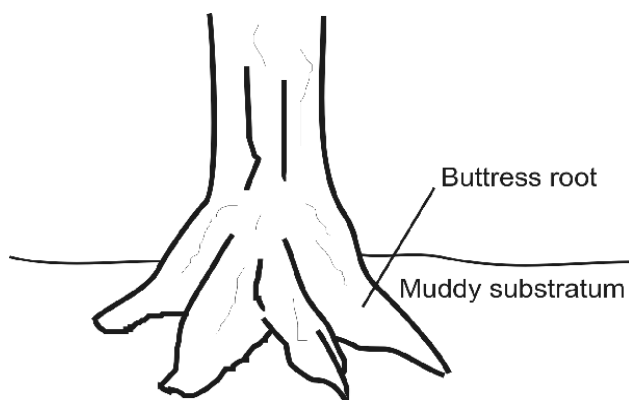


Stilt roots. These are roots which develop from stems of some plants growing in muddy places e.g. Red mangrove.

Function. Stilt roots provide extra support to the plant.

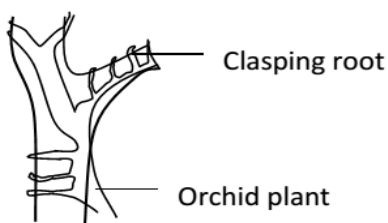


Buttress roots. These are large thick roots growing from the base of certain stems e.g. *Mvule trees*, *silk cotton*, etc. ***They provide extra support to the plant by anchoring it firmly in the soil.***



Clasping roots

These are roots growing from the nodes of climbing stems such as *figs (mituba trees)*, *vanilla* and *orchids*. They secrete a sticky substance which dries up in air. **This helps such plants to cling on to other plants for support.**



(iv) Sucking roots

These are roots found in some parasitic plants which grow on other plants e.g. dodder plant.

Function. They are used to absorb food materials from the host plant.

Note: All roots which appear above the ground are called aerial roots.

Functions of roots to the plant

There are three primary functions of roots. These include;

1. They absorb water and mineral salts from the soil.
2. Roots anchor (fix) the plant firmly into the soil.
3. Roots conduct water and mineral salts up the stem.

Other functions of roots;

1. Some roots are used for storage of food e.g. cassava, carrot, etc.
2. Some roots are used to provide extra support to the plant e.g. prop roots, stilt roots, buttress roots, etc.
3. Some roots are used for gaseous exchange e.g. breathing roots.

INTERNAL STRUCTURE OF THE ROOT

Diagram of a transverse (cross) section of a dicotyledonous root

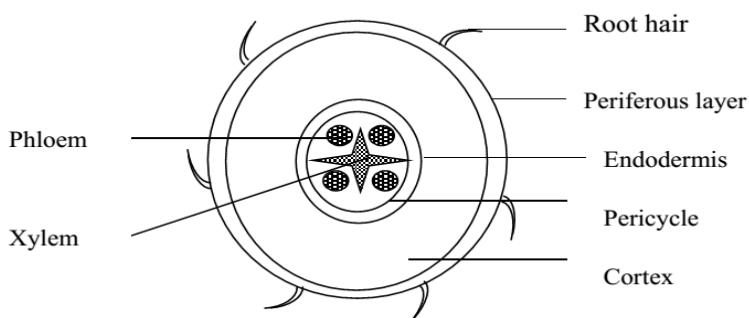
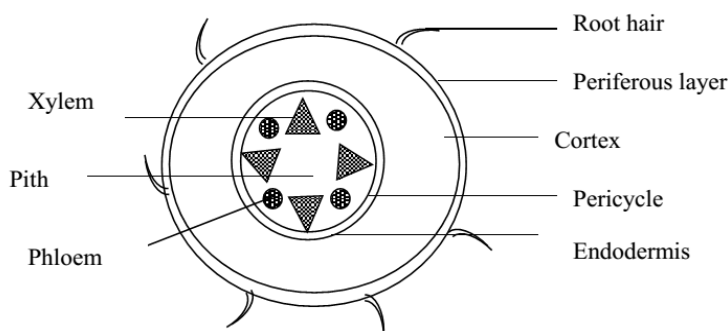


Diagram of a transverse (cross) section of a monocotyledonous root



Functions of the parts of the root

Periferous layer (epidermis). This is the outermost part of the root from which root hairs develop.

Functions

- Protects inner parts of the root.
- Has root hairs for absorption of water and mineral salts from the soil

The cortex. This is made up of parenchyma cells with air spaces between them to allow gaseous exchange.

Functions

- For storage of food
- For gaseous exchange
- **Xylem** is the water conducting tissue through which water and mineral salts pass from the soil upwards to the stem and leaves.
- **Phloem** is the food conducting tissue that carries manufactured food from the upper parts of the plant mainly leaves and distributes it to various parts of the root.

Note: The phloem and xylem in dicots are separated by a cambium.

The cambium cells divide by mitosis to form new xylem and phloem.

The division of the cambium brings about secondary growth.

Note: Monocotyledonous plants do not undergo secondary growth because they lack a cambium. The phloem and xylem form the **vascular bundle**.

Endodermis. This surrounds the vascular bundles.

Function. Regulates or controls movement of solutes into the xylem.

Pericycle. This gives rise to lateral roots.

Pith. This is the inner most part of the root

Function. For storage of food and water.

Differences between dicot and monocot roots.

Dicot

Has no pith

Has a big cortex

Has a cambium

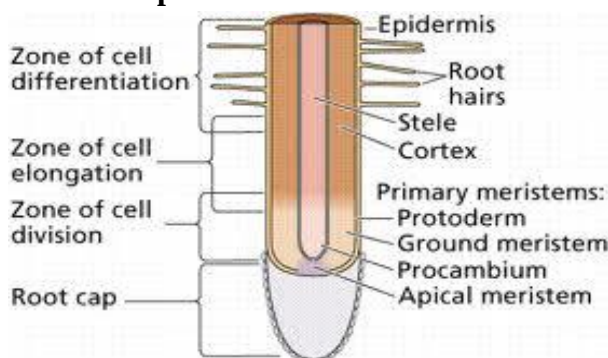
Monocot

has a pith which is wide

has a small cortex

has no cambium

Diagram of a longitudinal section of the tip of the root



Root cap. This protects the tip of the root from mechanical damage.

Root hairs. These absorb water and mineral salts from the soil.

Region of cell division/meristematic region

This is the growing apex of the root lying just behind the root cap. The **cells in this region undergo repeated divisions** to form new root cap and new cells that increase the length of the root.

Region of cell elongation

The cells in this region undergo rapid elongation and enlargement by absorbing water.

This results in an overall growth in the length of the root. **Region of cell differentiation**

This is also called the region of absorption. The characteristic feature of this region is the development of root hairs; these are fine, delicate, unicellular hair like extensions of epidermal cells (periferous layer). They absorb soil water and dissolved mineral salts from the soil. The cells in this region acquire specific shapes and functions thus they are said to be differentiated or specialized.

NB: the region behind the zone of differentiation is the oldest part of the root. It has permanent tissues and is covered by a layer of cork which prevents the evaporation of water from the roots.

Exercise

Diagram

1. The diagram above is of a certain part of a plant.
 - (a) Name the part of the plant
 - (b) Name the regions marked A, B and C
 - (c) Briefly explain what takes place in region C.
 - (d) Name the parts X and Y and state the function of each.
2.
 - (a) Give the primary functions of roots.
 - (b) State any four root modifications. Give the function of each to the plant.
3.
 - (a) Draw and label a cross section of a dicot root.
 - (b) How is a dicot root different from the monocot root?

THE SHOOT SYSTEM

This is the part of the plant found above the ground. This system consists of the stem which bears leaves, buds, flowers and fruits.

THE STEM

This is the ascending part of the axis of the plant which develops from the plumule of the embryo.

Characteristics of the stem

The stem bears;

1. Leaves (scale leaves and foliage leaves).
2. Has buds in the axiles called axillary buds.
3. Has nodes and internodes.
4. Some have adventitious roots.

Note: A node is the part of the stem where a leaf is attached.

An internode is the region of the stem between two successive internodes.

A typical stem has a growing point at the tip called the terminal bud.

The angle between each leaf and the stem bears a bud called the axillary bud.

Types of stems

There are two main types of stems;

1. Aerial stems. These are stems above the ground.
2. Underground stems. These are stems under the ground.

Aerial stems

- (i) Woody stems – found in woody plants (trees and shrubs).
- (ii) Herbaceous stems – found in plants called herbs.
- (iii) Creeping stems – these are long thin stems which creep horizontally along the soil surface giving off adventitious roots at the nodes. They are also called runners or stolons e.g. oxalis, strawberry.
- (iv) Climbing stems. These are stems which climb onto other stems by using tendrils or clasping roots e.g. passion fruits.
- (v) Twining stems – these are long and slender stems which grow spirally around other stems for support e.g. morning glory, Dutchman's pipe.

Note: Aerial stems are either weak or erect.

Erect stems can stand upright while **weak** stems cannot support themselves upright. They creep on the ground or climb around a support.

(v) Underground stems

These are modified stems which permanently remain under the ground. They are fleshy and swollen to store food for the plant. Underground stems include;

- (i) Rhizomes. A rhizome is a horizontally growing underground stem. It bears scale leaves, buds, adventitious roots, nodes and internodes.

A rhizome is swollen and fleshy in order to store food for the plant.

