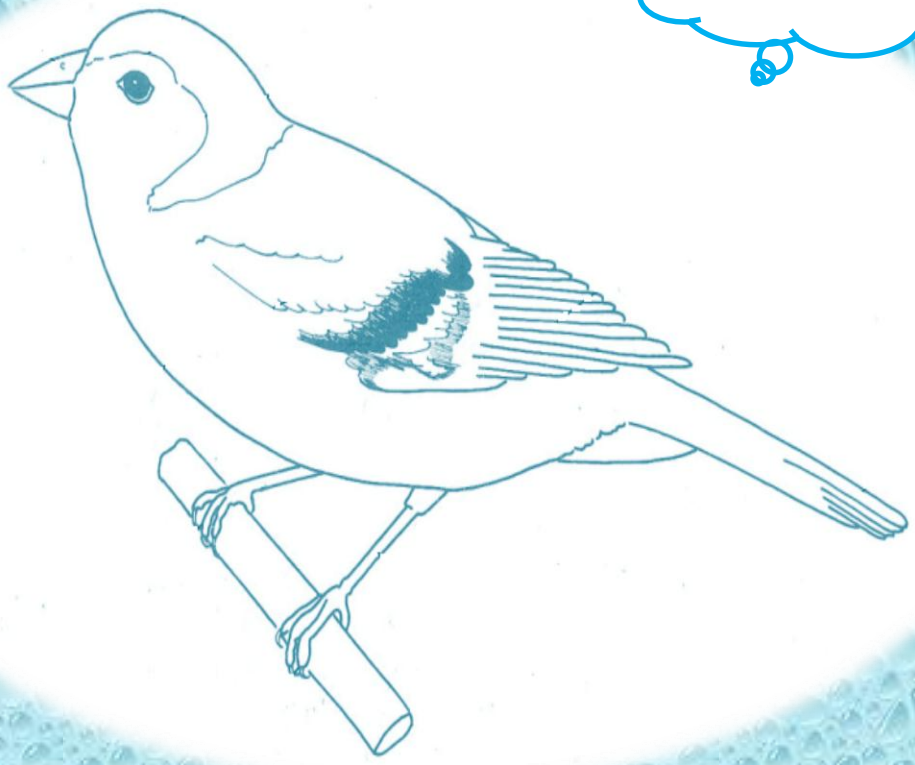
Arthur's Diverse World of Living Organisms;

SENIOR ONE BIOLOGY CLASS NOTES

2019
Online edition



A practical approach to theory teaching practices for the Uganda Certificate of Education with revision questions

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BIOLOGY

Table of contents

INTRODUCTION TO BIOLOGY

Biology is a word derived from **two Greek** words i.e. **"*Bios*"** and **"*logos*"** where ***Bios*** means **life** and ***logos*** means **knowledge**.

Therefore *Biology is the study of life or living things*. All living things are called organisms.

Branches of biology

1. **Botany**, the study of plants.
2. **Zoology**, the study of animals.
3. **Anatomy**, the study of the structure of living things.
4. **Nutrition**, the study of food and how living things feed.
5. **Ecology**, the study of how organisms relate to their environment / surrounding.
6. **Mycology**, the study of fungi.
7. **Virology,** the study of virus.
8. **Bacteriology**, the study of bacteria.
9. **Entomology**, the study of insects.
10. **Microbiology**, the study of microorganisms.
11. **Physiology**, the study of process and functioning of the body parts.
12. **Genetics,** the study of inheritance.
13. **Taxonomy**, the study of classification of organisms
14. **Ornithology**, the study of birds.
15. **Ichthyology,** the study of fish.

Why do we study biology?

- To get knowledge on how to treat the sick.
- To get knowledge needed to become doctors, and nurses.
- To get knowledge on how to manufacture drugs.
- To get knowledge on how to conserve the environment.
- To know how our body functions.
- To know more about living organisms in relation to their surroundings.

Characteristics of living things

1. Nutrition/feeding

It's a process by which living things obtain nutrients that support metabolic/biochemical processes in their bodies to support life. Green plants make their own food while the rest obtain already made food from the environment.

2. Respiration

This is the breakdown of food to release energy in the body.

3. Excretion

Is the process by which waste products are removed from the body e.g. urea in urine, carbon dioxide, etc.

4. Reproduction

This is the ability of an organism to give rise to new organisms/off springs.

5. Movement

This is the ability of an organism to transfer its body or part of its body from one place to another. They move in search for food, water, shelter, mates, and run away from predators. Locomotion is when an organism moves its whole body from one place to another. Plants do not locomote but can move their branches.

6. Growth

Growth is a permanent increase in size of an organism. It is followed by development.

7. Irritability / sensitivity

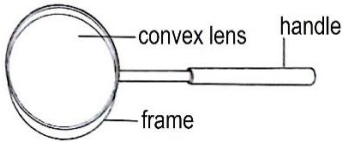
It is the ability of an organism to respond to changes like light, coldness, etc. in its environment.

Revision questions

1. *Define the term biology.*
2. *Explain what you understand by the following branches of biology:*
   - *i) Zoology*
   - *ii) Botany*
   - *iii) Ecology*
   - *iv) Parasitology*
3. *List the characteristics of living organisms.*
4. *State three reasons why biology should be learnt.*

SPECIAL TOOLS USED IN THE STUDY OF BIOLOGY

1. Hand lens:



It is used to magnify the whole object or tiny features on the surface of biological objects (specimens). For example; hairs on the legs of house flies, segments of the antennae of a cock roach, spines on the legs of a cock roach, etc.
When using this tool, the object appears bigger through the convex lens than its real size. The object is said to be magnified. **Magnification** refers to how much bigger the object appears compared to its real size. When the object is drawn, we use a formula to calculate how much bigger the drawing appears from the real object.

Magnification = $\frac{size\ of\ the\ image/drawing}{size\ of\ the\ object}$

Example: Calculate the magnification of an object, which is 10cm tall whose image appears to be 20cm tall.

Solution

Magnification $= \frac{size\ of\ the\ image/drawing}{size\ of\ the\ object} = \frac{20\ cm}{10\ cm} = x2$

Biological drawings

The following suggestions are important when making a biological drawing:

1. A well sharpened lead pencil should be used for drawing.
2. The drawing should occupy a half or three quarters of the space provided.
3. Each drawing should have a title preferably placed at the top.
4. Enough space should be left all around the drawing for labelling.
5. The outline should be simple and clear.
6. Double lines should only be used when showing a cut surface.
7. Label lines should touch the structures.
8. Label lines should not have arrow heads. Arrow heads indicate direction of movement.
9. The magnification of the drawing should always be worked out.
10. The drawing should not be shaded whether by pencil or crayons.

Assignment:

Following the rules above, draw and label a black jack leaf (or any other simple small leaf from any plant in the school compound).

2. Microscope:

It is an instrument used to view objects that are too small to be seen by an unaided eye.

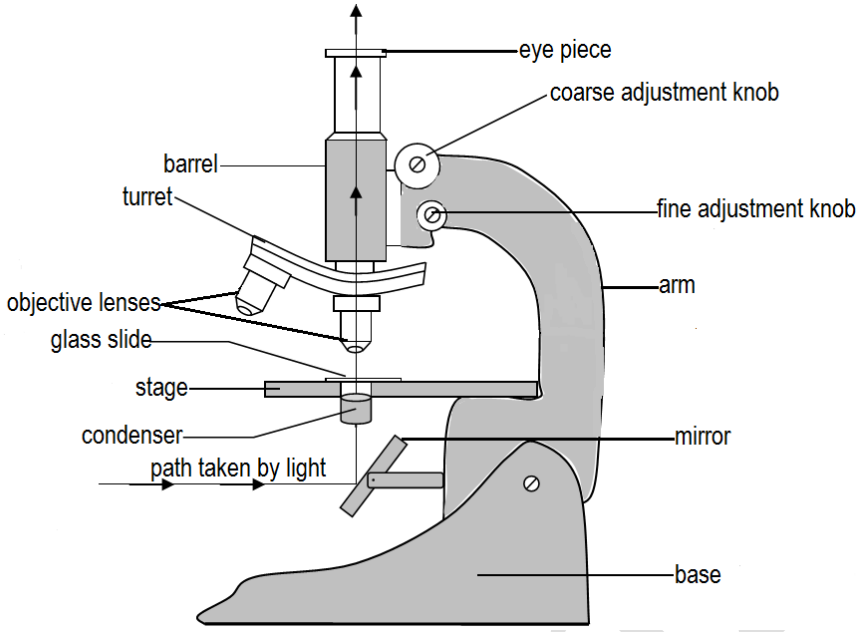
Types of microscopes

- The electron microscope which uses a beam of electrons.
- The compound light microscope.

The compound light microscope

It is called so because it uses a beam of light to view objects and has more than one convex lens. It is used in hospitals, schools and some industries.

Structure of a compound light microscope



Functions of the different parts

1. Eye Piece:
It is where the eye is placed while viewing the specimen.
Enables one to view the specimen.
It magnifies the image from the objective lens.

1. 2. Barrel:
Provides support for the eye piece and objective lens.

2. 3. Nose piece/turret:
It holds the objective lenses in position.
Can be rotated to position a particular lens required for a particular magnification.

3. Stage:
It is where a prepared slide is placed for observation.

4. 5. Mirror:
It reflects light from external source through the specimen.

5. 6. Stand/Base:
Supports instrument in on a flat surface.

6. 7. Clip:
Keeps the slide firmly on the stage.

7. 8. Diaphragm:

8. Regulates the amount of light passing through the specimen

9. 9. Condenser:
Concentrates the light reflected by the mirror through the object / specimen on the stage.

10. 10. Arm:
Used for carrying the instrument.

11. 11. Coarse adjustment knob:
Used for focusing of the object under study.

12. 12. Fine adjustment knob:
Brings specimen into a sharp clearer focus (final focusing).

13. 13. Objective lens:
Magnifies the specimen under study. They are normally two or three. Low power (shortest), medium power and high power (longest).

Care of a microscope

The microscope is very delicate, expensive instrument which is very useful in the study of biology. Thus it should be handled carefully doing the following;

- It should be carried with both hands.
- Should never be dropped.
- Always kept in an upright position
- Only wipe the lens with soft lens tissue.
- It should always be kept in its special designed box.

Determination of magnification of a microscope

Magnification refers to how much larger the object appears compared to its real size.
Magnification = magnification of the eye piece lens X magnification of the objective lens.

Example:
If the eye piece is marked **x10** and the magnification of the objective lens is **x40**, what is the total magnification of a microscope?

Magnification = magnification of the eye piece lens x magnification of the objective lens.
=10 x 40=400
The specimen was magnified X400

Revision questions

1. *What is a hand lens used for?*
2. *A leaf drawn using a hand lens measured 10 cm long. The actual length of the leaf was 5 cm. work out the magnification of the drawing.*
3. Complete the table below

Eye piece lens	Objective lens	Magnification
X15	X7	……
X60	……	X240
……..	X17	X340
X25	X8	……

4. If the magnification power of the eye piece lens is x10 and the total magnification of a specimen observed using the microscope is x300, work out the magnification power of the objective lens.

LEVELS OF ORGANISATION IN ORGANISMS

This is the building plan of an organism's body from the simplest to a more complex structure called an organism. The starting or smallest unit of life is the cell. The organisationnis as follows:

Cell ⟶ tissue ⟶ organ ⟶ organ system⟶organism

The living organism is a system of interwoven and overlapping hierarchies of organization. Each level makes the base for the next higher level. The properties of that level are unique and are different from any level.

Each level of organization is more complex and has fewer units than the previous one, i.e. there are lesser tissues than cells. Cell is the lowest level that is considered to be alive. The structural hierarchy represents how matter has become more and more organized with each level.

Level of organization	Definition	Examples and functions
1. Cell	Smallest basic unit of life	Red blood cell, root hair cell, cheek cells.
2. Tissue	A tissue is a group of similar cells linked together to perform a particular function. A tissue may be made up of single type of cell or may comprise of different types of cells.	i) Blood tissue made up of red blood cells, white blood cells and platelets. Blood transports materials in the body and offers protection. ii) Nervous tissue made up of nerve cells. It transmits impulses in the body. iii) Muscular tissue made up of muscle cells which cause movement of body parts iv) Photosynthetic tissue made of palisade cells for photosynthesis.
3. Organ	An organ is a collection of tissues specialized in carrying out a specific function. An organ is made up of different types of cells grouped together as a unit	i) Eye for sight ii) Heart for pumping blood iii) Ear for hearing iv) Kidney for purifying blood v) Leaves for photosynthesis vi) Roots for absorbing water and mineral salts
4. Organ system	An organ system is a collection of different organs performing a specific function(s)	i) Nervous system (Brain, Spinal cord and nerves), ii) Circulatory system (Heart, Lungs and Blood vessels), iii) Digestive system (gullet, stomach, small intestines). iv) Shoot system (leaves stems. flowers) v) Root system (roots)
5. Organism	This is a collection of organ systems working together efficiently as a unit.	man, cow, banana plant

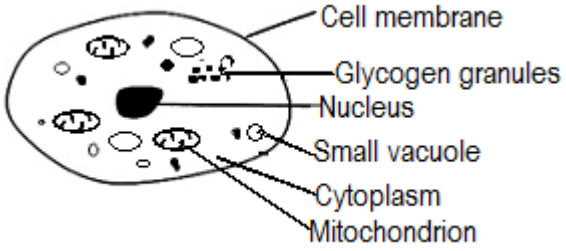
THE CELL

The cell is the smallest basic unit of life. Unicellular organisms are only made up of a single cell e.g. amoeba, paramecium. Multicellular organisms are made up of many cells e.g. man, cows, bean plant, etc.

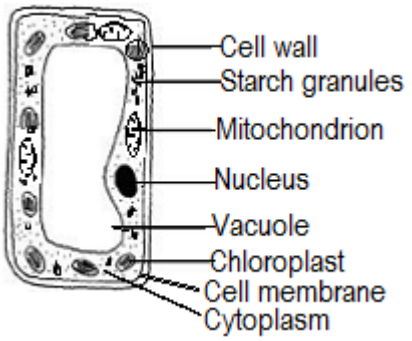
The origin of new cells

New cells are formed from already existing cells by a process called cell division. The already existing cell is called a parent/ mother cell; and the new cells formed are called daughter cells.

Animal cell



Plant cell



Cell parts and their functions

Cell part	Description	Function
1. Cell Membrane	Thin layer surrounding the protoplasm of cells. In animal cells it's the outer most and in plant cells it's beneath the outer layer called cell wall.	• It allows movement of materials in and out of the cell. • Offers protection to the inner parts of the cell. • Binds protoplasm/cytoplasm hence regulating the shape and strength of a cell.
2. Cell Walls	Outer most layer in plant cells. It is made up of a material called cellulose which gives the cell its rigid tough nature.	• It offers mechanical strength to the cell. • It gives the plant cell its shape. • Protects the inner parts of the cell. • Allows movement of materials in and out of a cell.
3. Nucleus	It is surrounded by double membrane called the nuclear membrane. The contents of the nucleus are called **nucleoplasm**.	• Controls cell activities. • Controls cell division. • Stores the genetic material of a cell.
4. Cell Vacuole	Contains a watery substance called cell sap and is surrounded by a single membrane called the ***tonoplast.*** Each Plant cell possesses one large permanent large central vacuole while each animal cell has many small temporary vacuoles.	• Stores waste materials before they are expelled. • It is a temporary food store. • Gives shape to the cell.
5. Cytoplasm	It is a fluid material that contains cell organelles e.g. mitochondria, nucleus etc.	• Site for cell activities i.e. metabolic reactions. • Site for storage of energy producing materials e.g. starch and glycogen.
6. Mitochondria	This is the cell 'power house'. It is found in both plant and animal cells.	• It manufactures and releases energy through respiration.
7. Chloroplast	Found only in plant cells.	• Contains a green pigment called chlorophyll that traps sunlight for photosynthesis.

Comparing a plant and animal cell

Similarities

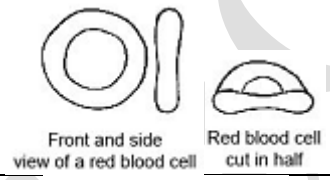
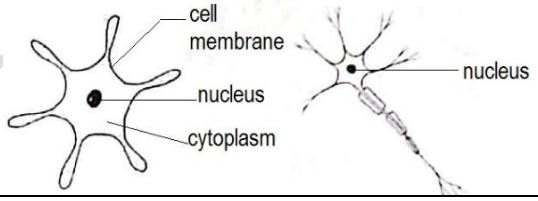
- Both have a nucleus.
- Both have mitochondria.
- Both have a vacuole.
- Both have a cytoplasm.
- Both have a cell membrane.

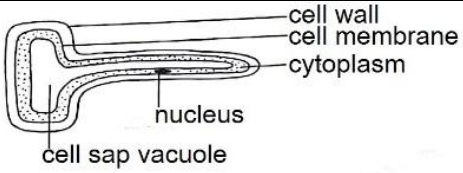
Differences:

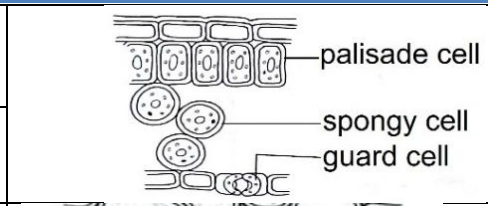
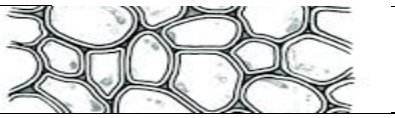
Plant cell	Animal cell
i) Regular in shape	Irregular in shape
ii) Has a cellulose cell wall.	Lacks a cellulose call wall.
iii) Has chloroplast.	Lacks chloroplast.
iv) Large vacuole centrally located.	Cell vacuole very small and positioned at the side.
v) Has a middle lamella.	Lacks a middle lamella.
vi) Nucleus is positioned at one side.	Nucleus centrally located.
vii) Store food as starch granules.	Store food as glycogen granules.
viii) Has a tonoplast around the vacuole	Has no tonoplast
ix) Has a Thin layer of cytoplasm	Has a thick layer of cytoplasm
x) Has a permanent vacuole	Has a temporary vacuole

SPECIALISED CELLS

These are individual cells modified to perform a particular function.

Specialized animal cell	Drawing	Function
Red blood cells		These transport oxygen in our bodies.
Sperm cells		These fuses with the ovum to form a zygote during fertilization
Ovum or egg cell		This is the female reproductive cell that fuses with a sperm to form a zygote.
White blood cells		This defends the body against infections and diseases
Nerve cells		They transmit impulses.

Specialized plant cell	Structure	Function
Root hair cells		They are found in plant roots They absorb water and mineral salts from the soil

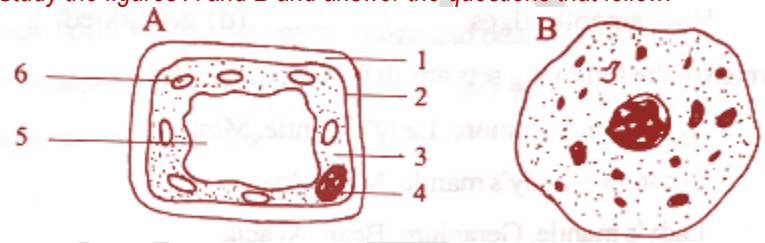
Palisade cells		These are found in leaves of green plants. They carry out the process of photosynthesis
Guard cells		They control the opening and closing of stomata in leaves
Parenchyma cells		Support in herbaceous plants Storage of starch.

Differences between plants and animals

Plants	Animals
Their cells have cell wall.	Their cells lack cell wall.
Have chlorophyll.	Lack chlorophyll.
They are generally stationary. However, they move parts of their body such as opening and closing of petals.	Animals move from one place to another.
They make their own food by photosynthesis.	Feed on already made food.
Respond to stimulus slowly.	Respond to stimulus very fast.

Revision questions

1. *Which of the following in **not true** about the cell wall? It is*
   - *A. Freely permeable*
   - *B. Non-living*
   - *C. Selectively permeable*
   - *D. Found in plants*
2. *Genetic material in a cell is located in the*
   - *A. Cytoplasm*
   - *B. Chromosome*
   - *C. Nucleus*
   - *D. Membrane*
3. *Study the figures A and B and answer the questions that follow:*



a) *What does A and B represent?* *(2 marks)*
b) *Name the parts labelled 1 – 6* *(3 marks)*
c) *State two functions of part labelled 5.* *(2 marks)*
d) *Part 6 contain a green pigment called: ……* *(1 mark)*
e) *The part which controls the activities of the whole cell is part …….* *(1 mark)*
f) *Part 5 contains a liquid made up of water and dissolved solutes. The liquid is called……(1 mark)*
g) ***A** has 3 parts which are absent from **B**, Name the 3 parts.* *(3 marks)*

4. *Differentiate between a cell and an organelle.*
5. *Define the following terms giving two examples in each case:*
   - *a) Tissue.*
   - *b) Organ.*
   - *c) Organ system.*
6. *Name the organelles that would be found in large numbers in the cells of a rapidly respiring tissue. Give a reason to support your answer.*
7. *Name two structures which are present in plant cells but absent in animal cells*

TOPIC 1: DIVERSITY OF LIVING ORGANISMS

CLASSIFICATION OF LIVING THINGS

Classification is the process of placing animals and plants into groups according to their similarities in structure, physiological processes and behavioral.
This involves collecting organisms, observing their structural characteristics and sorting them into groups known as ***taxa.***
The branch of biology concerned with classification is called ***taxonomy.***
The word taxonomy is derived from a Greek word *taxis*- meaning arrangement and *nomia*-meaning distribution.

Levels of classification

The level of classification is called taxon. *Plural* –taxa. A taxon is a unit of classification made of similar organisms. The largest taxon is the kingdom and the smallest taxon is the species. All organisms have been put in seven major taxa and these include:

1. Kingdom
2. Phylum (*plural*-phyla)
3. Class
4. Order
5. Family
6. Genus (*plural*-genera)
7. species

Easy formula for seven taxa from highest to lowest

Kids	**P**lay	**C**ards	**O**n	**F**airly	**G**ood	**S**ides
K	P	C	O	F	G	S
(Kingdom)	***(Phylum)***	***(Class)***	**(*Order*)**	***(Family)***	***(Genus)***	***(Species)***

Kingdom:
A kingdom is the largest taxon, and all the other taxa (groups of living organisms) are placed in one of the kingdoms. In modern classification system, there are 5 kingdoms:

1. Monera (bacteria)
2. Protoctista
3. Fungi (Mycota)
4. Plantae
5. Animalia

Note:
Viruses are not classified in any of the five kingdoms because they do not have all the characteristics of all living things. For example;

- ✓ They do not have cellular structures like cytoplasm and organelles.
- ✓ They use nuclear material and organelles of other living organisms to carry out their metabolic processes.
- ✓ They can survive out of their host's cell as inert organic crystals.

Species:
A species is the smallest taxon which is made up of individuals that have almost the same characteristic features and can interbreed freely to produce viable off springs i.e. reproductively fertile off springs

Examples of hierarchy system of classification

	Human	**Honeybee**	**Maize**	**Meadow mushroom**
Kingdom	Animalia	Animalia	Plantae	Fungi
Phylum	Chordata	Arthropoda	Angiospermophyta	Basidiomycota
Class	Mammalia	Insect	Monocotyledoneae	Basidiomcetes
Order	primates	Hymenoptera	Commelinales	Agaricales
Family	Hominidae	Apidae	Poaceae	Agaricaceae
Genus	*Homo*	*Apis*	*Zea*	*Agaricus*
Species	*sapiens*	*mellifera*	*mays*	*campestris*

Binomial system of nomenclature

Binomial nomenclature is the system of giving a scientific name to an organism.
The word binomial comes from two words *bi*- meaning *two* and *nomio*-meaning *name*.
The first accepted classification and nomenclature was introduced by a Swedish scientist, **Carl Linnaeus (1707-1778).**

Rules of binomial system of nomenclature

1. Each organism should be given two Latin or Greek names which include generic (genus) name followed by specific (species) name.
2. The generic name should start with a capital letter and a specific name starts with the small letter.
3. When written both names should be **underlined** **separately** or ***printed in italics.***

Examples of some scientific name for common organisms.

Human – scientific name is *Homo sapiens* (Homo sapiens – when hand written)
Maize – scientific name is *Zea mays*

Importance of classification

- ✓ It is easy to study organism in a group since the members of a specific group resemble.
- ✓ It helps new organisms to be easily classified since they share certain characteristics with those in existence.
- ✓ It helps the scientist to easily identify organisms belonging to the same group.
- ✓ The use of scientific names enables to prevent confusion that would arise if the organism had different names used in different places.

Exercise

1. *What is a species?*
2. *Explain the following terms:*
   a) *Classification*
   b) *Taxonomy*
   c) *Binomial nomenclature*
3. *Explain the relationship between genus and species.*
4. *Name the major taxonomic units used in classifying living organisms.*
5. *Why is it important for organism to be given scientific names?*
6. *Write the scientific names of the following; honey bee, meadow mushroom and house fly.*
7. *Blackjack (Bidens pilosa) belongs to the family compositae. What is its*
   a) *Genus?* b) *Species?*
8. *Who is Carl Linnaeus (1707-1778)?*

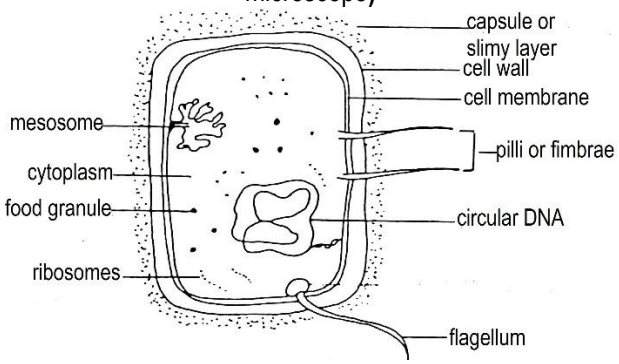
KINGDOM MONERA

This basically comprises of bacteria which are prokaryotes. They lack membrane bound organelles.

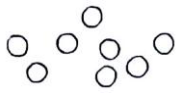
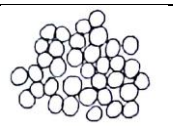
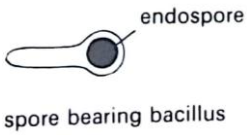
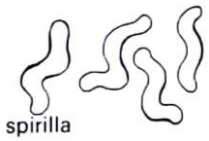
General characteristics

- ✓ They are microscopic, unicellular and small organisms with cells occurring either alone or in colonies.
- ✓ They have autotrophic, saprophytic and parasitic mode of life.
- ✓ They reproduce asexually by means of spores or binary fission.

General structure of bacterium (under electron microscope**)**



Bacteria are grouped according to their shapes. There are four groups of bacteria

Shape	Type	Structure
Spherical	**Cocci:** These are spherical bacteria. **Diplococci:** These occur as a pair of spherical bacteria.	
	Staphylococcus: Spherical shaped occurring in a bunch or group.	
	Streptococcus: Spherical bacteria in a chain.	
Rod shaped	**Bacilli:** Single rod shaped bacterium.	
	Spherical spore bacilli: These have spherical spore at the head e.g. *clostridium tetani* which causes tetanus.	
Curved	**Spirilla:** These are spiral shaped bacteria.	

Economic importance of bacteria

i) Saprophytic bacteria decay organic material and release nutrients for use by green plants.
ii) Rhizobium converts the nitrogen into nitrates in the soils.
iii) Bacteria manufacture vitamin B_{12} and K.
iv) Bacteria destroys harmful organisms in sewage during sewage treatment.
v) Used in industrial processing of food like vinegar, cheese and yoghurt.
vi) Symbiotic bacteria in ruminants help in digesting cellulose by secreting cellulase enzyme.
vii) Bacteria cause decay and food spoilage.
viii) Denitrifying bacteria converts nitrates into free nitrogen in the soil.
ix) Parasitic forms cause diseases to both plants and animals like anthrax in man.

KINGDOM PROTOCTISTA

Kingdom Protoctista is made up of two sub-kingdoms namely ***protozoa*** and ***algae***. Protoctists show various life styles, some resemble the plants, some animals and some fungi. Those that make their own food like plants are the algae, those that do not make their own food are the protozoans.

Characteristics of Protoctists

They have a nucleus surrounded by a membrane
Cytoplasm has membrane bound organelles like mitochondria.
Some may have flagella or cilia for locomotion.

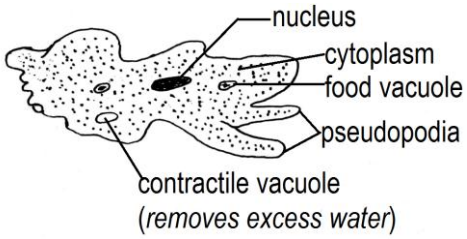
Sub kingdom Protozoa

Protozoans are unicellular organisms. I.e. single celled organisms.
Examples of protozoans include ***Amoeba, Paramecium, Euglena, Trypanosome and plasmodium***.

1. Amoeba

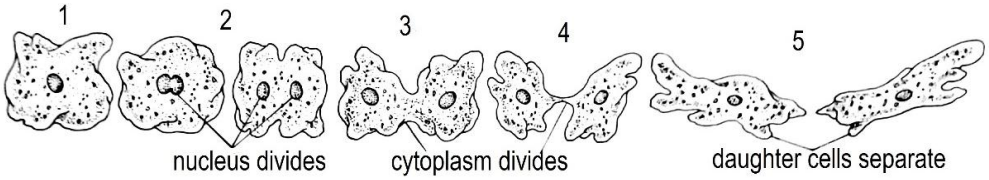
Amoeba is a free-living protozoa found at the bottom of ponds. It has temporary extensions called *pseudopodia used for locomotion*. The pseudopodia are also used for enclosing food particles which form food vacuoles.

The excess amount of water can be regulated and removed by **contractile vacuole.**



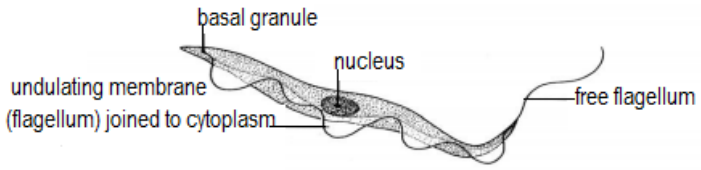
Reproduction in amoeba

- Amoeba reproduces by ***binary fission.***
- An amoeba ready to reproduce stops moving and rounds off.
- The nucleus then constricts and divides into two identical parts.
- The cytoplasm begins to constrict so that the separation of the remaining parts into 2 can occur.
- Two identical amoebae forms and move apart to feed and grow into mature amoebae before they divide again.



2. Trypanasoma.

These use the flagella for locomotion. Trypanosomes cause disease sleeping sickness in humans and Nagana in cattle. It is transmitted by the Tse tse flies.

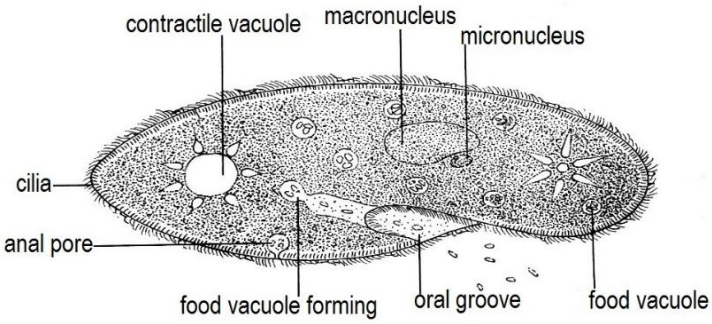


3. Plasmodia: Plasmodium causes malaria in humans.

4. Paramecium:

Paramecium is covered by rows of short, flexible hairs called cilia. Cilia are for movement and for capturing of food. It has two nuclei; a macro nucleus and micro nucleus. The macronucleus controls basic processes and the micronucleus controls reproduction.

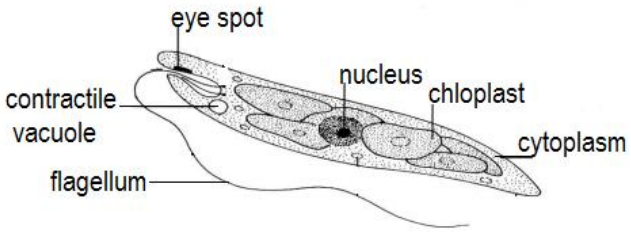
The paramecium



5. Euglena:

Euglena is commonly found in water and in soil. It is photosynthetic and moves by means of flagellum.

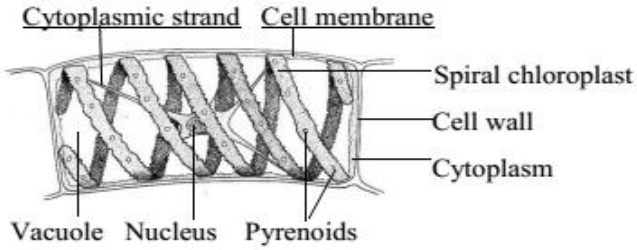
Euglena



Sub kingdom Algae

This is a collective name for a varied group of phyla. They are normally aquatic or live in damp terrestrial habitats. The most common phylum is Chlorophyta (green algae); which comprises of unicellular algae and **filamentous algae (spirogyra**). It's found in fresh water of slow flowing water in ponds, streams, and lakes.

One cell of spirogyra



Characteristics of spirogyra

- ✓ It is unbranched and filamentous.
- ✓ They have a green pigment called chlorophyll.
- ✓ Each cell has 1 to 7 spiral chloroplast from one end to another.
- ✓ The chloroplasts are ribbon-shaped, with wavy edges.
- ✓ Small protein bodies called pyrenoids are present on each ribbon like chloroplast and are used to store starch.
- ✓ The nucleus is in the center to control the activities of the cell.