Functions of a rhizome

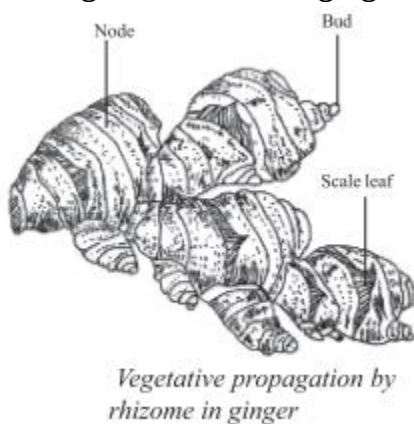
- Stores food for the plant.
- Used for vegetative reproduction.

Adaptations for the functions

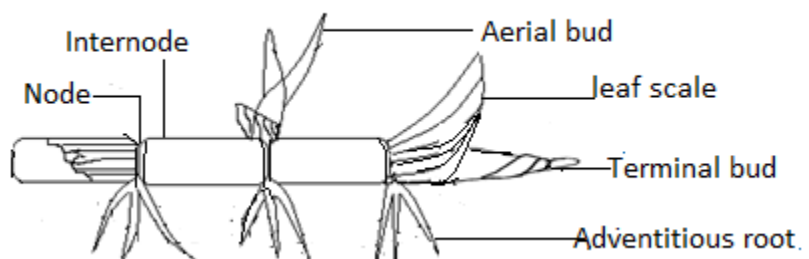
- It is thick/swollen for storage of food.
- Has buds for vegetative reproduction

Examples of rhizomes. Ginger, couch grass, cannalily, spear grass

Drawing of a rhizome of ginger



Drawing of a rhizome of spear grass



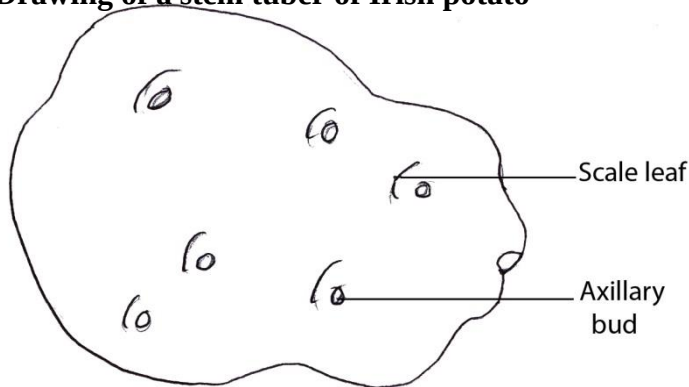
- (ii) **Stem tubers** e.g. Irish potatoes, yams.

A stem tuber is a swollen fleshy underground stem. A stem tuber has scale leaves and buds.

Functions

- Stores food for the plant.
- Used for vegetative reproduction.

Drawing of a stem tuber of Irish potato



(iii) **Bulbs** e.g. onion, garlic

A bulb is a modified underground shoot with a very short stem and thick fleshy storage leaves. The thick fleshy leaves are covered by dry brown, thin scale leaves.

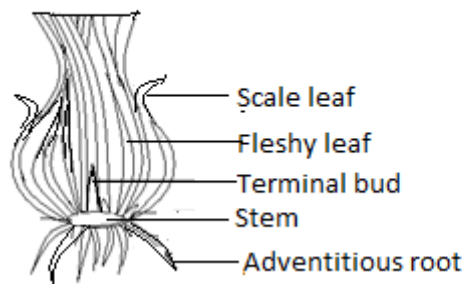
A bulb also has axillary buds, a terminal bud and adventitious roots.

Note: All leaves of a bulb have parallel veins, a characteristic of monocotyledonous plants.

Functions of a bulb

- Stores food for the plant. The food is stored in the thick fleshy leaves.
- Used for vegetative propagation.

Drawing showing a Longitudinal section of bulb



Functions of the parts

Scale leaves. - Protects fleshy leaves from mechanical damages and water loss.

Fleshy leaves. - For storage of food.

Buds. - For vegetative reproduction.

Adventitious roots. - For anchorage and for absorption of nutrients/water from the soil.

Stem – for holding leaves.

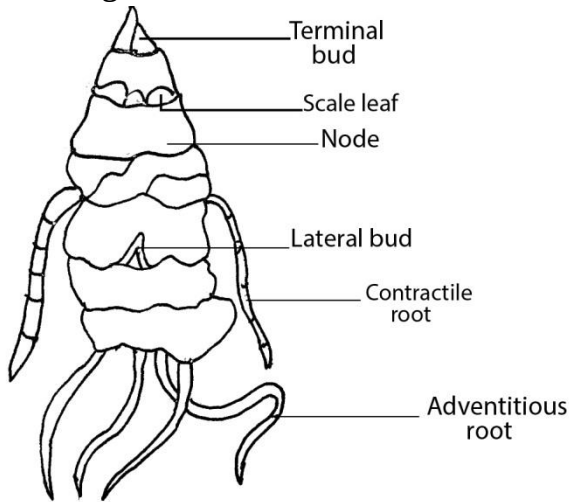
Drawing of a transverse section of an onion

(iv) **Corms** e.g. cocoyam, gladiolus.

A corm is a short swollen vertical underground stem.

A corm has buds, scale leaves and adventitious roots, there are no fleshy leaves.

Drawing of a corm



Functions

- For storage of food.
- For vegetative reproduction

Modified stems (Stem modifications)

Modified stems are the stems which are modified to carry out special functions e.g. storage of food. Modified stems include;

- (i) Twining stems – for support
- (ii) Climbing stems – for climbing onto other plants
- (iii) Rhizomes – for storage of food and vegetative reproduction.
- (iv) Bulbs – for storage of food and vegetative reproduction
- (v) Corms – for storage of food and vegetative reproduction
- (vi) Stolons – for vegetative reproduction
- (vii) Stem tubers – for storage of food and vegetative reproduction.
- (viii) Suckers – for vegetative propagation e.g. bananas and pineapples.

FUNCTIONS OF STEMS

The primary functions stems include;

1. Conduct water and mineral salts from roots to the leaves.
2. Conduct food from leaves to other parts of the plant.
3. Hold leaves in suitable positions so that they can receive sunlight for photosynthesis.
4. Support fruits and hold them in best positions for dispersal.
5. They bear flowers.

Other functions of stems

1. Some stems store food for the plant e.g. stem tubers like Irish potato.
2. Some stems are used for vegetative reproduction e.g. bulbs and rhizomes.
3. Some stems provide support to the plant e.g. climbing stem of passion fruit.

Diagram of the tip of the stem

THE INTERNAL STRUCTURE OF STEM

Diagram of a transverse section of a dicot stem

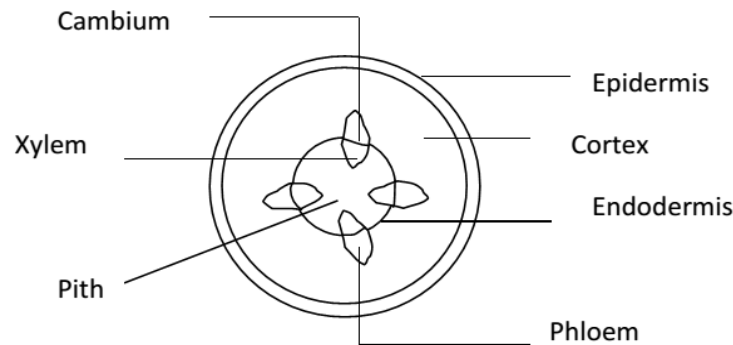
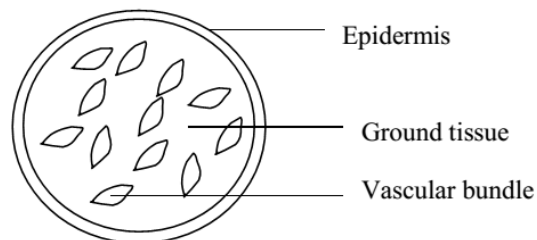


Diagram of a transverse section of a monocot stem



Functions of the parts of the stem

Epidermis. Protects inner parts from;

- Mechanical injuries
- Entry of micro – organisms
- Loss of water

Cortex. It is made up of parenchyma cells. The cortex stores food for the plant.

Xylem. Transports water and mineral salts. It also provides mechanical support to the plant.

Phloem. Conducts organic solutes/ transports food materials.

Cambium. For secondary growth.

Note: Monocotyledons lack a cambium and their vascular bundles are scattered within the stem.

Differences between dicot and monocot stems

	Dicot stem	Monocot stem
1.	Vascular bundles are arranged in a ring	Vascular bundles are scattered in the stem.
2.	Has a pith	No pith
3.	Big cortex	Small cortex
4.	Has cambium	No cambium

Differences between roots and stems

	Roots	Stems
1.	Have root hairs	Have no root hairs
2.	No nodes and internodes	Have nodes and internodes
3.	Do not have leaves, flowers and fruit	Have leaves, flowers and fruits
4.	Generally grow downwards	Most grow upwards towards light.

THE LEAF

A leaf is a thin flattened plant structure. Usually green, made up of thin walled cells supported by the veins.