Role of algae in the environment

- ✓ Algae are used in the manufacture of agar which is used in laboratory experiments.
- ✓ They provide food for humans and fish.
- ✓ When they die, they sink at the bottom of the sea bed on which they can turn into oil.
- ✓ During photosynthesis, they release oxygen that is necessary for the respiration of animals that live in water.
- ✓ They pollute water, i.e. producing foul smell.
- ✓ They clog water pipes hindering the flow of water.

Revision questions

1. *Which of the following combinations of words about amoeba are related*
   - *A. Pseudopodia, reproduction*
   - *B. Nucleus, movement*
   - *C. Contractile vacuole, water*
   - *D. Ectoplasm, digestion.*
2. *The smallest cellular animals belong to the*
   - *A. Protozoa*
   - *B. Viruses*
   - *C. Bacteria*
   - *D. Algae*
3. *Which of the following protozoa has cilia?*
   - *A. Amoeba*
   - *B. Paramecium*
   - *C. Euglena*
   - *D. Plasmodium*
4. *A euglena can be considered an animal or plant. State the characteristics that makes it;*
   i. *An animal* *ii) A plant*

KINGDOM FUNGI

Kingdom fungi mostly have multicellular organisms such as mushrooms, puff balls, rusts, mould, toad stools, smuts, penicillium, mucor (grows on soil and dead plants) and rhizopus (common bread mould). Some are unicellular like yeast. The study of fungi is called **mycology.**

General characteristics of Fungi

- Their vegetative body called mycelium is composed of thread-like hyphae.
- The hyphae may be divided by cross walls (septa) into short, multinucleate sections.
- The fungi lack chlorophyll and their nutrition is non-photosynthetic.
- Some feed as parasites, others are mutualistic, but most are saprotrophic (secreting enzymes on to the food and absorbing the products of external digestion).
- They reproduce by means of spores.

Kingdom fungi comprises of the following phyla:

1. Phylum Zygomycota (Zygomycetes):

This comprises of the saprophytic fungi in soils and dung, and in decaying foods.

The mycelium is composed of hyphae without cross walls. Examples of the Zygomycetes are mucor, rhizopus and **mould**. Rhizopus is saprophytic fungus which grows on decaying food like bread and fruits.

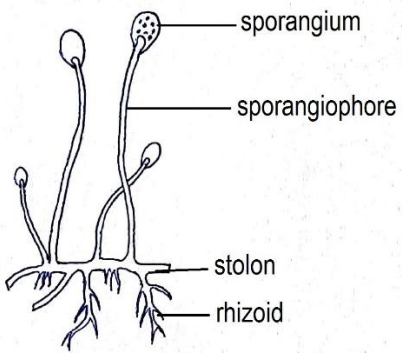
2. Phylum Basiodiomycota (Basiodiomycetes):

They are composed of septate hyphae (divided by cross walls). Examples of Basiodiomycetes are the **mushrooms**, toad stools, puff balls, rusts and smuts.

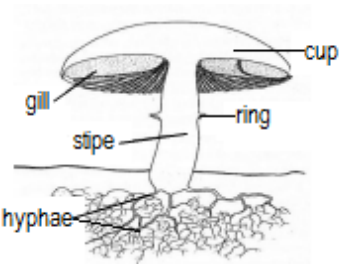
3. Phylum Ascomycota (Ascomycetes):

This consists of yeast. Yeast is mainly found on the surface of plants and animals, on animal mucous membranes and in soil and dung. Yeast feed on sugars, and they produce ethanol as a waste product. The ethanol formed is toxic to living cells, including the yeast cells themselves.

Drawing of common bread mould (Rhizopus)



Drawing of a mushroom



Role/importance of fungi in the environment

- ✓ Fungi decay dead organic materials to release materials needed by green plants.
- ✓ Yeast is used in the production of alcohol from sugar canes, grapes and barley for brewers and wine makers.
- ✓ Fungi are important in bakeries during making of foods like bread, yeasts change sugar and starch to alcohol and carbon dioxide gas. The gas makes dough rise.
- ✓ Fungi produce antibiotics e.g. penicillin made from penicillium mould.
- ✓ Fungi provide food e.g. mushroom also used in making cheese.
- ✓ Fungi can spoil food e.g. Rhizopus and penicillium on the bread, cakes, fruits and jam.
- ✓ Fungi causes plant disease e.g. rust, brown patch, white bright, smut, etc.
- ✓ Fungi causes diseases to man e.g. ringworm, athlete's foot.

KINGDOM PLANTAE

This kingdom contains multicellular organisms whose cells contain chlorophyll and are covered by a cellulose cell wall.

General characteristics

- ✓ They are mostly green in colour thus carry out photosynthesis
- ✓ They are multicellular.
- ✓ Their cells are surrounded by cellulose cell wall.

The kingdom is divided into two main divisions i.e. Bryophyta and Tracheophyta

DIVISION: BRYOPHYTA

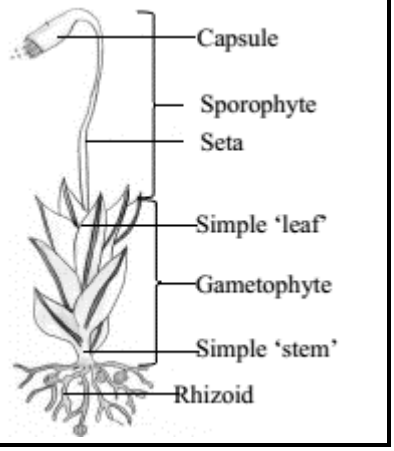
The division is comprised of liverworts and mosses.

Main characteristics

- ✓ They have simple leaves
- ✓ They have rhizoids that are root-like structures. They are used mainly for anchorage.
- ✓ Plants lack vascular bundles thus depend on diffusion for movement of materials.
- ✓ They are found in sheltered and moist areas.
- ✓ Their life cycle consists of the two generations which alternate; a gametophyte and sporophyte generations.

Examples are mosses and liverworts which belong to 2 classes; Musci and hepaticae respectively.

External structure of a moss



DIVISION: TRACHEOPHYTA

These also show alternation of generations. The sporophytes differentiate into roots, stems and leaves with lignified vascular tissues that are used for transportation of water and food. *This division is divided into 2 sub-divisions;* ***Pteridophyta*** *and* ***Spermatophyta.***

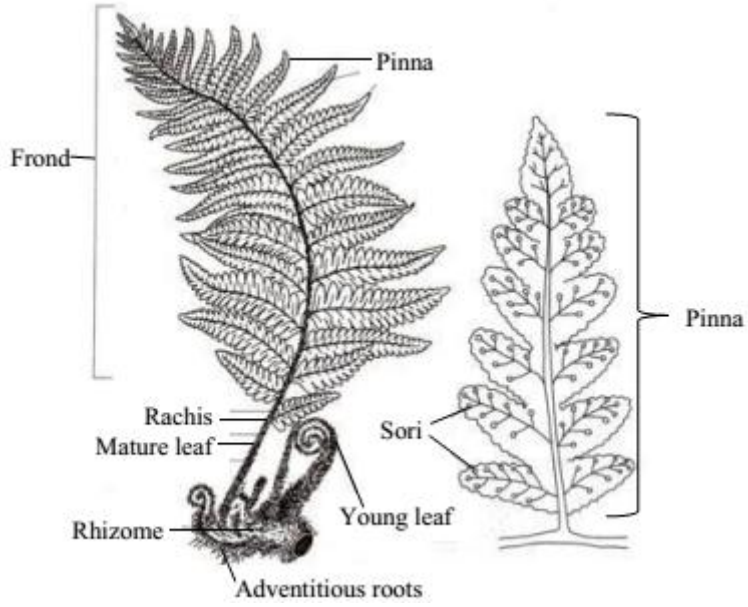
Pteridophyta

This is made up of ***ferns***. Ferns are commonly found in shaded places which are damp with cool temperature. Some ferns grow on trees as epiphytes.

Main characteristics

- ✓ Their plant body is called ***prothallus.***
- ✓ The body of a sporophyte fern is divided into leaves, stem and roots.
- ✓ The leaves are called ***fronds*** while the stems are rhizomes.
- ✓ The spore forming structures are called sporophyte which occur on the underneath of a frond in clusters called ***sori.***
- ✓ The sporophyte is the dominant generation while gametophyte generation is short lived.
- ✓ The rhizomes grow horizontally below the soil surface.
- ✓ Ferns have well-developed conducting tissues i.e. vascular bundles.
- ✓ They have the adventitious roots which anchor the plants into the soil and absorb materials.

Drawing of the external structure of a fern plant



Spermatophyta

The Spermatophyta comprises of well-developed plants which are adapted to a variety of habitats. The habitats include terrestrial and aquatic. The seed are either contained inside the ovary wall or exposed.

General characteristics

- ✓ The body is divided into leaves, stem and root system
- ✓ Plants have complex and well developed vascular tissues.
- ✓ The supporting tissues like xylem, sclerenchyma and collenchyma, are found in leaves, stem and roots. Turgid parenchyma cells also provide support.

The sub-division Spermatophyta is subdivided into two classes i.e. Gymnosperms and Angiosperms.

Gymnosperms (cone bearing plants)

These are commonly found in high altitude areas.

Examples include pines, cypress, cedar tree, cycads, etc.

Gymnosperms refers to plants that do not bear flowers.

Main characteristics

- ✓ They are non-flowering plants.
- ✓ Their seeds are found in the cone scales.
- ✓ Have needle-like leaves which reduce the rate of transpiration.

Angiosperms (flowering plants)

These are flowering plants where seeds are enclosed in the ovary of the fruits.

General characteristics

- ✓ They bear flowers
- ✓ Their seeds are enclosed in the ovary from where the fruits develop
- ✓ The reproductive organs are found within the flower

This class is divided into two sub-classes;

i) Monocotyledons:

These are mainly grass family. Examples include wheat, rice, barley, star grass, sorghum, maize, millet, sugarcane

Distinguishing characteristics of Monocots

- ✓ Seeds have one cotyledon
- ✓ Have fibrous root system
- ✓ Have parallel veins in their leaves
- ✓ Vascular bundles are scattered in the stem cross section
- ✓ Flowers are held on an inflorescence

ii) Dicotyledons:

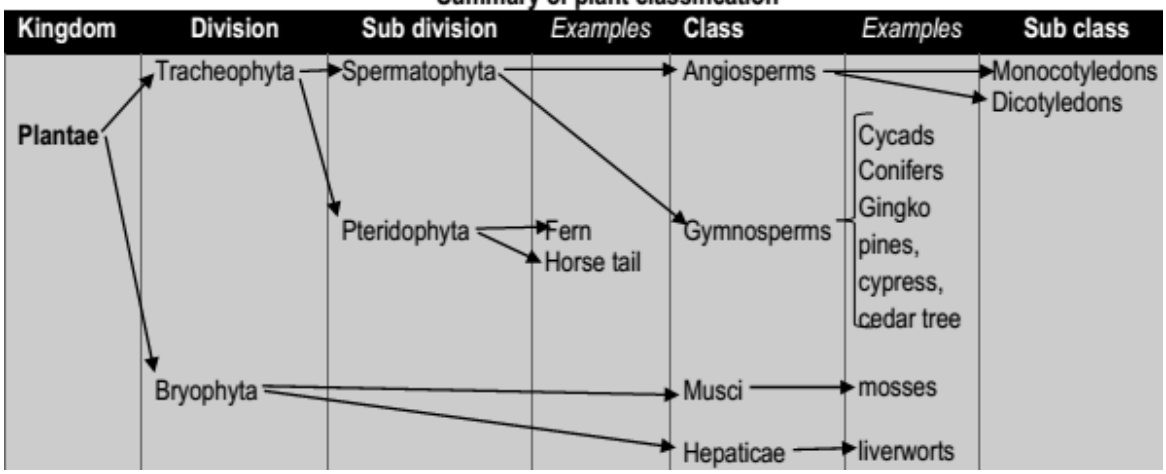
These include herbs, shrubs and trees.

Examples include beans, jacaranda, hibiscus, etc.

Distinguishing characteristics of Dicots

- ✓ Have seeds with two cotyledons
- ✓ They have tap root system.
- ✓ Have network (reticulate) venation.
- ✓ Leaves are generally broad and short.

Summary of plant classification



KINGDOM ANIMALIA

Kingdom Animalia has several phyla each of which consists of a variety of organisms. The phyla include:

Phylum	Examples
1. Porifera	sponges
2. Coelenterata	hydra
3. Platyhelminthes	'Flat' worms e.g. tapeworm
4. Nematoda	'Round' worms e.g. *Askaris lumbricoides*
5. Annelida	'Ringed' worms e.g. earth worms
6. Mollusca	snails
7. Echinodermata	star fish
8. Arthropoda	cockroach
9. Chordata	man

1. Phylum: Porifera – the sponges

The phylum is made of many types of ***sponges***

Sponge

characteristics

- Possess simple bodies which are hollow and sac-like.
- They are marine dwellers
- They have only one opening in their bodies.

2. Phylum: Coelenterata (Cnidarians)

They include the following; the ***jelly fish, sea anemones, hydra and corals***.

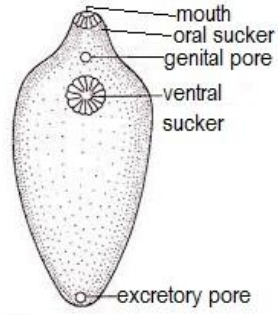
Jelly fish

characteristics

- They are aquatic or marine organisms.
- They have soft bodies which are sac-like with body cavity called enteron.

3. Phylum Platyhelminthes ('flat' worms): The phylum consists of ***flukes*** and ***tape worms***.

Liver fluke



Characteristics:

- They have dorso-ventrally flattened body
- They have bilateral body symmetry.

The phylum has 3 main classes;

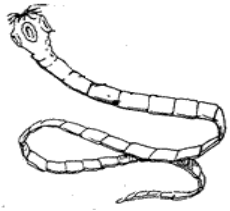
i) Turbellaria e.g. Planarians

- They are free living flat worms that live in wet soils, fresh water and seas.
- They have many simple eyes and cilia on the under surface of the body used for movement over stones and weeds.

ii) Trematoda e.g. Liver fluke

- They live as endo parasites in cattle and man.
- They have suckers for attachment on to the host.
- They suck digested food from the host.

Tapeworm



iii) Cestoda e.g Tape worm

- They live as endo-parasites in the gut of man, muscles of goats, cows and pigs.
- They have suckers and hooks for feeding and attachment on to the host.
- They have elongated bodies consisting of segments called proglotids.
- They absorb digested food directly from the host.

4. Phylum: Nematoda (round worms)

The phylum has the examples like **hookworms, pin worms, guinea worms, whip worms** and ***ascaris lumbricoides***.

characteristics

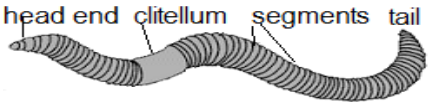
- They have unsegmented bodies.
- They have elongated and cylindrical bodies pointed at both ends.
- Some are parasitic and others are free living.

Askaris lumbricoides

5. Phylum: Annelida (ringed worm)

These are the ringed or segmented worms e.g. earthworms, leeches, rag worms, lugworms, etc.

The earthworm



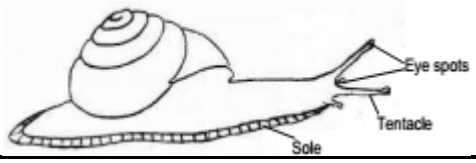
characteristics

- The body wall has three body layers of cells (triploblastic) i.e. ectoderm (outer), mesoderm (middle) and endoderm (inner).
- They are hermaphrodites and reproduce sexually but they often promote cross fertilization.
- They have bodies divided into sections called septae.
- Externally the body shows ring- like segments.

6. Phylum: Mollusca

Examples include snails, slugs, octopus, squids, mussels and oysters.

Garden snail



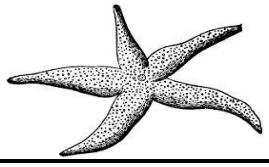
Characteristics

- They have soft bodies.
- Nearly all have shells with exception of octopus and squids.

7. Phylum: Echinodermata

These are marine organisms. Examples are bristles star, sea urchin, sea lilies, sea star, star fish, sea cucumber.

Star fish



Characteristics

- The body has three layers (triploblastic) i.e. ectoderm (outer), mesoderm (middle) and endoderm (inner).
- They have feet for locomotion and capturing food (feeding).
- They have spiny skin which is a hard plate.

8. Phylum: Arthropoda

Arthropoda has a wide variety of animals.

Characteristics:

- They have a segmented body.
- They have jointed limbs and appendages.
- They have an exoskeleton.

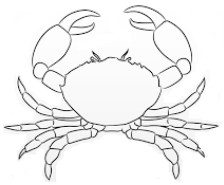
The exoskeleton is made up of chitin which is fairly hard but flexible. ***The exoskeleton has the following functions:***

- It provides support to terrestrial arthropods.
- It provides points of attachment for the muscles.
- It prevents the body from drying by secreting wax.
- It protects the organism from mechanical injury.

Phylum Arthropoda comprises of classes **Crustacea, Chilopoda, Diplopoda, Insecta and Arachnida.**

1. Class: Crustacea

Examples of Crustaceans include crabs, crayfish, lobsters, prawns, woodlice and shrimps.



Distinguishing characteristics

- ✓ Their body is covered by a carapace. A carapace is a hard shell.
- ✓ Their body is divided into two parts. Their head and thorax are fused to form a ***cephalothorax***. The second division is the abdomen.
- ✓ They have a pair of compound eyes each on a raised stalk.

2. Class: Chilopoda

Chilopoda is made up of *centipedes*.

Characteristics

- ✓ They have a clearly defined head, the rest of the segments are similar.
- ✓ They have dorso-ventrally flattened body.
- ✓ They have a pair of long antennae.
- ✓ They have biting mouth parts known as mandibles.
- ✓ They have one pair of legs on each body segment.
- ✓ They are carnivorous.

3. Class: Diplopoda

Class Diplopoda is made up of *millipedes*.

Characteristics

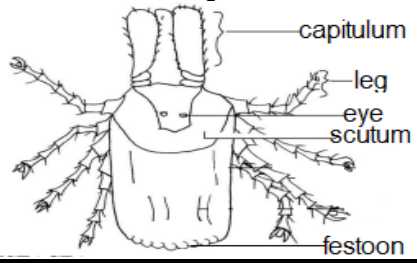
- ✓ They have a clearly defined head, the other segments are similar.
- ✓ They have a cylindrical body.
- ✓ They have one pair of antennae.
- ✓ They have biting mouth parts known as the mandibles.
- ✓ They have two pairs of legs on each body segment.
- ✓ They are herbivorous.

Millipedes are common in damp places.

4. Class: Arachnida

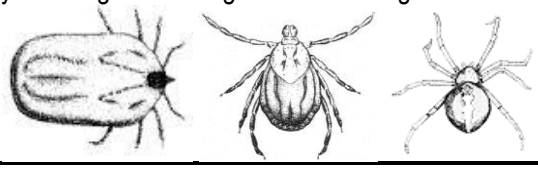
Arachnids are terrestrial arthropods. Examples of arachnids include spiders, ticks, scorpions and mites.

A drawing of a tick



Distinguishing characteristics of arachnids

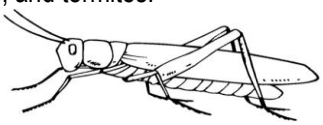
- ✓ They have **two main** body parts. The head and thorax are fused to form the cephalothorax and the second part is the abdomen.
- ✓ They have simple eyes.
- ✓ They **have four pairs (8 legs)** of walking legs.
- ✓ They use lung books for gaseous exchange.



5. Class: Insecta

Insects are the largest group of arthropods.

They occupy every habitat on earth in such places as air, soil and water. However, they mainly inhabit terrestrial habitats. Examples of insects include grasshoppers, houseflies, butterflies, bees, and termites.



Distinguishing characteristics of insects

i) Insects have three main body parts, namely: the head, thorax, and abdomen.

ii) They have three pairs of walking legs on the thorax. One pair of walking legs per segment of the thorax.

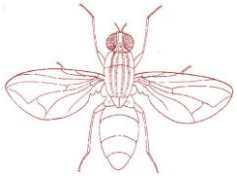
iii) They have three segments of the thorax i.e. prothorax, mesothorax and metathorax.

Some common orders of insects

Order	Characteristic features of the order (*The word ptera means wing*).	Examples
Dictyoptera	Have hard outer wings and soft membranous inner wings.	Cockroach and praying mantis.
Hymenoptera	Have two pairs of membranous wings.	Wasps, bees and ants.
Coleoptera	Outer wings hardened to form horny covers covering the inner membranous wings.	Beetles and weevils.
Isoptera	Equal length of the two pairs of wings (swarming adult termite).	Termites
Lepidoptera	Have membranous wings covered with scales. Have sucking mouth parts.	Moths and butterflies
Diptera	They have a single pair of wings. In houseflies, second pair is reduced into halteres for balancing.	Mosquitoes and houseflies
Orthoptera	Have leathery straight fore wings and membranous hind wings.	Grasshopper, locusts and crickets

Revision questions

*An S.1 student was provided with the following specimens labelled **P, Q, R, S, T, U.** Use them to answer the questions that follow.*

P 	***Q*** 	***R*** 
S 	***T*** 	***U*** 

1. *To which phylum do the above specimens belong?* *(1 mark)*
2. *Give three main characteristics of organisms under the phylum you have mentioned above.* *(3 marks)*
3. *Which organisms **P, Q, R, S, T** and **U** shown above belong to class Insecta?* *(1 mark)*
4. *Give three reasons for the above grouping into class Insecta.* *(3 marks)*
5. *State the orders to which the specimens P, S and U belong.* *(3 marks)*
6. *i) Other than class Insecta, which other class is represented in the specimens shown above?* *(1 mark)*
   ii) Mention one characteristic feature typical of organisms under the above mentioned class in 6) (i). (1 mark)
7. *The above organisms are all small sized. State one advantage of the above statement.* *(1 mark)*

9. Phylum: Chordata

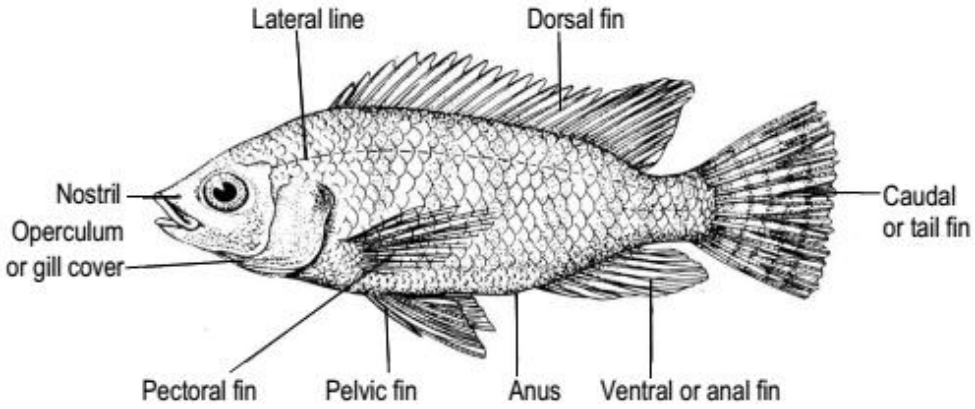
Chordate refers to animals which possess a notochord.

Main characteristics

- ✓ The presence of a notochord during the early stages of development.
- ✓ They have bilateral symmetry.
- ✓ The body is composed of head, trunk and usually a tail at some stage of development.
- ✓ Possess a hollow dorsal nerve cord.

This phylum mainly consists of the vertebrates and they are divided into 5 classes. The 5 classes include the following;

1) Pisces (fishes) e.g. tilapia and the Nile perch



Characteristics

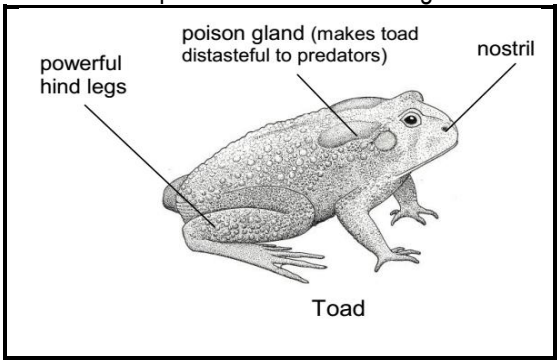
- ✓ They have a streamlined body.
- ✓ They have scales on their skin.
- ✓ They breathe using gills.
- ✓ They have fins for swimming.
- ✓ Their eggs are fertilized outside the body (external fertilization).

Revision questions

1. *Outline functions of each labelled part on a tilapia fish above.*
2. *How is the fish adapted to its mode of life?*

2) Amphibia, e.g. newt, salamander, toad and frog.

The word amphibian comes from two greek words: amphi- (both) and bios (life).

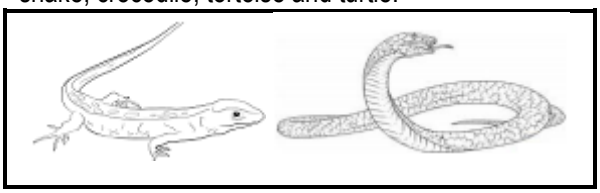


Characteristics

- They spend part of their life (as larvae or tadpoles) in water, and part of their life as adults on land.
- They live on land but require water for breeding.
- Amphibians have a soft moist skin without scales.
- They have visceral clefts at the larval stages which are used as gills for gaseous exchange. Adult amphibians use lungs and the skin surface for gaseous exchange.
- Amphibians have middle and an inner ear but no external ear. However, they have a tympanic membrane also called the ear drum.

3) Reptilia

Reptiles are mainly terrestrial with the exception of the turtle which lives in water. Examples of reptiles include the lizard, snake, crocodile, tortoise and turtle.

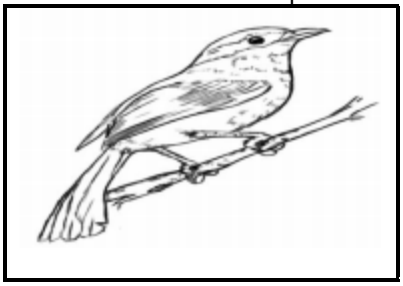


Characteristics

- Reptiles have dry skin with horny scales.
- Some reptiles have a three-chambered heart; two auricles and one ventricle. Others have four chambered heart for example crocodile.

4) Aves - birds

Aves refer to birds. Examples of birds include eagle, ducks, flamingo, heron, dove, etc.

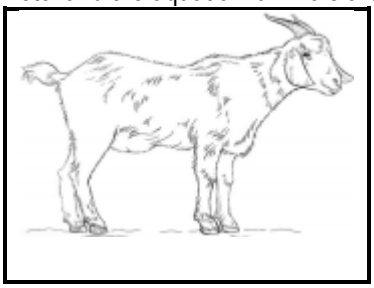


Characteristics

- ✓ The skin is covered in feathers, except the legs which are covered by horny scales. The feathers keep the bird warm and also used for flight.
- ✓ The skeleton is made of hollow bones. The hollow and light bones reduce weight and enable flight.
- ✓ They have two pairs of pentadactyl limbs. The fore limbs modified into wings for flight while the hind are feet for walking or swimming.
- ✓ They lay eggs in calcareous shells.

5) Mammalia

Mammals comprise a wide variety of animals. Examples of terrestrial mammals are cows, pigs, goats, monkeys, rats, lions etc. and the aquatic mammals are seals, dolphins and whales.



Characteristics

- ✓ The skins of mammals are covered by hair or fur.
- ✓ The skin has sweat glands called sebaceous glands.
- ✓ They have an endoskeleton made up of bones.
- ✓ They have four types of teeth for feeding.
- ✓ They have muscular diaphragm which separates the thoracic organs from the abdominal organs.
- ✓ They have mammary glands.

EXTERNAL FEATURES, LIFE CYCLES AND ECONOMIC IMPORTANCE OF SELECTED INSECTS

A branch of biology that deals with the study of insects is known as entomology. Insects exhibit the longest level of organization in animals, i.e. social organization especially in bees, wasps and ants. They are the only invertebrates which can fly. They are the most successful arthropods on land.

Their success on land is attributed to:

i) Evolution of special organs for flight. The wings which enable them to diverse and colonize new areas.
ii) Impervious exoskeleton made of chitin which has protected them from drying up in the terrestrial environment.
iii) The small size has enabled them to tackle every place.
iv) Excretion of toxic products as uric acid has enabled them to conserve water
v) Tracheal system has enabled them to carry efficient gaseous exchange.
vi) Disposition of legs enables them to maintain swift locomotion.
vii) The compound eyes that provide wide field of view for food and enemies.
viii) The modified mouth parts that suit a variety of food materials.
ix) The high reproductive rate that ensures enormous number of offsprings is produced.

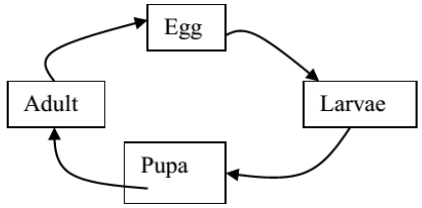
Some insects are directly beneficial to man these include pollinators like butterfly, moth and bees others are beneficial indirectly such as parasitic pest species.
Harmful insects include those that directly live on man as parasite like lice, flies, mosquitoes, tsetse flies.
Insects have an exoskeleton which is rigid and prevents expansion of the insect during growth. Before the insect grows, it sheds the exoskeleton in a process called moulting (ecdysis).
Without the exoskeleton, the insect then expands and grows. A new exoskeleton then forms and growth stops until another moulting. Successive moults result into formation of a new form of the insect. This is called ***metamorphosis***.

Insect metamorphosis

Metamorphosis is the gradual developmental change from the eggs to the adult stage. It occurs in insects and amphibians. Insect metamorphosis is divided into two types.

Complete metamorphosis (**holometabolous**)

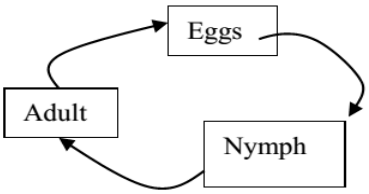
This is a gradual development change where the eggs hatch into larvae and the larvae change into pupa and finally the pupa change into an adult. It involves four stages.



Insects, which undergo complete metamorphosis, include butterflies, mosquitoes, houseflies, tsetse flies, bees, wasps, and beetles.

Incomplete metamorphosis (hemimetabolous)

This is the gradual developmental change where an insect undergoes only 3 stages, when eggs hatch, they give rise to adult-like nymphs which latter change into adults. Insects showing this include locusts, grasshoppers, bedbugs, cockroaches, and termites.



COCKROACH (Periplaneta americana)

Classification

Taxon		Reason
Kingdom	Animalia	1. They have a mouth.
Phylum	Arthropoda	1. It has a hard exoskeleton. 2. It has segmented body. 3. It has jointed legs.
Class	Insecta	1. It has three pairs of jointed legs. 2. It has three main body parts i.e. head, thorax and abdomen. 3. It has thorax divided into three segments.
Order	Dictyoptera	1. It has a pair of hard fore (outer) wings.

NB: Other insects belonging to the order Dictyoptera include; weevils, beetles, ladybirds.

Habitat:

Cockroaches live in dark, dirty and dump warm places e.g. pipes that carry sewage. During day they live in crevices of walls, cupboards, underneath drawers and in boxes.

They are active at night thus referred to as nocturnal.

External features of a cockroach

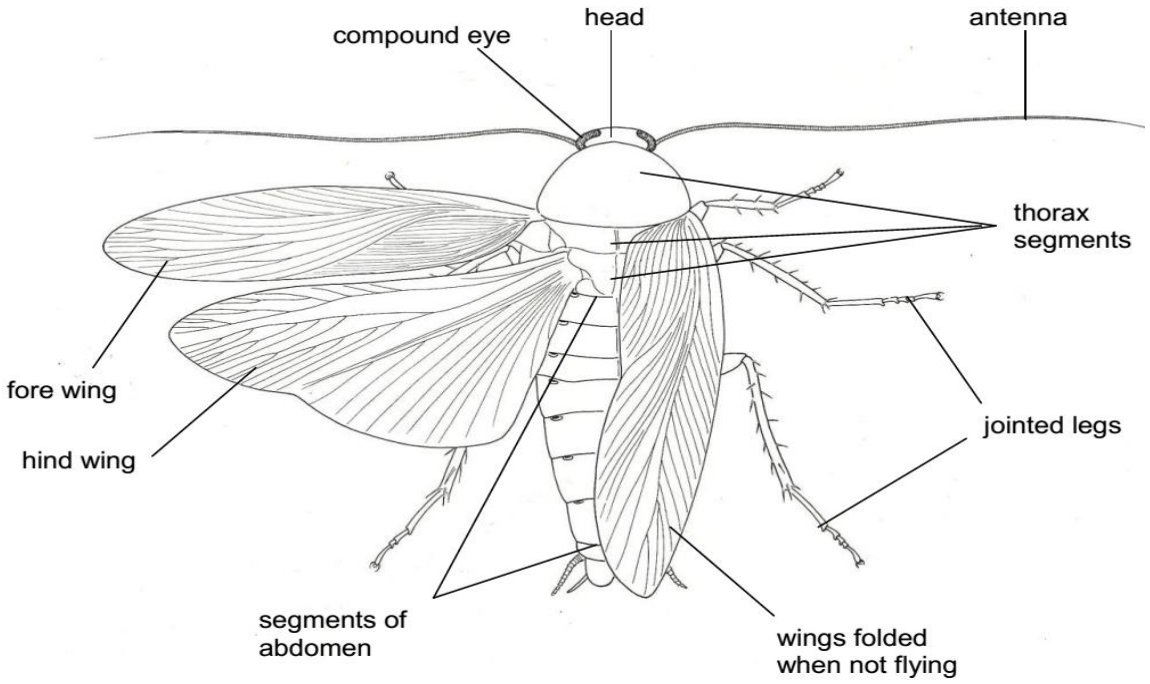
It has a dorsal- ventrally flattened body.