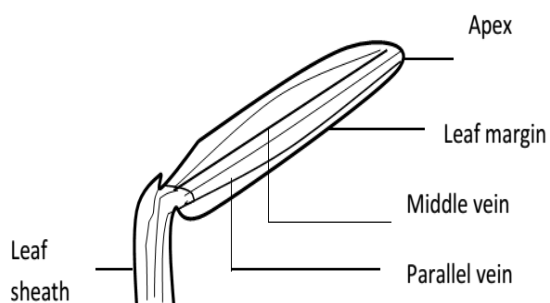
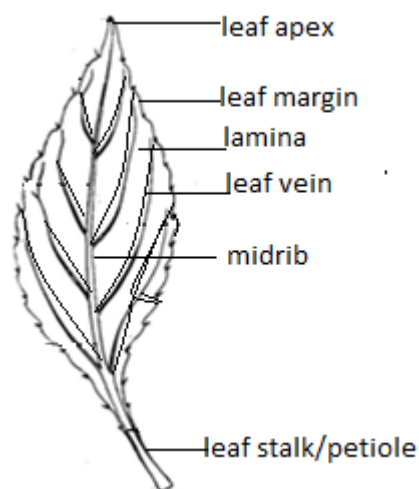
External structure of a leaf

A leaf consists of main parts. These are;

- (i) Lamina or leaf blade
- (ii) Petiole or leaf stalk

The edge of the lamina is called the **leaf margin**.

The petiole continues up the center of the lamina to form the mid-rib or main vein. The main vein supports the leaf.

Drawing of a leaf of a monocot plant**Drawing of a leaf a dicot plant**

Differences between monocot and dicot leaves

	Monocot leaf	Dicot leaf
1.	Has parallel veins	Has network veins
2.	Narrow lamina	Broad lamina
3.	Has a leaf sheath	Has no leaf sheath

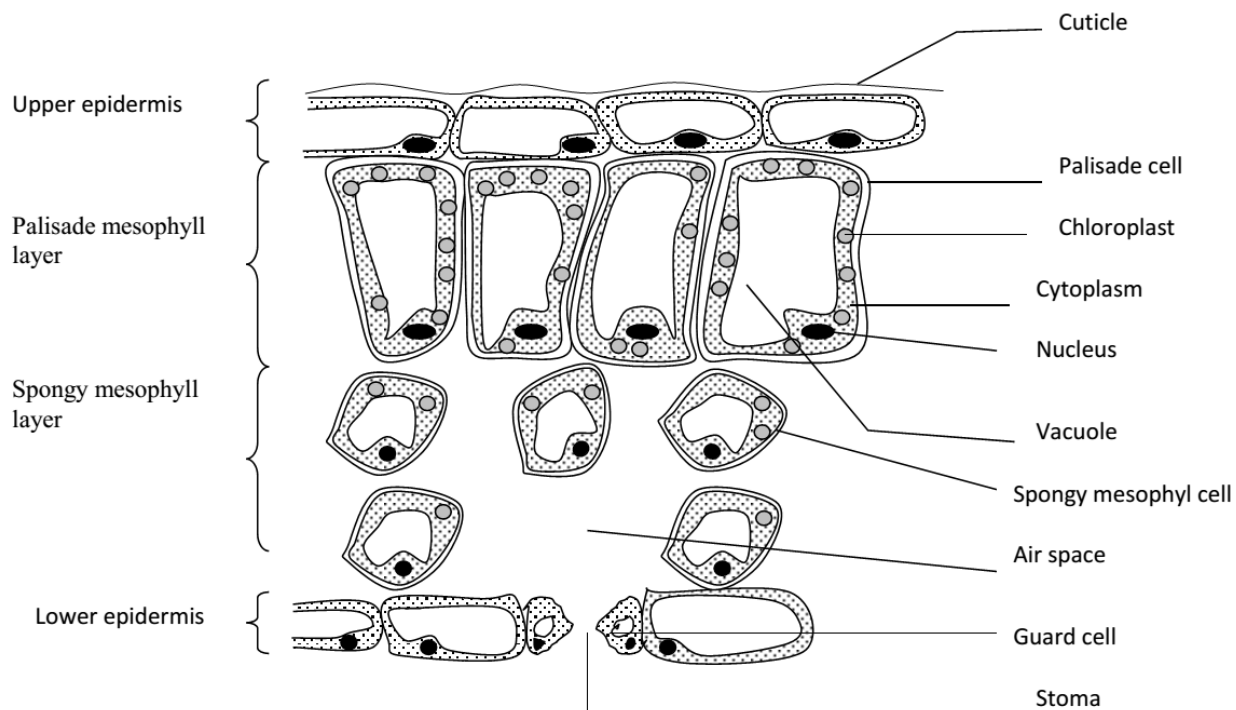
Parts of the leaf and their functions

The petiole. Supports the leaf onto the stem. It also has vascular tissue for transport of substances into and out of the cell.

Lamina (leaf blade). This contains the green pigment, chlorophyll which traps sunlight energy for photosynthesis.

Veins. This contains vascular bundles for transport of water into the leaf and food materials away from the live. The veins also support the leaf.

Mid-rib: gives support to the leaf.

INTERNAL STRUCTURE OF A LEAF

The epidermis. This is the outer layer of the leaf. It found at both sides of the leaf.

The upper epidermis, on the upper surface and the lower epidermis on the lower surface of the leaf. The epidermis is covered by a **waxy cuticle** made of **cutin**.

The epidermis bears stomata (singular: stoma) especially in the lower epidermis.

The epidermal cells do not have chloroplasts and therefore do not carry out photosynthesis.

Functions of the epidermis

1. It protects the inner parts of the leaf from mechanical injuries and bacterial attack.
2. It bears stomata which allows gaseous exchange between the plant and its surroundings.

3. It prevents excessive loss of water from the leaf by evaporation.
4. It maintains the shape of the leaf.

The palisade mesophyll layer

This layer consists of long cylindrical cells called palisade cells.

The palisade cells are closely packed and have very small air spaces. They have numerous (many) chloroplasts.

Note: Most photosynthesis in a leaf takes place in the palisade cells because;

- (i) They have many chloroplasts.
- (ii) They are located in the upper surface of the leaf and receive more sunlight energy.

The spongy mesophyll layer

This consists of cells called spongy mesophyll cells. The spongy cells are loosely arranged and irregular in shape.

The spongy mesophyll layer has large air spaces or intercellular spaces to allow gaseous exchange by diffusion.

The spongy mesophyll cells contain fewer chloroplasts compared to the palisade cells.

The chloroplasts

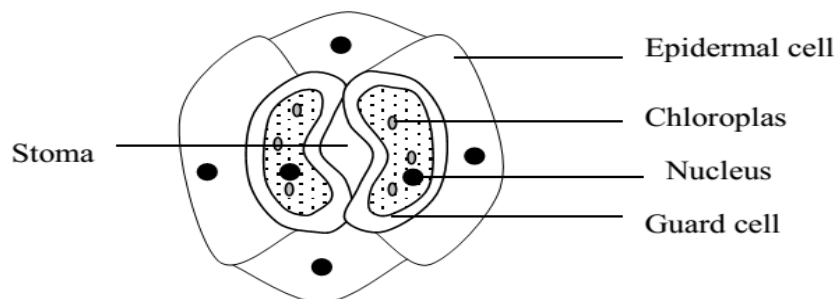
These contain the green pigment, chlorophyll which traps sunlight energy for photosynthesis.

The stomata. These are small cells in the epidermis of the leaf.

The stomata are more abundant in the lower epidermis than in the upper epidermis. Each stoma is found between two cells called **guard cells**.

The guard cells open and close the stomata. Guard cells also contain chloroplasts.

Drawing of two guard cells showing the stoma



LEAF VENATION

This is the arrangement of veins in a leaf.

Types of leaf venation

Network or reticulate venation. This is the type of venation in which the veins are arranged in a network e.g. in a bean leaf. Network venation is a characteristic of dicotyledonous plants.

Parallel venation. This is the type of venation where the veins run parallel to one another e.g. in a maize leaf. Parallel venation is a characteristic of monocotyledonous plants.

TYPES OF LEAVES

There are two main types of leaves i.e. **simple** and **compound** leaves.

Simple leaves

A simple leaf is one whose lamina is not divided into leaflets i.e. it has a single lamina.

Note: In some simple leaves e.g. passion fruit and cassava leaf, the lamina is divided but not completely divided into leaflets. Such lamina is said to be lobed.

Exercise

Provide each student with a simple leaf e.g. of a mango or jackfruit and another lobed simple leaf e.g. passion fruit or cassava leaf. **Ask the students to draw (labeling is not required)**

Compound leaves

A compound leaf is one whose lamina is completely divided into leaflets.

A leaf let is different from the leaf in that it does not have an axillary bud in the axil.

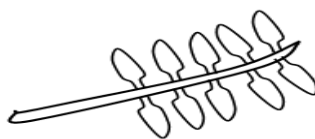
Types of compound leaves

(i) **Pinnate leaves.** These are compound leaves which have leaflets arranged in pairs opposite to one another or alternately along the main stalk.

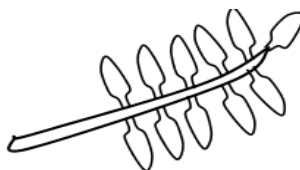
The pinnate leaf is said to be **paripinnate** if it has no terminal leaflet.

The pinnate leaf is said to be **imparipinnate** if it has a terminal leaflet.

Drawing of a paripinnate leaf e.g. cassia

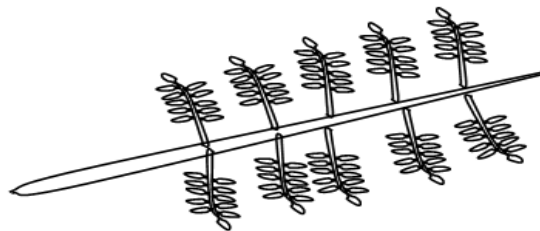


Drawing of imparipinnate leaf e.g. acacia, tomato



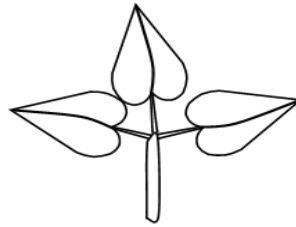
(ii) **Bipinnate leaves.** These are compound leaves in which each pinnate leaflet is divided into pinnule leaflets called pinnules e.g. jacaranda, flamboyant.