It is brown in colour.

It has a hard thick exoskeleton made of chitin.

The body is made up of ***three main divisions***, each segment of thorax and abdomen consists of dorsal plate tegmen (plu:-terga) a ventral plate, sternum (plu-sterna) and two internal plates, pleura.

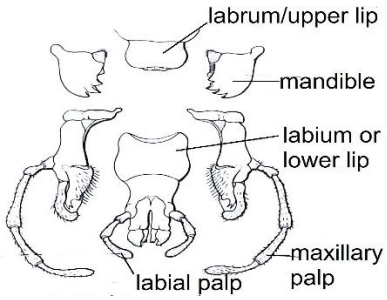
A drawing of the dorsal view of the cockroach with the left wings spread



The head

- The head is small and pear-shaped.
- It bears a large kidney-shaped pair of compound eyes.
- In front of each compound eye lies a long thread- like segmented antennae (feelers). These are sensitive to touch, smell and vibrations.
- The head has biting and chewing mouth parts–mandibles for cutting and crushing food, maxillary palps for holding food, a labrum (upper lip) and labium (lower lip).
- The head is connected to the thorax by short neck.

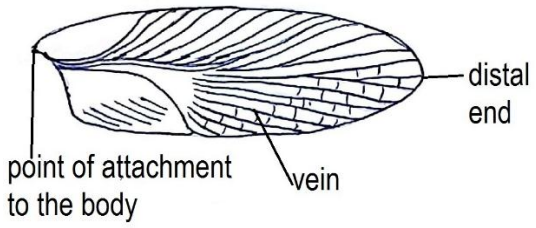
Mouth parts of a cockroach



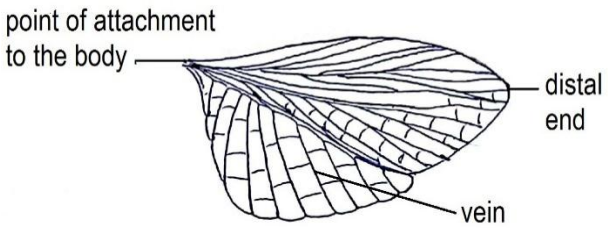
The thorax

- The thorax consists of three segments: the prothorax, the mesothorax and the metathorax.
- Each of the segments bears a pair of jointed legs on its ventral surface.
- The legs have sharp spines for defense.
- Each leg end in a pair of ***sharp claws for walking on rough surfaces*** with a ***soft glandular pad/arolium between claws for walking on smooth surfaces.***
- The prothorax is the largest of the thoracic segment
- The paired wings are attached to dorsal surface of mesothorax and metathorax.
- The anterior (fore) wings are narrow, brown, and leathery and are called elytra or tegmina. They are not used for flight but for covering and protection of broad, membranous inner/hind wings when at rest.

Drawing of the fore wing



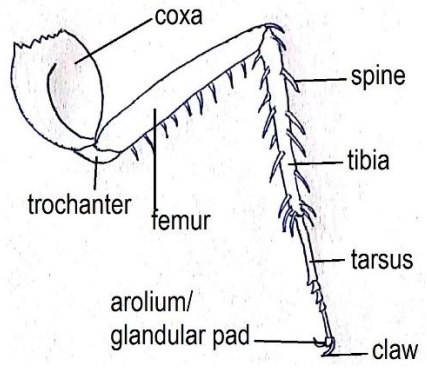
Drawing of the hind wing



Revision questions

1. *State similarities and differences between the fore wing and hind wing.*
2. *How is the leg of a cockroach adapted to its function?*

Drawing of the hind leg



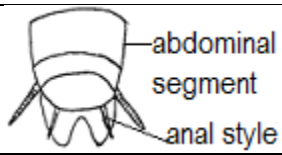
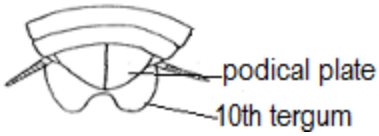
The abdomen

This is made up of 10 segments. Only seven are easily seen because tergum of seventh segment covers the 8th and 9th segment.
The flat broad tergum of the 10th segment bears a pair of jointed sensory structures the cerci. Males have another additional pair of short structures, the styles.

Identification of a cockroach's sex

In males, there is a pair of slender ***styles*** that are used to hold and manipulate the female during copulation.
In females, there is a pair of boat shaped structures called the ***podical plates*** used for holding eggs.

Differences between a male and female cockroach:

Male	Female
Has a narrow abdomen	Has a broader abdomen
Lack ootheca	Has ootheca which develops after fertilization.
Has rod-shaped structures called styles on the 9th abdominal segments.	No styles on the 9th abdominal segment.
No podical plates.	Has podical plate for carrying eggs.
	

Adaptation of a cockroach to its environment

i) Cockroaches have dorso-ventrally flattened bodies to fit in narrow places.
ii) Its body is dark brown to camouflage well against a dark background.
iii) They are smooth and greasy to escape easily from predators.
iv) It has one pair of long antennae for feeling and smelling the area around their body.
v) Since they are omnivorous, they survive on a wide variety of food materials.
vi) Their nocturnal emergence renders them less liable to capture.
vii) They have spines on their legs for defense.

The life cycle of a cockroach

A cock roach undergoes incomplete metamorphosis. After mating, the fertilized eggs are stored in an egg-case called ootheca. The female carries ootheca for a number of days before depositing them in dark obscure places. Within a week, it turns dark brown.
After six weeks, the eggs hatch out into young, wingless and colorless cockroaches called nymphs. After 2 weeks they turn brown like adults but wingless. The nymph grows and undergoes ecdysis, about 7 times and every two ecdysis, the nymphs are called instars. After the last ecdysis, the nymph becomes adult cockroach which has a life span of about 2 months.

Biological role/importance of cockroaches

- They destroy clothes, books, shoes, furniture and spoil food.
- They spread disease causing germs such as cholera, dysentery etc. especially those in latrines
- They contaminate food if not properly covered.
- They are food to some organisms like birds.
- They are used in biological studies as specimens.

Control of cockroaches

- Improve personal and public hygiene.
- Use of environmentally friendly insecticides like doom, etc.
- Use of biological control methods.
- Polish the walls of the house to close the small crevices.

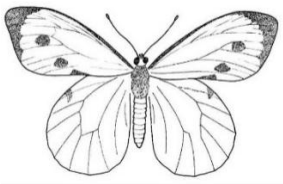
CITRUS BUTTERFLY (Papilio demodocus)

Classification:

Taxon		Reason
Kingdom	Animalia	Has mouth for feeding.
Phylum	Arthropoda	It has a hard exoskeleton. It has segmented body. It has jointed legs.
Class	Insecta	It has three pairs of jointed legs. It has three main body divisions. It has thorax divided into three segments.
Order	Lepidoptera	It has scales on its wings.

Habitat:

Butterflies live in gardens and forests and where they can feed on nectar from flowers. They are active during day.



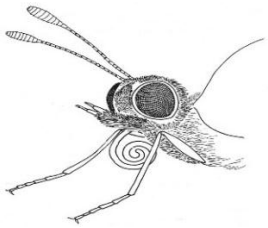
External features

The butterfly has three body divisions the head, thorax, and abdomen.

The head:

- The head bears two large, bulging brown compound eyes.
- There are two simple eyes (ocelli) behind the compound eyes.
- Above eyes is pair of antenna. These are long jointed and lobbed at the ends. They are sense organs for touch and smell.
- The head has a proboscis adapted for sucking nectar. The proboscis is long, hollow and a flexible tube. This has a modified pair of maxillae which coils up when not in use.

The head



The thorax:

- The thorax consists of prothorax, mesothorax and metathorax. These segments are covered by hairs and divisions are not clearly seen.
- Each thoracic segment bears a pair of jointed walking legs.
- The mesothorax and Metathorax in addition bear a pair of wings each which are large with powdery scales.

The abdomen:

- The abdomen has ten segments and each bears a pair of spiracles.
- It is hairy and obscures the segmentation.

Butterflies and moths

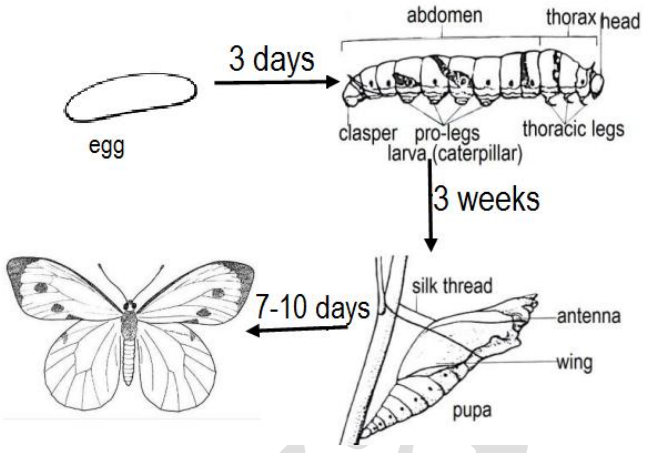
Butterflies and moths are both members of the Lepidoptera. Although they appear very similar, there are differences in their bodies and behaviour.

Differences between a butterfly and a moth

Butterfly	Moth
It is diurnal i.e. active during day time	Nocturnal i.e. active during night
Wings are held upright at rest.	Wings are held horizontally at rest.
Small body	Fatter body
Body brightly colored	The body is dull coloured.
Antennae are clubbed or knobbed at the tip	Antennae are pointed at the tip and feathery
Pupate above the ground	Pupate in cocoons or in the soil

The life cycle of a butterfly

A butterfly undergoes complete metamorphosis.
A fertilized female butterfly lays eggs.
The eggs hatch into larvae (caterpillars) after about 3 days. The thoracic segments of the larvae bear each a pair of true walking legs and abdomen bearing a pair of claspers on the last segment.
After three weeks of feeding on leaves, **the caterpillar develops to pupa**. The pupa is inactive i.e. it does not feed nor move. *During pupa stage, there is internal reorganization of tissues* involving the formation of wing, compound eyes, proboscis and reproductive organs. This lasts for about 7-10 days after which the pupa case split along the dorsal region.
After about 1 hour while the wings expand and dry, the adult butterfly emerges ready to fly, feed, mate and lay more eggs.



Biological role/importance of citrus butterflies

i) From the cocoons of butterfly, silk threads are obtained for making silk clothes.
ii) The larvae spoil the leafy vegetable with fecal drops such as dodo.
iii) The scales may be respiratory hazards when inhaled.
iv) The caterpillar stage destroys crops by feeding on green leaves of crops.
v) Some caterpillars feed on insects thus help in destroying insect pests.
vi) The butterflies also are of much importance to the farmers in pollinating flowers of the crops.
vii) They are source of food to some organisms like birds.

Control measures against butterflies

i) Killing the caterpillars with environmental friendly insecticides. Caution should be taken not to kill the adult butterflies because of their role in pollinating crop plants.
ii) Use of biological control methods like feeding them to birds.
iii) By hand picking of the infected leaves and burning or burying them. This destroys the eggs.

THE HOUSE FLY (Musca domestica)

Classification

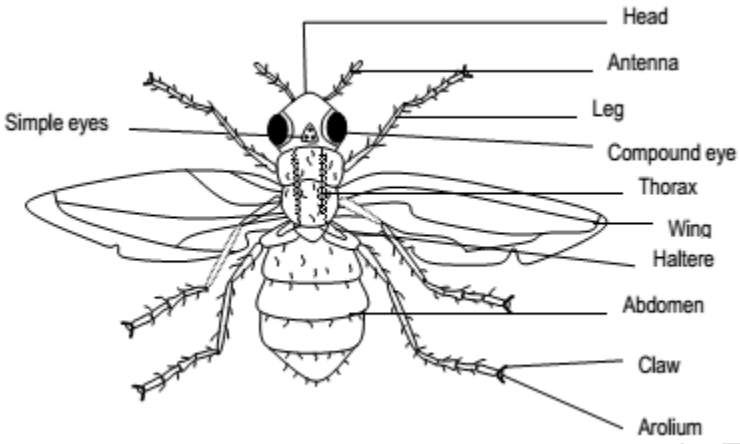
Taxon		Reason
Kingdom	Animalia	Has mouth for feeding
Phylum	Arthropoda	It has a hard exoskeleton. It has segmented body. It has jointed legs.
Class	Insecta	It has three pairs of jointed legs. It has three main body divisions. It has thorax divided into three segments.
Order	Diptera	It has a single pair of transparent wings.

Examples of members in the order include mosquitoes, housefly, tsetse fly etc.
Habitat: House flies live in filthy or dirty places such as toilets, dust bins, etc.

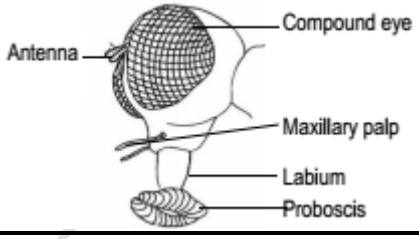
External features of a house fly

The body of the housefly is divided into three main parts, head, thorax and abdomen.
Its body is hairy.

Drawing of the dorsal view of a house fly



Drawing of the head of a house fly



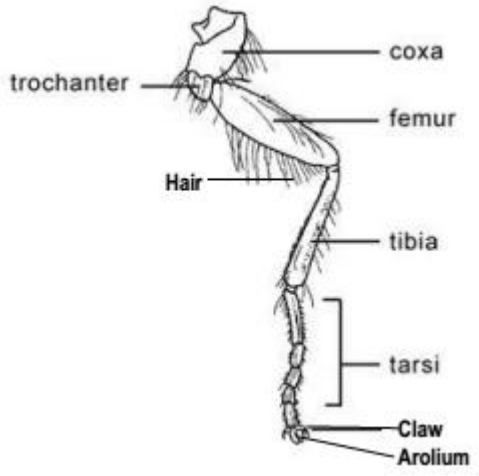
The head:

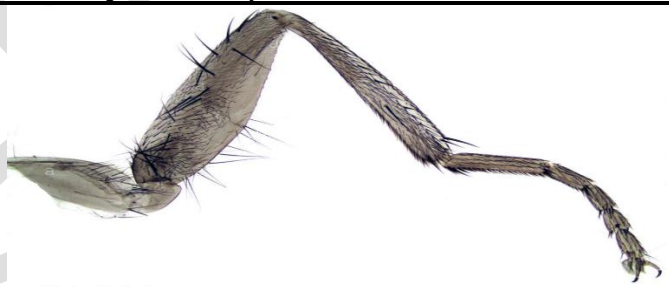
- The head bears three simple eyes (ocelli) arranged in triangle and on each side is a large or prominent compound eye.
- The antennae are short with three joints with last having spine hair.
- The labium (lower lip) is modified into proboscis for sucking, which is expanded at the distal end to form a funnel shape.

The thorax:

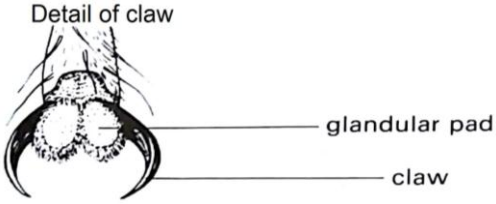
The thorax is divided into three segments with each segment bearing a pair of jointed, hairy legs.
The thorax bears one pair of transparent wings and halteres for balancing the house fly.

Drawing of the hind leg of a house fly





Detail of claw



Life cycle of a housefly

The housefly undergoes complete metamorphosis.

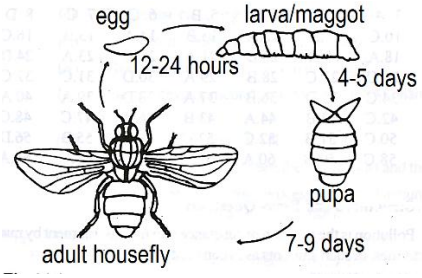
After mating, the female housefly lays eggs in batches. The eggs are laid on rotting matter such as meat or faeces, where it is warm and moist.

After about 12 to 24 hours, the eggs hatch into larvae. The larvae (maggots) are white and conical shaped.

After 4 to 5 days and shading its cuticle twice. It then moves to a drier region of the meat or faeces and pupates.

The cuticle hardens, darkens and becomes brown to form the pupa case. This forms a protective covering as internal reorganization of tissues takes place inside.

After 7 to 9 days, the pupa case bursts open, the adult fly emerges. The wings expand and harden and after a few hours, the fly flies away.



Biological role/importance of house flies

i) They feed on faeces and manure heaps, hence help in garbage disposal.
ii) They are vectors of diseases i.e. spread or transmit diseases such as dysentery, cholera, red eyes & trachoma.
iii) They are a source of food for some organisms such as chameleons.
iv) They are specimens for study purposes.

Control of house flies and prevention of diseases they spread

i) Spraying with an insecticide such as pyrethrum to kill the adult.
ii) Proper disposal of faeces in latrines with covers, so that flies cannot get to the waste to lay eggs.
iii) Washing hands with soap and clean water after visiting the latrine and before eating or preparing food.
iv) Disposing of wastes in such a way that flies cannot reach them. E.g. burning or burying them.
v) Covering or storing food properly so that flies cannot settle on it.

THE MOSQUITO

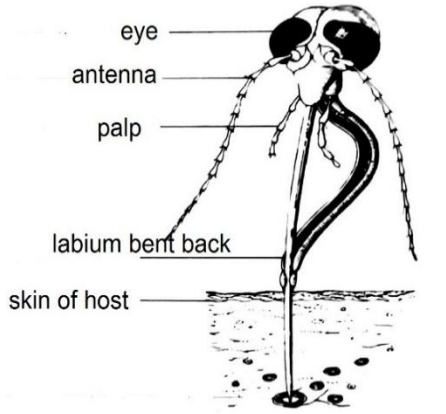
Classification:

Taxon		Reason
Kingdom	Animalia	Has a mouth for feeding.
Phylum	Arthropoda	It has a hard exoskeleton. It has segmented body. It has jointed legs.
Class	Insecta	It has three pairs of jointed legs. It has three main body divisions. It has thorax divided into three segments.
Order	Diptera	It has two pairs of membranous wings, one pair reduced to halteres.

The mosquitoes are majorly found in the tropics and are best known for carrying disease germs. The important three genera are:

i) Anopheles that are vectors of malaria.
ii) Aedes which are vectors of yellow fever and dengue fever.
iii) Culex, the vector of elephantiasis.

Head of female Anopheles mosquito



External features of a mosquito

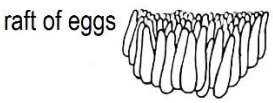
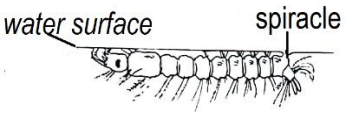
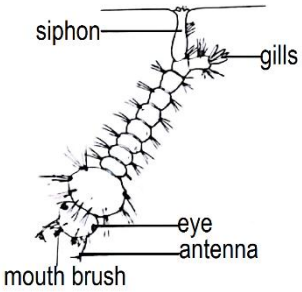
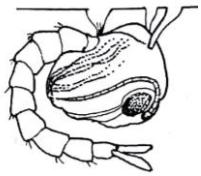
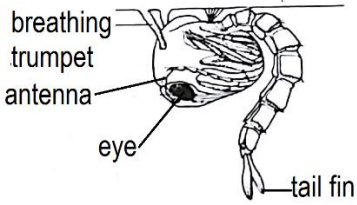
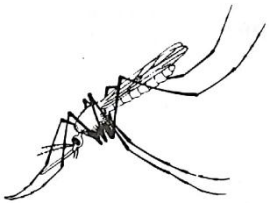
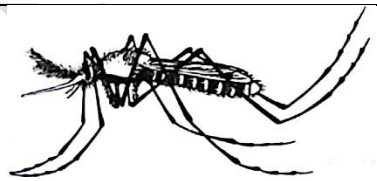
Has a pair of large compound eyes on the head.
Has a pair of long segmented antennae.
Has a pair of short segmented palps.
Has a sharp, long piercing stylet.
Has three pairs of long slender jointed legs.
Has two pairs of wings, one pair reduced to halteres to provide balance.

Mode of life of a mosquito

Hates light and like resting in dark places during day and comes out to feed at night.
They feed mainly within late evening and early morning.
Male mosquitoes feed on plant juices and nectar while the female feeds on blood.

Life cycle of a Mosquito

It begins with mating and internal fertilization and is a complete metamorphosis. The difference however are observed for both anopheles and Culex mosquitoes.

Anopheles mosquito		Culex mosquito
	Eggs	
	Larva	
	Pupa	
 *Adult anopheles*	Adult	 *Adult Culex mosquito*

Biological role of mosquitoes

i) They are source of food to aquatic organisms like fish and frogs.
ii) They are vectors for malaria, yellow fever and elephantiasis:
- *Aedes species carry a virus which causes Dengue. They also transmit the yellow fever virus which cause yellow fever.*
- *The Culex species carry* ***filarial worms which cause elephantiasis****. It is not a killing disease but causes discomfort due to large swelling of the legs and/ arm.*
- The female anopheles mosquito transmits malarial parasites, **plasmodia** which cause malaria.

Symptoms of malaria

- ✓ A Person with malaria has very high fever.
- ✓ Headaches.
- ✓ Sometimes vomiting.
- ✓ Pain in the joints and sometimes the general body.
- ✓ There is alternate cold and shivering spells as well as hot sweating.
- ✓ Loss of appetite.
- ✓ Anemia.
- ✓ Enlarged liver and spleen.

Malaria may cause convulsions and sometimes death in children and abortions in pregnant women due to destruction of red blood cells by the parasites.

Control of spread of malaria

To control the spread of malaria, effective control of the mosquitoes that carry the plasmodium parasites is the way to go.

Appropriate measures include;

- ✓ Destroying the breeding places where larvae develop from by draining or applying a film of oil over the water surface to prevent oxygen reaching the mosquito larva.
- ✓ Burning or burying all empty containers to prevent water from collecting during the rainy season.

- ✓ Clearing bushes around homestead. Mosquitoes like to rest and breed on them during the rainy season.
- ✓ Biological control which involves the introduction of fish into water bodies which feed on the larvae and pupa.
- ✓ Mosquitoes can be killed by spraying with insecticides using special sprayers.
- ✓ Removal of small water containers such as old tins, bottles, and drainage channels, so as to reduce on breeding sites.
- ✓ protecting our bodies from mosquito bites by using mosquito nets at night as well as wearing clothes which cover both legs and arms in the evening
- ✓ Applying mosquito repellant cream to the body.

Differences between anopheles and culex

Anopheles	Culex
i) Eggs are laid singly	Eggs are in rafts
ii) Eggs have air floats to keep buoyant	Eggs have air float
iii) Eggs are boat shaped	Eggs are cigar shapes
iv) Larva lies parallel to the water surface	Lies at an angle to the water surface
v) Larva has a pair of spiracles for breathing	Larva has siphon for breathing
vi) Adult at rest lies at an angle to the object	At rest lies parallel to the object

THE HONEY BEE (*Apis mellifera*)

Classification

Taxon		Reason
Kingdom	Animalia	Has a mouth for feeding.
Phylum	Arthropoda	It has a hard exoskeleton. It has segmented body. It has jointed legs.
Class	Insecta	It has three pairs of jointed legs. It has three main body divisions. It has thorax divided into three segments.
Order	Hymenoptera	It has transparent membranous wings.

Habitat: Bee hive

Other examples of insects under hymenoptera include ants, gull wasps, etc.

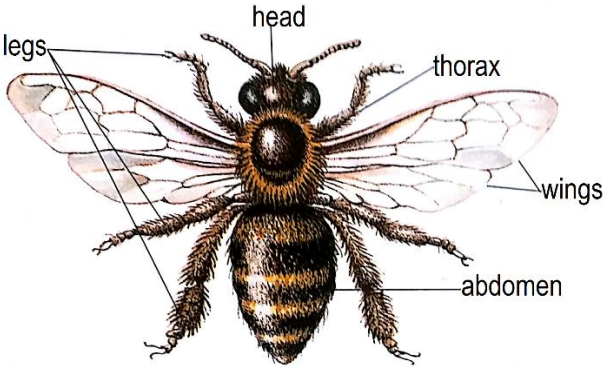
Generally, bees are social insects and live in colonies (large numbers) in bee hives. They show division of labor among the castes for instance;

The queen produces other bees.

The drone fertilizes the queen.

The workers have a number of duties among which include collecting food and cleaning the hive.

The worker bee



External features on the honey bee especially worker include:

- ✓ It has a cylindrical or rounded body.
- ✓ Has a hard exoskeleton.
- ✓ The body is segmented.
- ✓ It is hairy
- ✓ It has 3 main divisions i.e. head, thorax and abdomen.

The Head:

- ✓ The head is not fixed on the thorax and therefore it is free to move (mobile).

- ✓ Has both biting and sucking mouth parts. The mandibles are blunt, with a curved tongue. The proboscis is tubular. It is used for lapping during feeding and also used for construction, the glossa is also modified for sucking.
- ✓ Has hairy and segmented labial palps.
- ✓ Has one pair of large compounds eyes.
- ✓ The eyes are dorsal laterally/anteriorly positioned.
- ✓ Has a pair of short segmented antennae.

Thorax:

- ✓ It is hairy.
- ✓ Has three main segments.
- ✓ Has two pairs of membranous wings.
- ✓ Has 3 pairs of hairy jointed limbs which differ in various aspects as shown below.

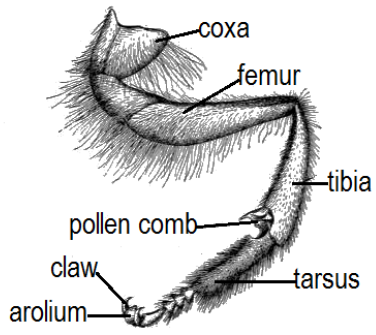
Thorax:

- ✓ It is hairy.
- ✓ Has three main segments.
- ✓ Has two pairs of membranous wings.
- ✓ Has 3 pairs of hairy jointed limbs which differ in various aspects as shown below.

The fore leg

The fore leg has a pollen comb located at the end of the tibia. This is used for cleaning pollen off the head.

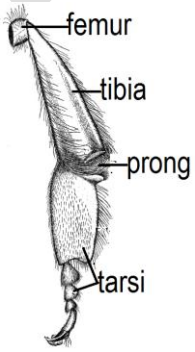
A drawing of the fore leg of a honey bee



The middle leg

These legs possess a hair like structure, prong at the distal end of the tibia. The prong is used for scooping pollen grains out of the pollen basket on the hind leg.

Drawing of the middle leg cut off from the femur

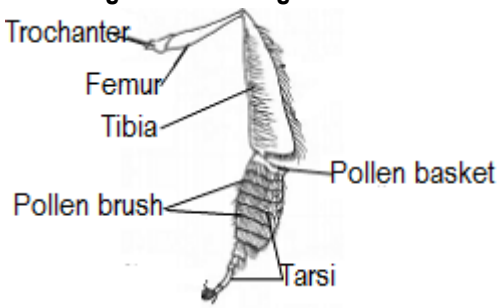


Hind leg

The leg is hairy with pollen baskets, which are responsible for carrying pollen grains.

These have pollen baskets on their tibia which are used for carrying the collected pollen grain to the hive. They also possess tufts of hairs on the tarsus called **pollen brush** which are used for cleaning pollen off the body into the basket on the other leg.

Drawing of the hind leg without the coxa



Abdomen:

The abdomen is short, cylindrical, hairy and segmented with a hard/ tough cuticle/ exoskeleton.

Roles played by the different castes in bees

1. The Worker bees:

The workers do not lay eggs because they are infertile/sterile females. They are the smallest in size among the bees. They perform the following duties among others:

i) Cleaning the bee hive by eating away dirt and rubbish.

ii) Feeding the old grubs (larva) on honey and pollen.

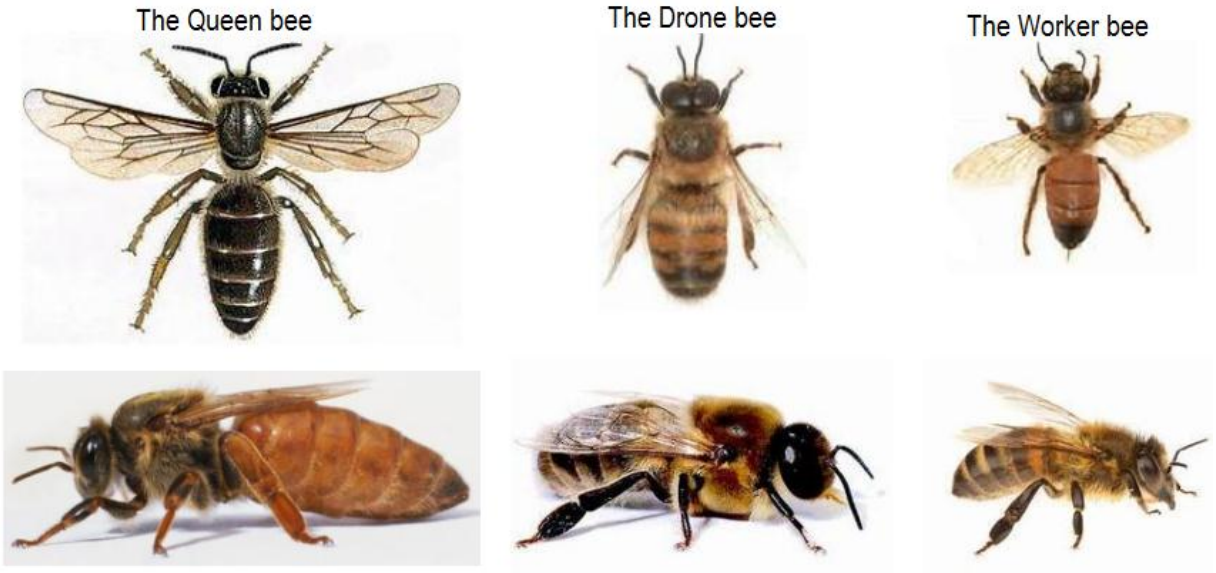
iii) Packing and storing honey and pollen in the cells of the honey comb.
iv) Feeding the young grubs on their milk produced by their own salivary glands.
v) Producing wax from their wax glands.
vi) Field work to collect food and pollen.
vii) Guarding the bee hive.

2. The drone bees:

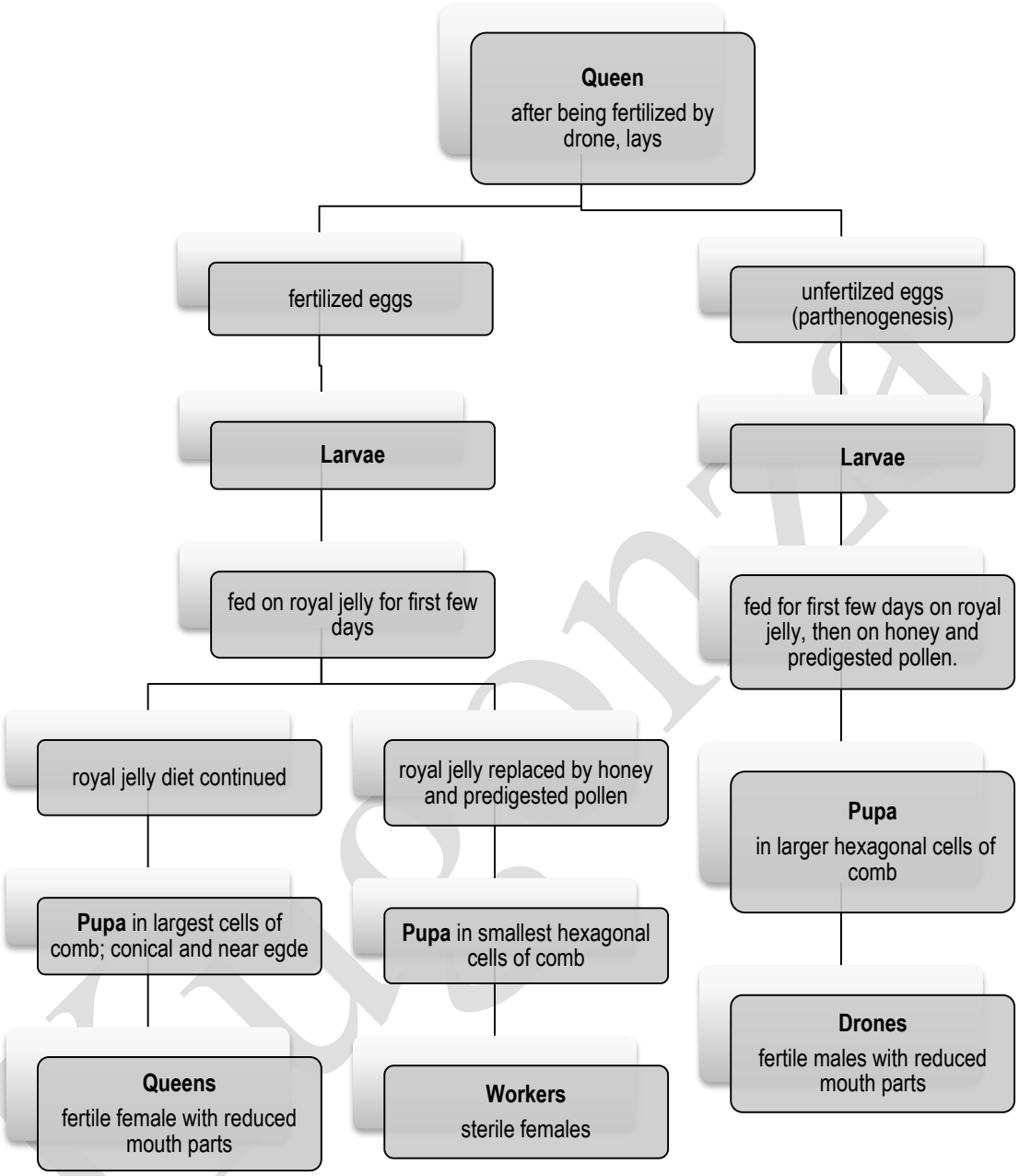
These are male bees. They are larger than workers and are usually very few in the hive. Their role is to fertilize the queen after which they are stung to death by workers.