Drawing of a bipinnate leaf

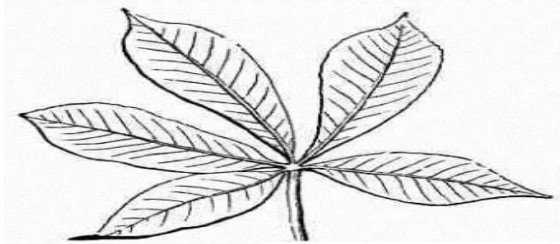


(iii) **Trifoliate leaves.** These are compound leaves in which each leaf consists of three leaflets e.g. bean leaf.

Drawing of a bean leaf



- (iv) **Compound digitate leaves.** These are compound leaves in which the leaflets radiate from the end of the leaf stalk, like the fingers on the hand e.g. silk cotton.



Note: A cassava leaf is not a compound leaf. It is a simple leaf called simple digitate.

Leaf arrangement

Leaves are arranged on the stem of a plant in various ways. These include;

1. Alternate leaf arrangement

In this case only one leaf arises from each node and arranged on opposite sides on the stem.

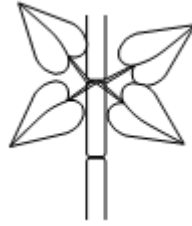


2. Opposite (decussate) leaf arrangement

This is when two leaves arise from nodes that are opposite each other and are at the same level.



3. Whorled leaf arrangement. In this case more than two leaves arise from each node.



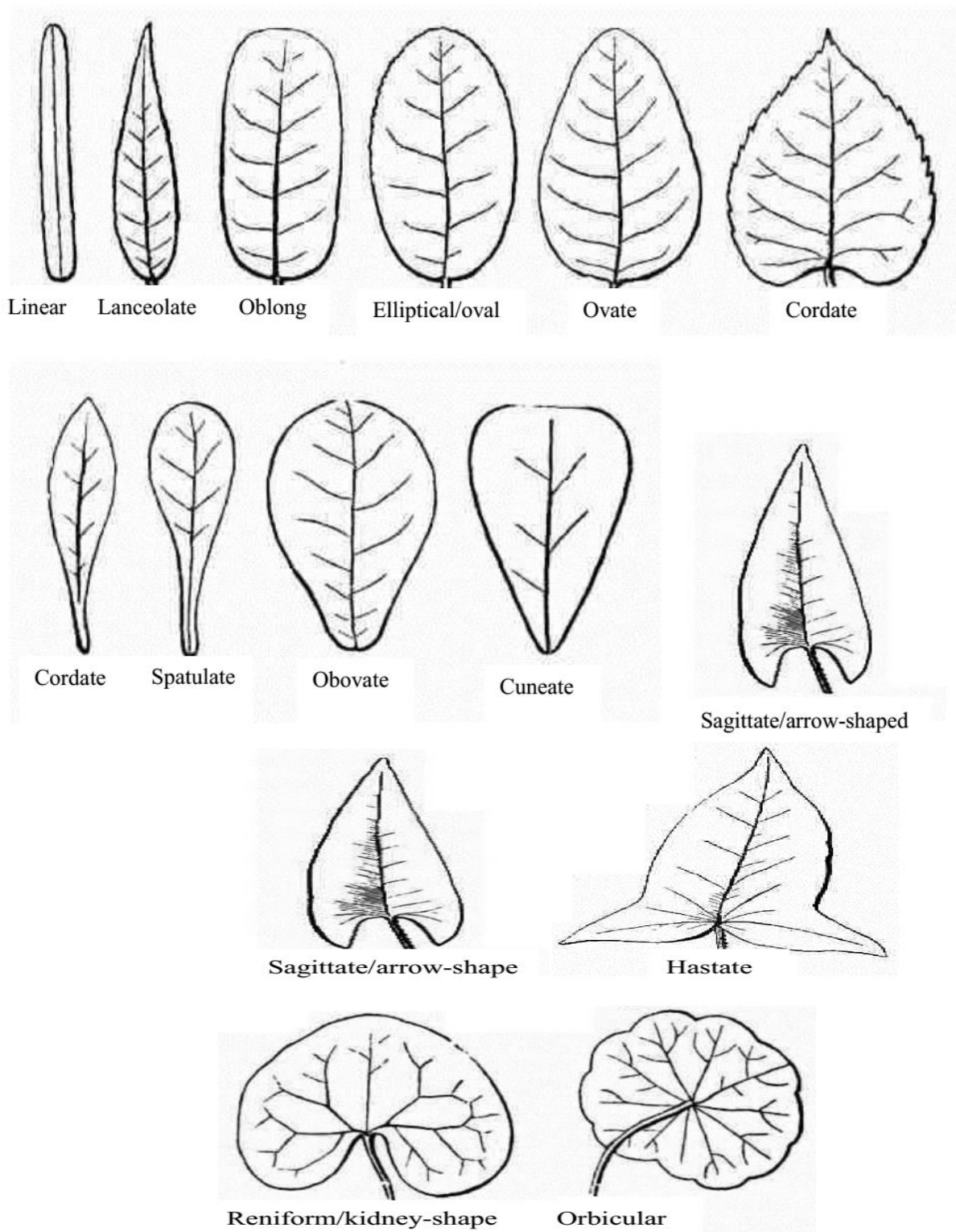
4. **Spiral leaf arrangement.** In this case the leaves are spirally arranged around the stem.

Leaf margins. Leaf margin is the edge of the lamina.

TYPES OF LEAF MARGINS

LEAF TIPS/APICES

LEAF SHAPES



Leaf modifications

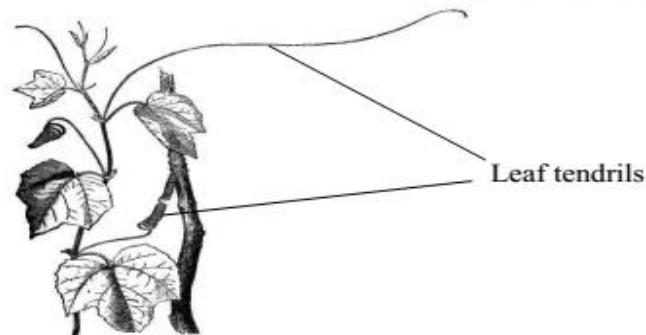
Some leaves of certain plant species are modified to perform certain functions.

These leaf modifications include;

1. **Leaf tendrils.** These are thread-like structures which wind (twine) around a support. Tendrils are used to provide more support to the plant.

In some plants e.g. peas, some of the leaflets are modified into tendrils for climbing and support. In other plants e.g. in Gloriosa, the leaf tip (apex) is modified in the tendril.

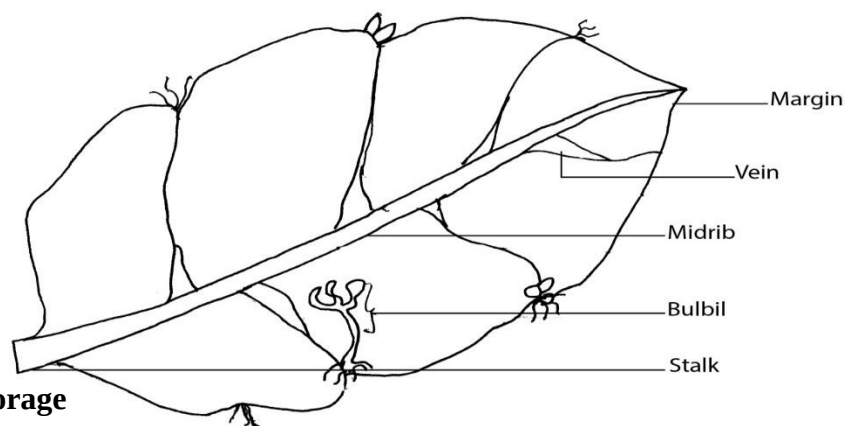
Note: Other parts of the plant other than the leaves can also be modified into tendrils e.g. in passion fruits and pumpkins, some of the lateral branches become modified into tendrils.



2. Modification for vegetative reproduction

Some leaves are modified for vegetative reproduction e.g. Bryophyllum leaf. Such a leaf develops buds which grow into new plants.

Drawing of Bryophyllum leaf



3. Modification for food storage

Some leaves are modified to store food for the plant e.g. in an onion where the leaves become thick and fleshy in order to store food for the plant.

4. Modification for feeding.

Some leaves are modified for feeding. In insectivorous plants, some leaves are modified for capturing and digesting insects. Insectivorous plants grow in nitrogen deficient soils. These plants obtain nitrogen by capturing and feeding on insects e.g. pitcher leaves of pitcher plant capture and digest insects.

5. Modification to attract pollinators.

Some leaves are modified to attract pollinators e.g. Bougainvillea. Some leaves are brightly coloured in order to attract pollinators.

6. Modification for protection. Some leaves in some plants are modified for protection e.g. the scale leaves in bulbs like an onion and in rhizomes.

Protect the inner parts of the plant from mechanical damages.

7. Leaf spines. Some leaves develop sharp and pointed spines for protecting the plant from being eaten by herbivores e.g. in goose berry, aloe, prickly pear, etc.