3. The queen:

This is the fertile female bee. It is usually one in the hive. Its work is to produce all the other bees in the hive.



Life cycle of a bee



Reasons for the successful survival in its habitat

- ✓ Possession of pollen basket on limbs for carrying pollen grains
- ✓ Possession of prongs on their limbs for removing the pollen from the pollen basket
- ✓ Hairy body for trapping pollen grains
- ✓ Mandibles for moulding wax and pollen grains
- ✓ Membranous wings for flight.
- ✓ Spoon like tongue for lapping/sucking
- ✓ Exoskeleton to reduce water loss and protect the body from physical injuries
- ✓ Segmented body for flexibility during movement
- ✓ Tubular expanded proboscis for sucking liquid food
- ✓ Large compound eyes for wide field of view
- ✓ Veins in wings for free circulation of air / strengthening the wings.

Biological role/importance of bees in the environment

- ✓ Source of honey which is a rich food (carbohydrate)
- ✓ Pollinate plants most of which provide food for man.
- ✓ Provide wax used in industry to make candles, varnish, shoe polish etc.
- ✓ Their honey is a drug for many diseases like cough.
- ✓ The worker bee-stings inflict irritation on our bodies.

Revision questions

1. *Describe the life cycle of a worker bee.*
2. *How are the legs of the honey bee adapted to their role?*

TERMITES

Termites are social insects and very many in the topics.

Classification

Taxon		Reason
Kingdom	Animalia	They have a mouth for feeding.
Phylum	Arthropoda	It has a hard exoskeleton. It has segmented body. It has jointed legs.
Class	Insecta	It has three pairs of jointed legs. It has three main body parts i.e. head, thorax and abdomen. It has thorax divided into three segments.
Order	Isoptera	

Habitat: ant hills

Termites avoid light. When they live their nests/ant hills in search for food, they build covered ways upon the sides of buildings and trees. Inside these tunnels they can carry out their activities protected from the light and the drying effect of the sun.

All termites are vegetarian. A few species feed on grasses, but most feed on wood or dead plant material in the soil.

A termite community consists of different types of castes on insects. These include:

Queen: this lays eggs.

King: this mates with the queen, workers and soldiers. The kings and the queen (reproductives) have wings early in their adult life and go on a nuptial or mating flight.

Workers: these perform all the tasks of the colony, like nest building. They also feed the other members.

Soldiers: these have large heads and jaws/mandibles. They defend the colony against enemies.

External features of termites

They have a hard exoskeleton.
They have segmented bodies.
They have three main body divisions
They have smooth bodies.

The head:
Soldier termites have broad oblong heads. The other castes have small round heads.
They have biting mouth parts.
They have pointed, hard, sharp and curved mandibles.
They have short, hairy and segmented maxillary palps.
They have hairy and segmented labial palps.
Has a pair short hairy and segmented antennae.
Has a pair of tiny compound eyes except the soldier termite which has no eyes.
The thorax:
Has three segments i.e. prothorax, mesothorax and metathorax.
Has three pairs of legs. One pair on each thoracic segment.
The thorax is smooth.
All legs are of the same size.
The abdomen:
The abdomen is cylindrical, segmented, elongated and smooth.

Adaptations / reasons to the habitat:

- Hairy antennae for increased sensitivity.
- Hard sharp mandibles for cutting solid food and defense.
- Curved/ sharp/pointed claws for movement on rough surfaces.
- Sticky arolium for moving on smooth surface.
- Segmented body for flexibility during movement.
- Body covered with exoskeleton for protection against water loss/ desiccation/ mechanical damage.
- Hairy maxillary palps to increase sensitivity to food.

Economic importance

- They help to turn the soil over, and keep it loose and aerated.
- They are source of food.
- They eat dead or living wood, in the process they damage timber including timber used in buildings, young trees and sometimes crops.

Control measures

- Use termite resistant paint on timber to be used for construction.
- Use construction materials that can't be attacked by termites like steel.

THE DICHOTOMOUS KEY

This is an artificial way of classifying specimens, basing on observable features. It involves dividing the specimens provided into two groups, which are further subdivided into two, until a single specimen remains in a group.
Only features observable and contrasting are the ones used, i.e. avoid using the word 'not' when stating an observable feature.

Characteristics considered in arthropods

- Wings i.e. present or absent.
- Number of wings i.e. one or two pairs.
- Number of legs i.e. 6, 8, or more than 8.
- Number of main body parts i.e. 2 or 3.
- Compound eyes i.e. present or absent.
- Antennae i.e. present or absent.
- Abdomen texture i.e. smooth or rough/hairy or non-hairy.
- Antennae shape i.e. pointed or clubbed (knobbed)
- Anal cerci i.e. present or absent.
- Simple eyes i.e. present or absent.
- Note: soldier termites lack both simple and compound eyes.

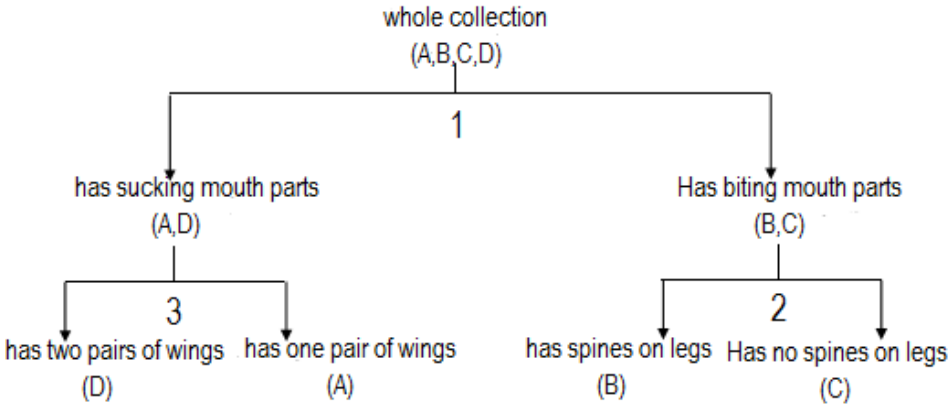
Methods of constructing a dichotomous key

You should use contrasting characteristics in each lead. Before constructing the dichotomous key, a ***flow chart*** should be made.

Consider four specimens:

Honey bee (A)
Cock roach (B)
Termite (C)
House fly (D)

Flow chart



The dichotomous key would then be as follows;

1 a) Has sucking mouth parts .....go to 2
b) Has biting mouth parts .....go to 3

2 a) Has two pairs of wings .....D
b) Has one pair of wings .....A

3 a) Has spines on legs .....B
b) Has no spines on legs C

Activity:

Provide students with any arthropods (more than 4) to construct a dichotomous key in groups while in class.

Practical exercise

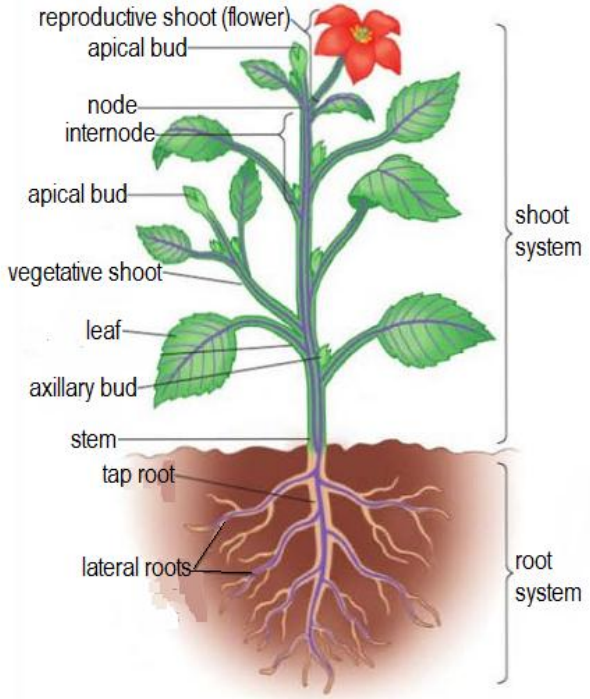
You are provided with specimen T. (cock roach)

a) *Observe the specimen and state the class the specimen belongs to. Give two reasons.*
Class:
Reasons:
b) *Examine the mouth parts of specimen T using a hand lens and suggest the type of food (solid or fluid) the specimen feeds on giving a reason.*
Type of food:
Reason:
Describe two ways how the mouth parts are suited for the type of food eaten by the specimen.
c) *Examine the outer and inner wings of the specimen and describe their structure.*
d) *State the function of the wings of T basing on their structure.*
e) *How is the structure of the hind limbs related to their functions?*
f) *Draw and label the ventral view of the last three abdominal segments.*

FLOWERING PLANTS

These are plants that bear flowers. A typical flowering plant is composed of 2 systems i.e. Root system and Shoot system
The two systems are made up of two categories of organs i.e.
Reproductive organs: these produce fruits and seeds. They are directly involved in the reproduction of the plant.
Vegetative organs: these are not directly involved in the reproduction. They include roots, stems and leaves.

Structure of a flowering plant

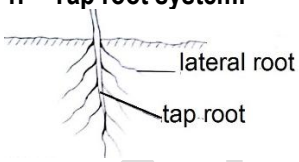


ROOTS

A root is a descending portion of the axis of the plant and develops from the radical of the embryo during germination.

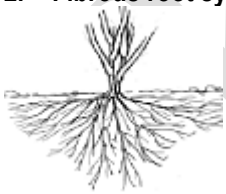
Types of roots

1. **Tap root system:**



This consists of a main root growing straight down wards from the radicle. It gives rise to side 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.

Functions of roots

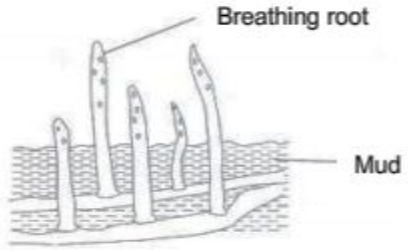
i) They anchor the plant firmly in the soil.
ii) They absorb water and mineral salts from the ground to the plant.
iii) They conduct the absorbed water and mineral salts up to the stems and leaves.
iv) In some plants, roots are modified into root tubers which store food e.g. cassava.
v) Some roots are modified for breathing e.g. white mangrove.

MODIFIED ROOTS

1. **Storage roots**

These are thick fleshly 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.***

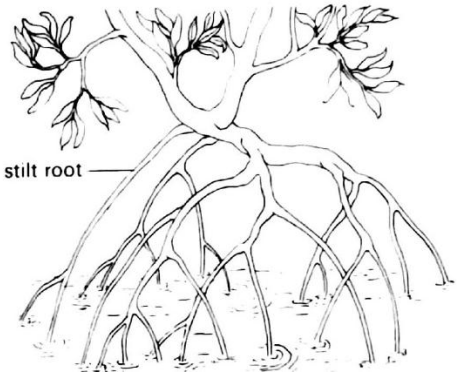
2. Breathing roots



These are found on some plants growing in swampy areas e.g**. *white mangrove***. Its roots grow up through the mud to the air. The root parts above the mud are spongy ***and absorb air from the atmosphere***. The main root of such plants bears branch roots.

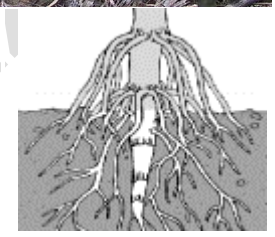
3. Stilt roots

These roots develop from the main stem in certain plants such as ***red mangrove*** which grow in muddy areas. ***Stilt roots provide additional support to the plant.***



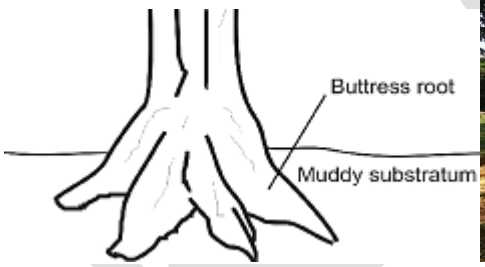
4. Prop roots:

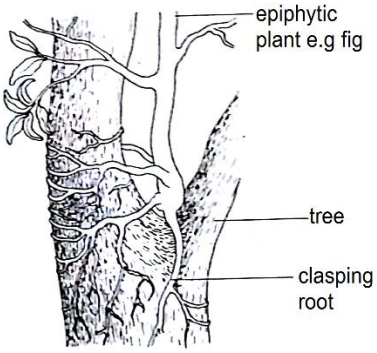
These are found growing on plants such as ***maize, sorghum and sugar canes***. They develop from the nodes of the stem close to the soil surface. ***They provide extra support by holding the plant firmly to the soil surface.***



5. 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.***





6. Clasping roots

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

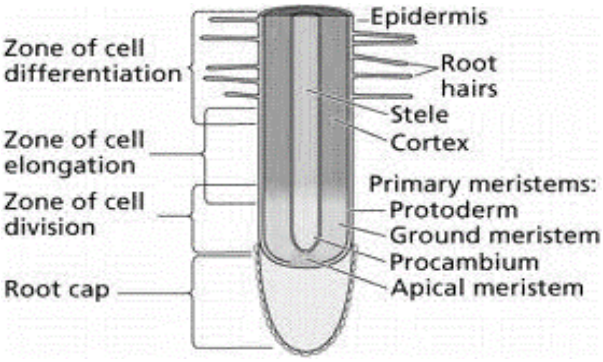
7. Epiphytic roots

These grow on certain plants called epiphytes. Epiphytes are plants which grow and get support from other plants. These roots hang freely in the atmosphere. ***They absorb moisture from the atmosphere.***

8. Sucking roots

These are roots found growing on certain parasitic plants e.g. ***figs (mituba)***. They grow from the stem and penetrate the host plant. ***These roots absorb water, mineral salts and organic food compounds from the host plant.***

INTERNAL STRUCTURE OF A ROOT (LONGITUDINAL SECTION)



In a longitudinal section through the growing end of a root, its parts are divided into 4 main zone or regions:

1) Root cap
2) Region of cell division (meristematic region)
3) Region of cell elongation
4) Region of cell differentiation (maturation)

1) Root cap

This is found at the tip of the root and is made up of loosely arranged cells. It protects the tender apex of a root from mechanical damage as it makes its way through the soil. It's absent in aquatic plants.

2) Region of cell division

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.

3) Region of cell elongation

This is the region lying just above the region of cell division. The cells in this region absorb water and develop vacuoles, the cells being elastic, elongated and enlarged. This causes an overall growth in the length of the root.

4) Region of cell differentiation

This is also called the region of absorption. The characteristic feature of this region is the development of root hairs. 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.

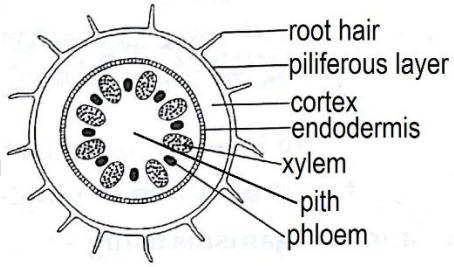
Transverse section of a root

The transverse or cross section of most young roots has two regions

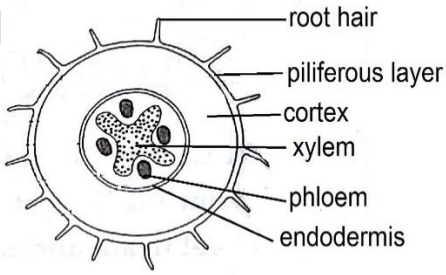
- The outer cylinder (cortex)
- The central cylinder (stele)

The vascular tissues are composed of xylem and phloem and may contain cambium and pith tissues.

Monocot root



Dicot root



Functions of the parts

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

Piliiferous layer: protects the cortex cells from mechanical damage. It also prevents loss of water from the cortex cells since it is impermeable to water.

Cortex: contains cells that provides mechanical strength to the root.

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.

Cambium: causes secondary thickening of the root. It adds all secondary xylem cells on its inner side and secondary phloem cells on its outer side by continuous cell division during growing season.

Pith: is a small area in the centre of the monocot root. It is composed of parenchyma cells for strengthening the root.
It's normally absent in most roots. It also stores food and water for the plant.

Differences between transverse section of monocot and dicot roots

Dicot root	Monocot
Has no pith.	Has pith.
Can form a ring of cambium.	Cannot form a ring of cambium.
The xylem is star-shaped occupying the central part.	The xylem and phloem alternates forming a ring.

STEMS

This is the ascending portion of the plant axis that develops from the plumule of the embryo. It has the following characteristic features;

i) It bears leaves at the nodes.
ii) It has nodes and internodes.
iii) It has buds in the axill called axillary buds.
iv) It has flowers or fruits.
v) Its terminal bud is located at the tip of the stem.

NB: the axill is the angle between the leaf and the stem.