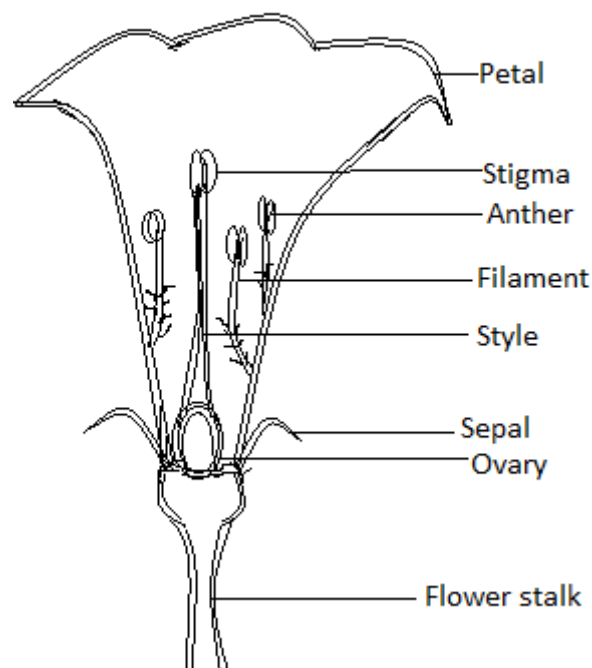
Functions of leaves to plants

1. Leaves manufacture food for the plant. They contain the green pigment chlorophyll which traps sunlight energy for photosynthesis.
2. Leaves have stomata to allow gaseous exchange between the plant and the atmosphere to take place.
3. Leaves carry out transpiration.
4. Some leaves are used to attract pollinators e.g. in Bougainvillea.
5. Some leaves are used for food storage e.g. the fleshy leaves in onions.
6. Some leaves are used for vegetative reproduction e.g. Bryophyllum leaves.
7. Some leaves are used for feeding e.g. the pitcher leaves in pitcher plant insectivorous
8. Some leaves are modified into tendrils to provide support to the plant e.g. in peas.
9. Some leaves e.g. scale leaves re used for protection. They protect the inner parts of the plant from mechanical injuries.

THE FLOWER

A flower is the reproductive organ of a flowering plant. It is a specialized organ for sexual reproduction.

Drawing showing L.S of a morning glory



Note: The floral leaves outside the sepals are called epicalyx e.g. in hibiscus flower.

Parts of the flower and their functions

Pedice (flower stalk). This holds the flower onto the stem.

Receptacle: This bears the floral leaves that is; it bears the sepals, petals, stamens and pistils.

Stamen: This is the male part of the flower. It is also known as androecium. The stamen is made up of two parts; the anther and filament. The filament supports the anther.

The anther contains pollen sacs where pollen grains develop. Therefore the anther produces pollen grains.

Note: The anther contains four pollen sacs.

Diagram of a cross section of the anther

Drawing of a stamen

Pistil. This is the female part of the flower. It is also known as **carpel** or **gynoecium**. A pistil has three parts. These are; stigma, style and ovary.

The **stigma** receives the pollen grains.

The **style** connects the stigma to ovary.

The **ovary** contains ovules.

Drawing of a pistil

Petals. These are usually brightly coloured to attract pollinators. They also protect the inner parts of the flower. The petals of a flower collectively form the **corolla**.

Sepals. These protect the inner parts of the flower. The sepals of a flower form the **calyx**.

Types of ovaries

Superior ovary (Hypogynous). This is one which arises above the rest of the floral parts.

A superior ovary is located on top of the receptacle.

Inferior ovary (Epigynous). This is one which arises below the rest of the floral parts. In this case the receptacle grows and encloses the ovary.

Semi inferior ovary (Perigynous). This is the ovary located in a cup shaped structure. In this case the receptacle grows upwards to form a cup shaped structure which does not fuse with the ovary.

TYPES OF PISTILS

Monocarpous pistil. This is where the gynoecium consists of a single carpel e.g. croton flower.

Apocarpous pistil. This is where the gynoecium has several free carpels. The carpels are not fused e.g. Bryophyllum flower.

Syncarpous pistil. This is where the gynoecium consists of more than one carpel which are fused e.g. in Hibiscus flower.

Note: In this case the flower has several stigmas.

TERMS USED TO DESCRIBE FLOWERS

Bisexual flower. This is one which has both male and female parts. It is also called perfect or hermaphrodite (imperfect) unisexual flower. This is a flower which has either stamens or pistils only but not both. This is a flower which has either stamens or pistils only but not both. E.g. a male maize flower.

Pistillate flower. This is one which has only stamens.

Complete flower. This is one which has all the four floral parts that is; androecium, gynoecium, corolla and calyx.

Incomplete flower. This is a flower which lacks one or more floral parts.

Nude or naked flower. This is one which has no sepals and petals.

Regular flower. This is one which can be divided into two equal parts in more than one way e.g. hibiscus flower.

Irregular flower. This is one which can be divided into two equal parts in only one way e.g. crotalaria flower.

Polysepalous. Sepals are free or not fused with one another.

Gamosepalous. Sepals fused together.

Polypetalous. Petals are free or not fused e.g. Hibiscus flower.

Gamopetalous. Petals fused with one another e.g. morning glory.

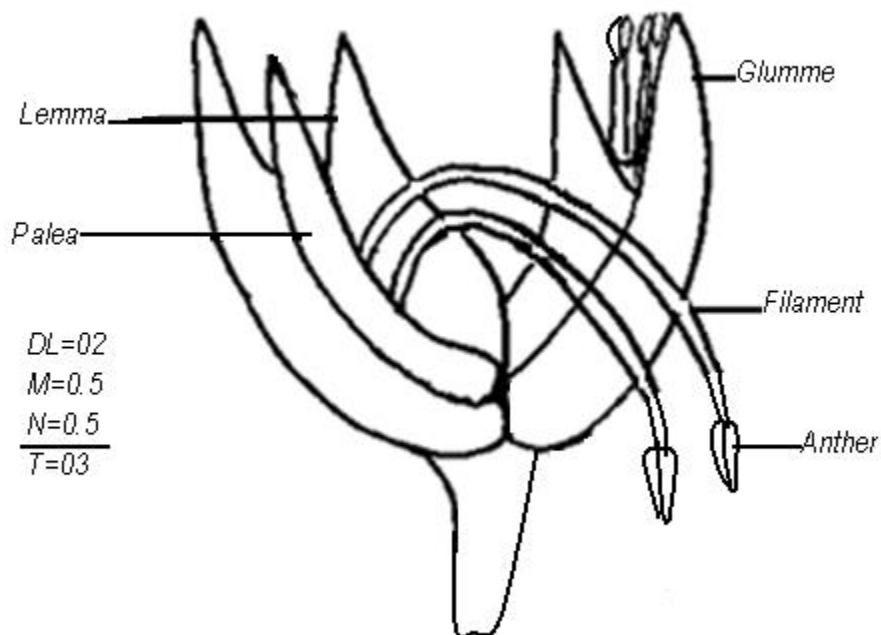
Inflorescence. This is a group of flowers born on the same main axis e.g. maize, *Panicum maximum*.

Monoecious plant. This is a plant with stamens and pistils born in separate flowers on the same plant e.g. maize plant.

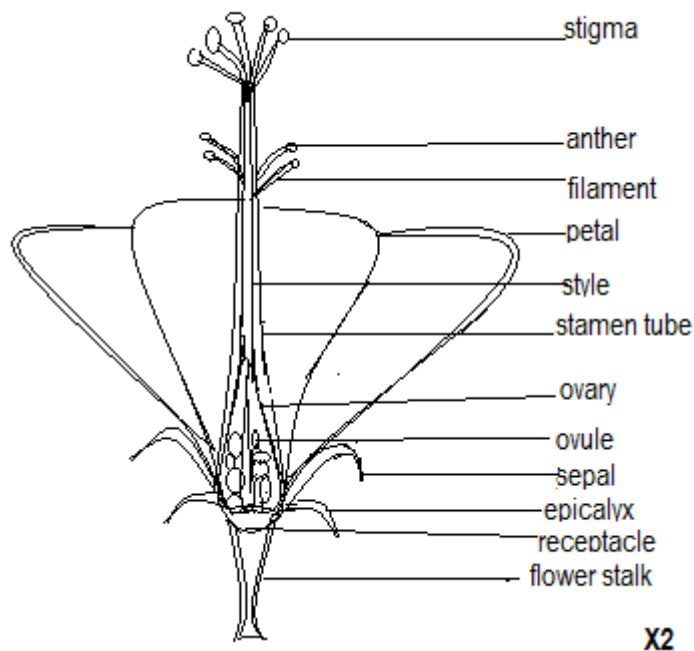
Dioecious plant. This is a plant in which the pistillate and staminate flowers are born on separate plants e.g. pawpaw.

Note: Teacher can mention common types of inflorescences and show them to the learners.

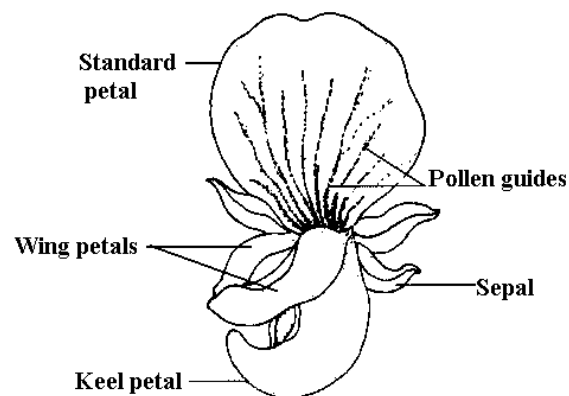
Drawing of a male maize flower



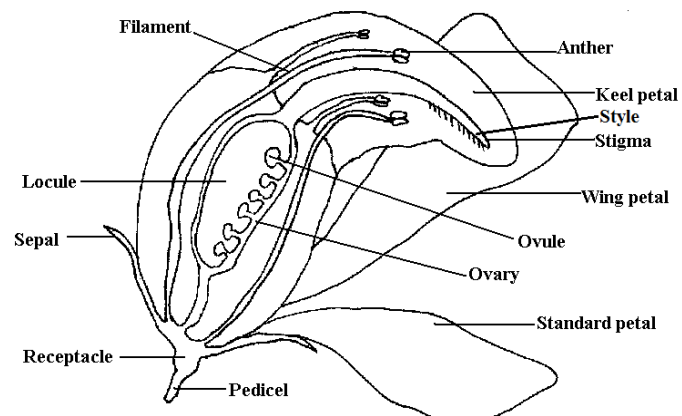
Drawing of L.S of Hibiscus flower



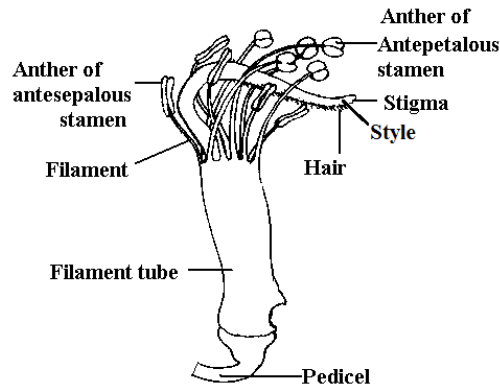
Drawing of crotalaria flower



Drawing of a longitudinal section of crotalaria flower



Drawing of crotalaria flower with all petals removed



Drawing of the ventral (front) view of crotalaria flower

Exercise

1. You are provided with specimen K (crotalaria flower) which is a plant part.
 - (a) What plant part is specimen K? Give three reasons
 - (b) Remove the keel petal from specimen K. Draw but do not label.
 - (c) Also remove the wing petal of specimen K. Draw but do not label.
2. You are provided with specimen M (morning glory flower)
 - (a) State the agent and type of pollination.
 - (b) Cut specimen M longitudinally into two halves. Draw and label one half.

POLLINATION

This is the transfer of pollen grains from the anthers to the stigma of flowers of the same plant species.

TYPES OF POLLINATION

There are two types of pollination

- (a)
- (b) Self-pollination
- (c) Cross pollination

Self-pollination. This is the transfer of pollen grains from anthers to the stigma of the same flower or another flower of the same plant.

How some plants promote self-pollination (Adaptations of flowers to self-pollination)

1. In some bisexual flowers and monoecious plants, stamens and pistils mature at the same time.
2. Petals of some flowers remain closed until self-pollination has occurred e.g. commelina.
3. Having both male and female parts on the same flower to increase chances of self-pollination.
4. In some flowers the anthers are above the stigma so that pollen grains from the anthers above fall onto the stigma below e.g. maize plant.

Ways in which plants (flowers) prevent self-pollination

1. Self-Sterility in bisexual flower or in monoecious plant. This means that the pollen grains of a flower or plant cannot germinate into the stigma of the flower on the same plant.
2. In some flowers of some plants, the male (stamens) and female (pistils) parts mature at different times. This is called dichogamy. When the stamens mature first and shed their pollen grains before the pistil is mature it is called **protandry**. In this case the pistils do not mature until the stamens have withered e.g. in sunflower. On the other hand when the pistils mature first before the stamens; the condition is called **protogyny**.
3. Some plants have unisexual flowers borne on separate plants. This is called Dioecious e.g. in pawpaw.
4. In some flowers the stigma is above the stamens. In this case the pollen grains from the anthers may not reach the stigma above on the same flower.

Disadvantages of self-pollination

1. It results in less resistant offspring.
2. Produces less variety.

Advantages of self-pollination

1. High chances of fertilization

Cross pollination. This is the transfer of pollen grains from anthers to the stigma of different flowers on different plants but of the same species.

Advantages of cross pollination (How plants promote cross pollination)

1. Self-sterility in bisexual flowers or monoecious plants.
2. Dioecious condition that is; pistillate and staminate flowers borne on separate plants.
3. Dichogamy that is; pistils and stamens mature at different times.
4. Stigma above anthers.

Agents of pollination

There are two main agents of pollination. These include;

1. Insects
2. Wind

Others. Birds, bats, water

Characteristics of insect pollinated flowers

1. Have brightly coloured petals.

2. They are usually scented.
3. They produce nectar which is food for insects.
4. Produce small quantities of sticky pollen grains.
5. Flowers are usually large and conspicuous.
6. Has sticky stigmas inside the flower.
7. Filaments and anthers are firm and anthers firmly attached to filaments.
8. Stamens and stigma enclosed by the petals.

Adaptations of flowers to insect pollination

1. Have brightly coloured petals to attract pollinators.
2. Produce nectar which attracts insects.
3. Produce sticky pollen grains which can stick on the body of the pollinator.
4. They produce scent to attract pollinators.
5. Flowers are large and conspicuous to be easily seen by insects.
6. Filament and styles are firm and anthers firmly attached onto filaments to support the weight of pollinators.
7. Anthers and stigmas are enclosed by petals to increase the chances of insects come into contact with them.

Characteristics of wind pollinated flowers

1. They are usually small and inconspicuous green in colour.
2. Usually have dull coloured petals; usually green in colour.
3. They do not produce nectar.
4. Produce large quantities of small smooth pollen light grains.
5. Anthers are large and loosely attached to filaments.
6. The anthers and stigma are exposed outside the petals.
7. Some have feathery stigmas.
8. They are not scented.

Adaptations of flowers to wind pollination

1. Feathery stigma to increase surface area for trapping pollen grains.
2. Produce large quantities of pollen grains to increase chances of pollination.
3. Anthers are loosely attached to filaments so that even the slightest wind shakes them to release pollen grains.
4. Produce small, smooth light pollen grains that can release pollen grains.
5. Anthers and stigma exposed outside the petals to expose them to wind which brings and carries away pollen grains.
6. Have large anthers to produce large quantities of pollen grains.

Significance/importance of pollination

It results into fertilization, leading to seed and fruit formation.

SEEDS

A seed is a fertilized ovule. A seed has one scar after fertilization the zygote develops into a young plant, the embryo.

A seed has either one or two cotyledons covered by an outer protective coat called the testa, and the inner coat called the tegmen.

A seed with one cotyledon is called **monocotyledonous seed** e.g. maize grain, while a seed with two cotyledons is called **dicotyledonous seed** e.g. a bean seed.

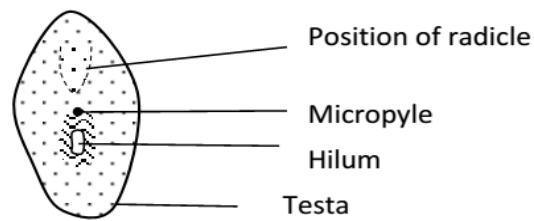
In some seeds the endosperm develops. The endosperm is used for storage of food in the seed.

Seeds which have the endosperm are called **endospermic seeds** while seeds without the endosperm are called non endospermic seeds.

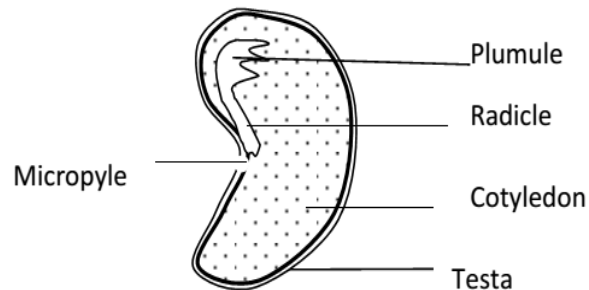
Non endospermic seeds store their food reserves in the cotyledons.

A seed has one scar.

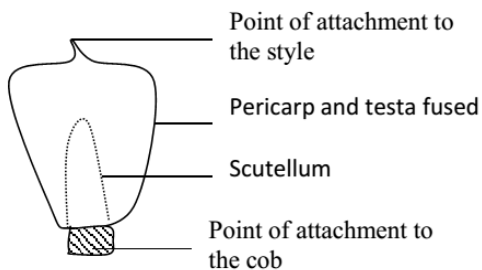
Drawing of the external structure of a bean seed



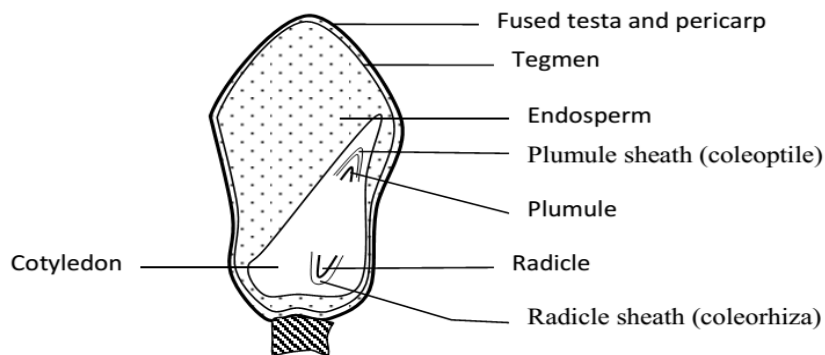
Drawing of a longitudinal section of a bean seed



Drawing of the external structure of a maize grain



Drawing of a longitudinal section of a maize grain



FRUITS

A fruit is a fertilized mature ovary of a flower. A fruit usually contains one or more seeds.

A fruit has two scars; one where it was attached the remains of the style.

During the formation of a fruit, the ovary wall becomes the fruit wall. The fruit wall is called the pericarp.

Some fruits in some plants develop from unfertilized ovaries that is develop without fertilization. This process is called parthenocarp and the fruits formed are called parthenocarpic fruits e.g. pineapples, bananas, seedless oranges, etc.

Functions of a fruit to the plant

1. It protects the seed(s)
2. It aids dispersal of the seeds

CLASSIFICATION OF FRUITS

Fruits are classified (grouped) into three main groups.

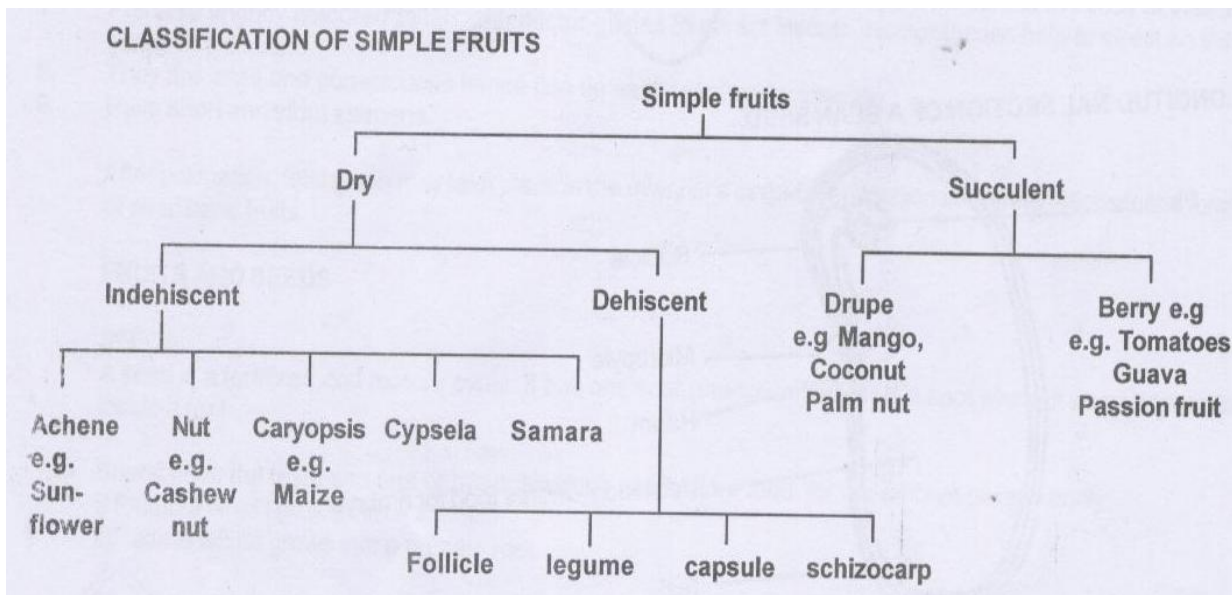
1. Simple fruits. These are fruits formed from one flower with a single carpel or several carpels which are fused (syncarpous pistil) e.g. mango, bean.

2. Aggregate fruits. These are fruits formed from one flower with several free carpels (Apocarpous pistil) e.g. rose fruit, strawberry fruit, Bryophyllum fruit.

3. Multiple fruits. These are fruits formed from inflorescence flowers whereby ovaries fuse after fertilization. E.g. pineapple, jackfruit.

SIMPLE FRUITS

Simple fruits are either dry or succulent



DRY INDEHISCENT FRUITS

These are fruits whose pericarps do not split to release the seeds when mature and dry.

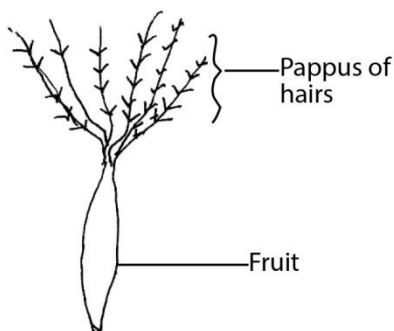
Dry indehiscent fruits include;

(a) **Achene**. This is a small dry single seeded fruit with persisted calyx which has hooks e.g. *Bidens pilosa* fruit, sunflower.

Drawing of *Bidens pilosa* fruit

(b) **Cypsela**. This is a single seeded fruit with persisted calyx which forms a parachute of hairs called pappus e.g. *Tridax*.

Drawing of *Tridax* fruit

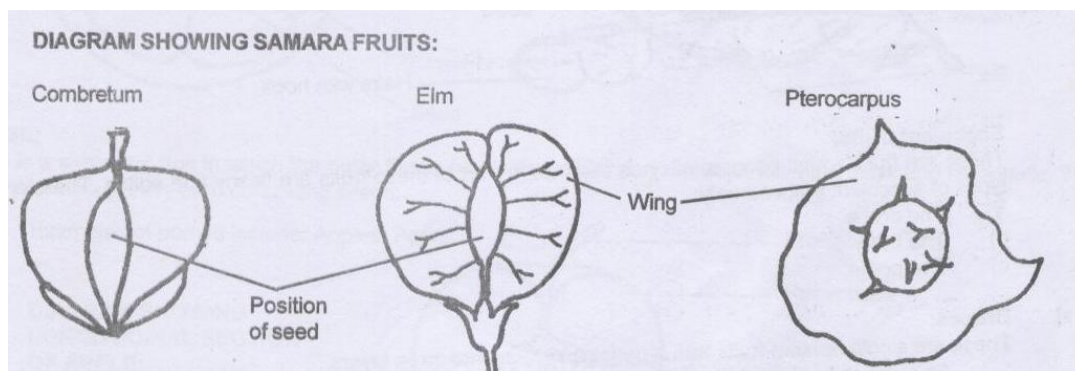


(d) **Caryopsis**. This is a fruit in which the pericarp and testa are fused together e.g. maize, wheat, rice, barley, etc.

(e) **Nuts**. A nut is a fruit with a very hard, tough pericarp e.g. cashew nut. A nut contains only one seed.

Note. Coconuts and ground nuts are not nuts.

(f) **Samara**. This is a dry fruit with a pericarp extended forming one or more wing-like structures e.g. jacaranda.



DRY DEHISCENT FRUITS

These are fruits whose pericarps split open when mature and dry to release their seeds.

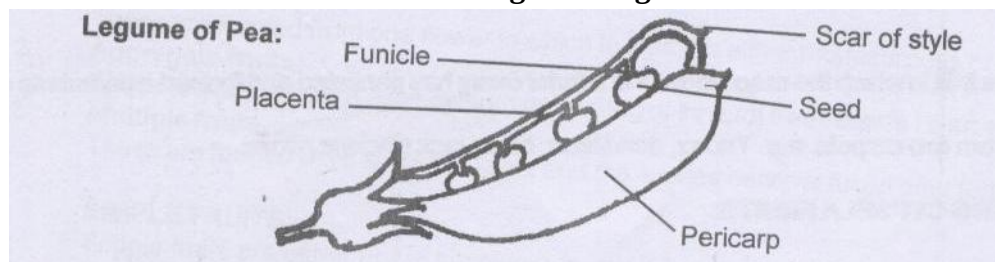
Dry dehiscent fruits are classified according to the number of lines of weaknesses called sutures in the pericarp.

The types of dry dehiscent fruits include;

(a) Follicles. A follicle is a fruit which splits open along one suture e.g. cassia, Sodom apple.

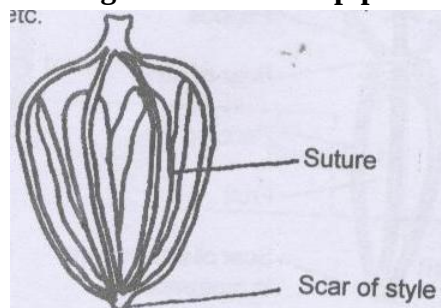
(b) Legumes or pods. A legume is a fruit which splits open along two sutures e.g. bean pod, peas, groundnuts, etc.

Drawing of a longitudinal section of a bean pod



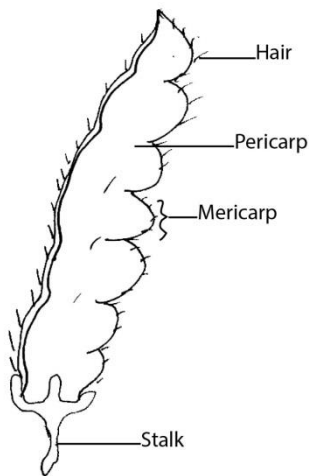
(c) Capsules. A capsule is a fruit which splits open along three or more sutures e.g. Dutchman's pipe fruit, castor oil, cotton, and poppy.

Drawing of Dutchman's pipe fruit



(d) Schizocarps. A schizocarp is a dry fruit which breaks down into several parts each containing one seed. The part or compartment which contains a seed is called a loment or lomentum. E.g. Desmodium fruit, sweetheart, etc.

Drawing of desmodium fruit



SUCCULENT FRUITS

A succulent fruit is one which has a fleshy and juicy pericarp e.g. tomato. The pericarp of a succulent fruit consists of three layers. These include;

1. The **epicarp**. This is the outermost layer of the fruit.
2. The **mesocarp**. This is the middle layer of the pericarp.
3. The **endocarp**. This is the inner layer of the pericarp.

Types of succulent fruits

There are two types of succulent fruits. These are drupes and berries.

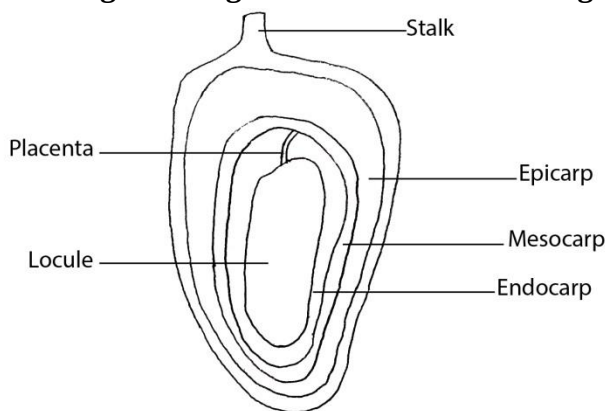
DRUPES. A drupe is a succulent fruit with one seed and a hard endocarp.

The endocarp of a drupe is hard and woody and encloses the seed.

Note: In a drupe the seed is centrally located and attached at the base of the fruit.

Examples of drupes. Mango, avocado, coconut, etc.

Drawing of a longitudinal section of a mango fruit



Drawing of a longitudinal section of avocado fruit

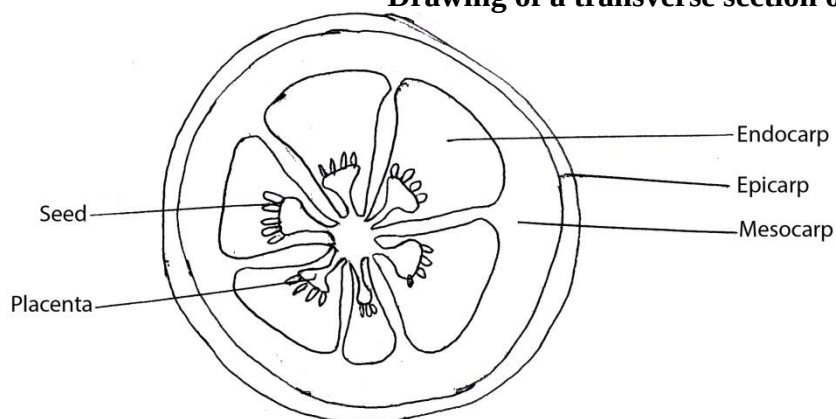
Drawing of a transverse section of a mango/avocado fruit

Berries. A berry is a succulent fruit with many seeds and a soft fleshy endocarp. Therefore the whole fruit is fleshy and succulent.

Examples of berries. Orange, tomato, passion fruit, pawpaw, guava, banana, eggplant.

Drawing of a longitudinal section of a tomato fruit

Drawing of a transverse section of a tomato fruit

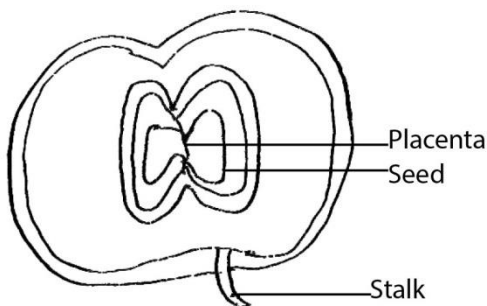


Drawing of a longitudinal section of an orange fruit

Drawing of a transverse section of an orange fruit

Pomes. These are succulent fruits whose edible part develops from the receptacle. In this case, the receptacle becomes swollen and fleshy e.g. apple, pear, etc.

Drawing of a longitudinal section of an apple fruit



PLACENTATION

This is the arrangement of the placenta in a fruit or ovary. The tissue on which the seeds are attached is the placenta.

Types of placentation

1. Marginal placentation. This is the type of placentation where the placenta develops along one the two margins of the pericarp e.g. in legumes such as bean pod, peas, cassia, etc.

Drawing of longitudinal section of a bean pod

Arrangement of seeds in a bean pod

The seeds are arranged linearly along the margins of the pericarp forming one line.

2. Axile placentation. This is the type of placentation in which the placenta is centrally located. In this case the fruit/ovary has compartments called loculi (singular: locule) e.g. in tomatoes, oranges, bananas, guava, eggplant, etc.

Question. Describe the arrangements/attachment of seeds in a tomato/orange.

Solution. The seeds are centrally located and radially arranged/attached on the central placenta (seed drawings)

3. Basal placentation. This is the type of placentation where the placenta develops directly from the base of the fruit/ovary. In this case the fruit has a single seed. E.g. mango, avocado, etc.

Question. Describe the arrangement/attachment of the seed in a mango fruit.

Solution. The seed is centrally located attached at the base of the fruit.

4. Parietal placentation. This is the type of placentation where the placenta develops on the inner wall of the pericarp/ovary. In this case the fruit/ovary has one chamber. E.g. pawpaw, passion fruits, etc.

Drawing of a transverse section of a passion fruit

Arrangement of seeds. The seeds are arranged all around on the inner wall of the pericarp.

5. Free Central Placentation. This is the type of placentation in which the placenta develops in central axis which has no connection to the fruit wall.

The central axis arises from the base and is suspended in the centre of the fruit e.g. green pepper.

Drawing of a longitudinal section of green pepper fruit

Note: The seeds are arranged all around on the central axis.

SEED AND FRUIT DISPERSAL

Seed dispersal is the scattering of the seeds from their parent plant.

Fruit dispersal is the scattering of fruits from their parent plant.

Importance of seed dispersal

1. It reduces overcrowding of plants of the same species.
2. It reduces competition for resources such as water, mineral salts, air, light and space among plants.
3. It reduces and prevents easy spread of diseases among plants.
4. It results in the colonization of new areas by plants.

Note: In some plants only the seeds are dispersed while in other plants the fruits with their seeds are dispersed.

Agents of seed and fruit dispersal

This refers to the means of dispersal of the seeds and fruits. These agents include;

- Wind
- Animals
- Water
- Explosive mechanism

Types/modes of seed and fruit dispersal

1. Wind dispersal
2. Animal dispersal
3. Water dispersal
4. Self-dispersal/explosive mechanism

Note: Censor mechanism only applies to follicles. In this case when wind blows, the seeds are shaken out of the opening of the dry pericarp e.g. cassia fruit.

Characteristics of fruits/seeds dispersed by wind and adaptations to wind dispersal

1. They are usually small, light and dry to be blown away by wind.
2. Some fruits have wing-like structure which to increase the surface area to allow them to be easily carried by wind e.g. Jacaranda, Tacoma seed, etc.

3. Some fruits have hairs which form a parachute known as pappus to increase the surface area to be easily carried by wind e.g. *Tridax*.
4. Some seeds e.g. cotton have thread – like structures called floss to increase the surface area for floating in air.

Characteristics of fruits/seeds dispersed by animals and adaptations of fruits dispersed by animals

1. Some fruits have hooks which attach the fruit to the body of the animal e.g. *Bidens pilosa*.
2. Some fruits have sticky hairs which attach them to the body of the animal e.g. *Desmodium*.
3. Some fruits have fleshy and succulent pericarps to attract animals e.g. mangoes, oranges and guavas.
4. Some succulent fruits have brightly coloured pericarps to attract animals e.g. ripe mango.
6. Some fruits have got scent (good smell) to attract animals e.g. jackfruit.

Note: That some succulent fruits, the whole fruit is fleshy and can be eaten e.g. guava, tomato, etc. in this case the seeds are indigestible that is; they resist digestion and passed out in the animals' faeces undigested.

Other succulent fruits such as mangoes, only the fleshy part is eaten, leaving the part containing the seed and throwing it away.

Exercise

You are provided with the following fruits;

- (i) Tomato
- (ii) Orange
- (iii) Black jack
- (iv) Mango
- (v) *Desmodium*

Describe the mode of dispersal of each fruit that is; describe how each fruit is dispersed.

Solution. The animal is attracted by the fleshy pericarp. The animal picks the fruit from the plant. Animal then eats the whole fruit but the seeds resist digestion and are passed out in the animals' faeces.

Orange. The animal is attracted by the fleshy pericarp or brightly coloured epicarp, animal picks the fruit from the plant, the animal eats the fleshy part of the fruit, leaving the seeds throwing them away.

Black jack. The hooks attach fruit onto the animal's body. The animal moves away with the fruit. The animal then removes/scratches off the fruit and drops it down.

Mango. The animal is attracted by the fleshy pericarp. The animal then picks the fruit from the plant. The animal eats the fleshy part of the fruit, leaving the part containing the seed, throwing it away.

Desmodium. Mode of dispersal is the same as that of black jack.

Characteristics of fruits/seeds dispersed by water and adaptations to water dispersal

1. Some seeds have air spaces in them which allow them to float on water e.g. coconut and seeds of certain water lilies.
2. Some seeds/fruits are covered by spongy fibrous and water proof coats to enable them float on water without rooting e.g. coconut fruit.

Dispersal by self-dispersal or explosive mechanism

The fruits are dry dehiscent and split open along sutures when mature and dry and the seeds are thrown away to another place e.g. beans, peas, castor oil, balsam fruit, cedar, mahogany, etc

Exercise

1. Describe the mode of dispersal of a bean pod.
2. Giving one example in each adapted to animal dispersal.
3. State the characteristics of seeds and fruits dispersed by wind.