Functions of stems

a) **Primary functions**

i) They hold leaves in the best position for receiving enough sun light needed in the process of photosynthesis.
ii) They conduct water and mineral salts from roots to leaves and manufactured food from leaves to other parts.
iii) They hold flowers and fruits in good position so that they can be easily pollinated or dispersed.
iv) When stems are young, they carry out photosynthesis thus making food for the plant.
v) Stems have lenticels (pores) that facilitate gaseous exchange.

b) Secondary functions

i) Some stems may specialize in storing food and water e.g. stem tubers like corms, Irish potatoes, rhizomes and sugar cane.
ii) Protect a plant against browsers by forming thorns, spines or prickles.
iii) Vegetative reproduction or propagation through the stem cuttings e.g. cassava and sweet potatoes.
iv) They support the plant by climbing stem tendrils e.g. *pasum* pea (wild pea).

TYPES OF STEMS

1) Erect stems

These can support themselves in an upright position. They may be woody or herbaceous.

Woody stems: These have a high content of lignin and are hard. They are found in shrubs and trees.

Herbaceous stems: These contain no or less woody materials e.g. tomatoes, rice. The herbs are shorter than grass.

2) Weak stems

These can't support themselves upright but either creep or climb for support.

3) Underground stems

These are modified stems which remain permanently underground. They are often swollen and serve as food storage organs.

NB:

- Annual herbs only live for one year
- Bi-annual herbs live for two years
- Perennial herbs live for many years

MODIFICATION OF STEMS

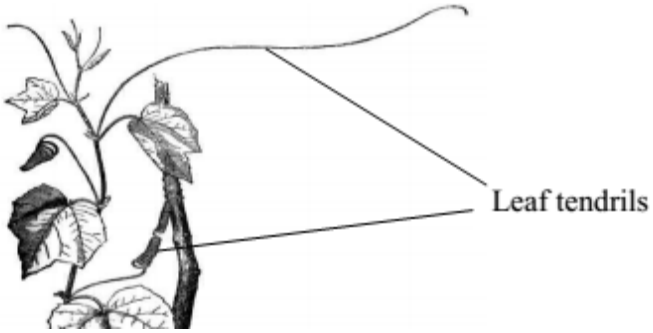
Weak stems

1. Twinning stems (twinners)

These are stems that grow ascending spirally around a support. They are usually long and slender e.g. Dutch man's pipe and lianas.

2. Climbing stems

These are stems that grow clinging to the support of other plants by means of **tendrils**. Tendrils are thin wire-like spirally coiled branches of certain stems. They may be modified at axillary buds e.g. in passion fruit plants or terminal buds



3. Creeping stems (creepers)

These are long thin stems which grow along the surface of the ground, giving off roots at certain intervals of the nodes.

Types of creeping stems are;

i) Runner

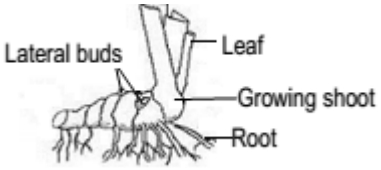
This is a slender trailing stem lying flat on the ground possessing long internodes. A runner arises as an axillary bud and creeps some distance away from the mother plant and grow into another plant e.g. **oxalis.**

ii) Offset stems

This is a horizontal thickened short stem. It originates from the axil of the leaf and grows flat on the ground. It produces many leaves above and a cluster of roots below e.g. water hyacinth and ***water lettuce***.

iii) Sucker

A sucker is a creeping stem that grows obliquely upwards, directly giving rise to a leafy shoot. E.g. **banana**, pineapple, sisal plant, etc.

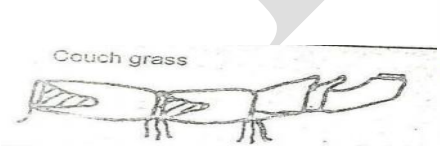


Underground stems

There are four types of underground stems namely: Rhizome, Corm, Stem tuber and Bulb.

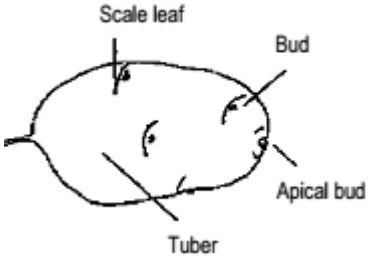
1. Rhizomes

This is a horizontal thick underground stem having adventitious roots growing from the lower side of the nodes. It has terminal buds which develop into aerial shoots. It bears buds in axils of the reduced brown leaves called scale leaves.
Rhizomes store a lot food for the plant. Some also act as organs for vegetative propagation e.g ginger, canalily, couch grass and Solomon's seal.



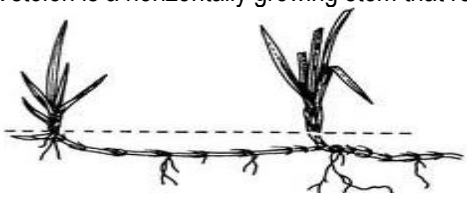
2. Stem tuber

This is a short, fleshy underground stem swollen with large amounts of stored food. It has scale leaves and axillary buds which form the 'eyes' e.g. Irish potato, yams.



3. Stolon

A stolon is a horizontally growing stem that roots at the nodes and develops buds that grow into new plants. E.g. straw berry.

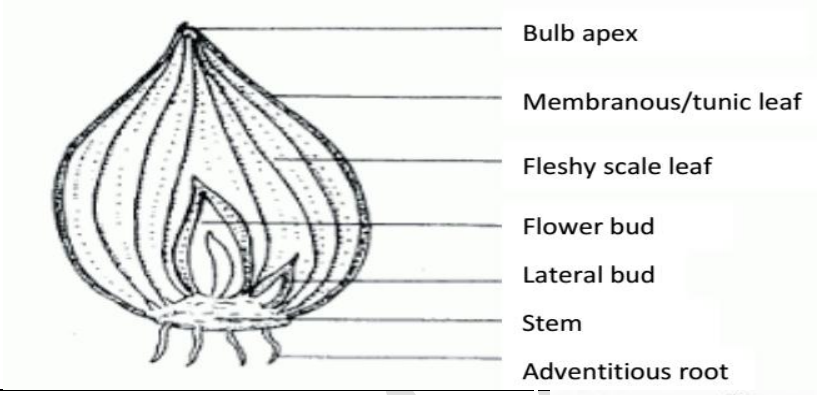


4. Bulb

A bulb is short conical-shaped underground stem comprising of thick fleshy leaves arranged in concentric circles. The thick fleshy leaves store food for the plant and are protected by outer dry brown leaves called scale leaves.

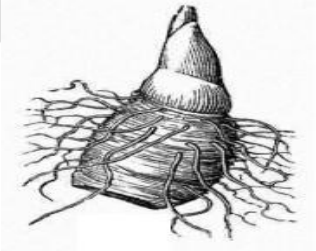
A terminal bud lies at the top of the stem and give rise to the aerial shoot. Axillary buds are situated between the leaf bases. Onions, garlic, tuberose, etc. are bulbs.

Structure of a bulb (onion)



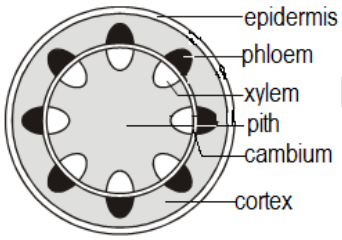
5. Corm

A corm is a swollen fleshy underground stem that grows in a vertical direction. It is round-shaped and somehow flattened from the top to bottom. It has a terminal bud lying at the top of the stem and has scale leaves a rising from the nodes. Its roots grow randomly from the stem. Examples of corms are coco yams and yams.

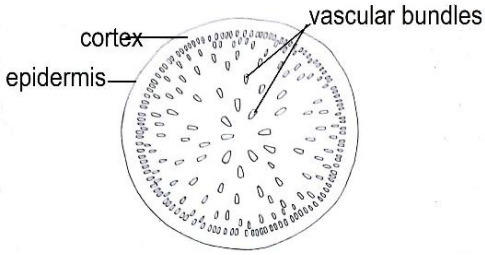


INTERNAL STRUCTURE OF STEMS

Transverse section through a dicot stem



Transverse section through a monocot stem



Internally stems have 3 main tissues;

1. Epidermis

It comprises of a single layer of cells which are brick-shaped. The outer wall of these cells is thickened by cutin, a waxy material which forms the outside skin of a stem called cuticle.

It protects the stem against water loss. It also protects the inner tissues of the stem from mechanical injury.

It prevents entry of bacteria and germs into stem.

2. Cortex

This is the part of the stem between the epidermis and the vascular bundles. It's made up of collenchyma, parenchyma and endodermis.

i) **Collenchyma:** This is the outer tissue of the cortex. It's 3 or more cells thick. The cells are small and tightly packed. They offer mechanical support, hence strengthening and giving rigidity to the stem.

ii) **Parenchyma:** This is made up of large thin walled cells. These cells have air spaces between them called intercellular spaces. The spaces provide passage for water vapour and gases in the stem. Parenchyma cells offer support to the stem when filled with water and also store some food.

iii) **Endodermis:** This is a single layer of rectangular shaped cells. It contains usually starch, and its main function is storage of food.

3. Vascular bundles

These are conducting or transporting tissues of a plant. They consist of xylem and phloem. The phloem lies externally and the xylem lies internally in each bundle.

Phloem:

The phloem conducts and transports manufactured food. It is made up of three main cells:

i) **Sieve tubes:** These are cylindrical tubes arranged end to end in long rows. Their cross-walls have many fine pores forming a sieve plate. They conduct manufactured food in the stem.

ii) **Companion cells:** These are smaller than the sieve tubes. They are filled with a dense cytoplasm and have nucleus. They control the activities of the sieve tubes.

iii) **Phloem parenchyma:** It stores some food in the stem. They are the first to be formed in the vascular bundle.

Xylem:

Xylem is water and mineral salts conducting tissue. It comprises of 2 types of cells i.e. vessels and tracheids. These cells have their walls thickened with a substance called lignin. The xylem also provides mechanical strength to the stem due to the presence of lignified dead cells. The lignified dead cells formed between the endodermis and phloem is termed as sclerenchyma.

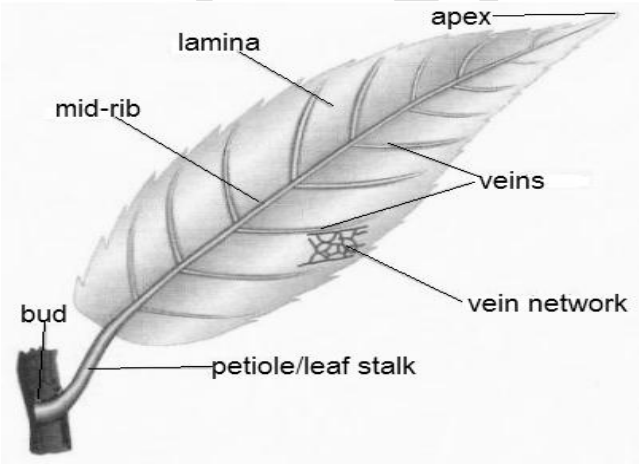
Differences between dicot and monocot stems

Monocot stem	Dicot stem
Lack cambium	Has cambium. The cambium is responsible for secondary growth or thickening of the stem.
The vascular bundles are scattered within the stem.	The vascular bundles are arranged in form of a ring.
Lack a distinct cortex and pith.	Has a distinct cortex and pith. The pith is wide.
Its cortex has several layers of parenchyma cells.	Its cortex has a few layers of parenchyma cells.

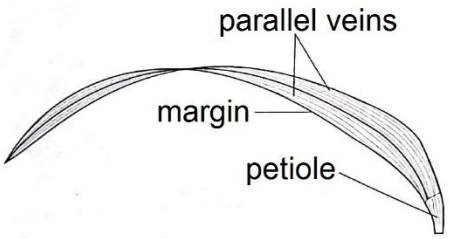
LEAVES

A leaf is a thin flattened structure which grows from the nodes of a stem or its branches and has a bud in its axil. Leaves are generally green although some are red or brown.

External structure of a dicot leaf



External structure of a monocot leaf



Leaves with a petiole are called ***petiolate*** and those without are called ***sessile.***

The ***leaf stalk*** is a characteristic of dicots while a ***leaf sheath*** is found in monocots. The leaf stalk/sheath can be hairy or smooth.

Lamina is the expanded and flattened portion of the leaf consisting of veins and midrib. The lamina texture may be hairy or smooth. It may be hard or soft.

Venation:

The arrangement of veins in the lamina of a leaf is called venation. Two broad types of venation are;

1. **Network venation/reticulate venation**

In network venation, the veins in the lamina branch while intersecting to form a network. It's a characteristic of dicots.

2. **Parallel venation**

In this venation, the veins run side by side without branching. This is a characteristic of monocotyledonous plants.

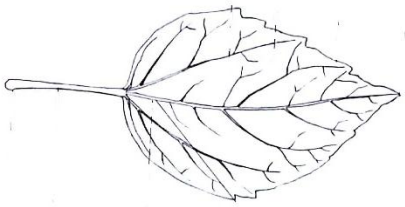
Leaf complexity

Leaves can be classified according to whether the leaf lamina is completely divided or not divided. Two broad types are: ***Simple leaves*** and ***Compound leaves***.

1. **Simple leaves**

A simple leaf has a single lamina which isn't divided up into leaflets e.g. Avocado, mango, orange, hibiscus, pawpaw, cassava, etc. Cassava and pawpaw leaves are partly divided. The lobes are not considered to be leaflets because the divisions do not reach down the midrib. They are simple digitate i.e.

Simple leaf



Simple digitate leaf of cassava

A swelling at the base of the leaf stalk is called ***pulvinus*** e.g. beans and cassava. Some leaves have it while others do not have it.

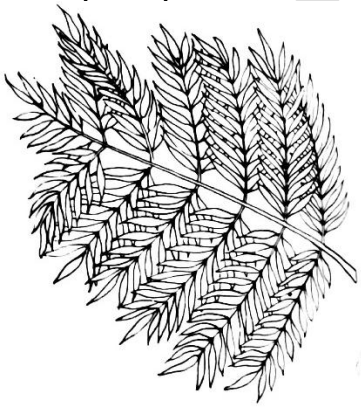
2. **Compound leaves**

A compound leaf has a lamina which is completely divided into leaflets.

They resemble leaves but are not leaves because the axillary buds are absent in the axis of leaflets e.g. beans, oxalis, cassia, etc.

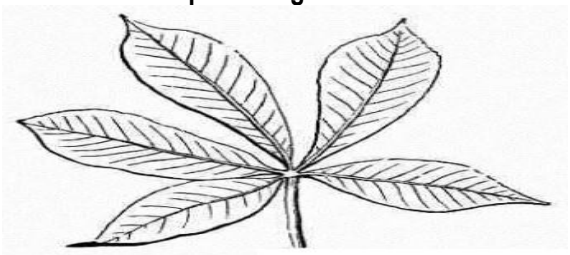
Types of compound leaves

Compound pinnate leaves



Compound bipinnate leaves

Compound digitate leaves

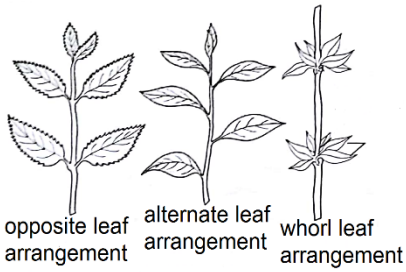


Compound trifoliate leaves

NB: stipules (foliar appendages) are attached to the leaf base or petiole e.g. in beans, hibiscus and cassia.

Arrangement of leaves on a stem

Leaf arrangement is the insertion of leaves on the stem. Leaves develop at the nodes in the stem and are arranged in different ways.

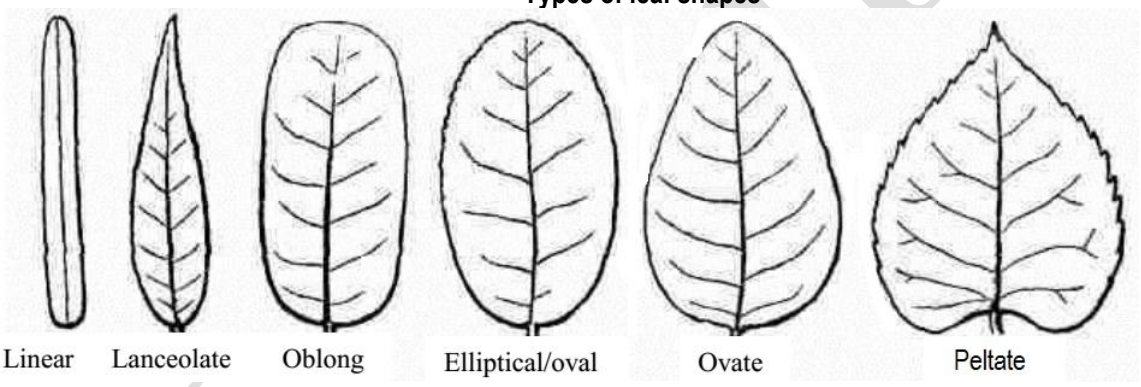


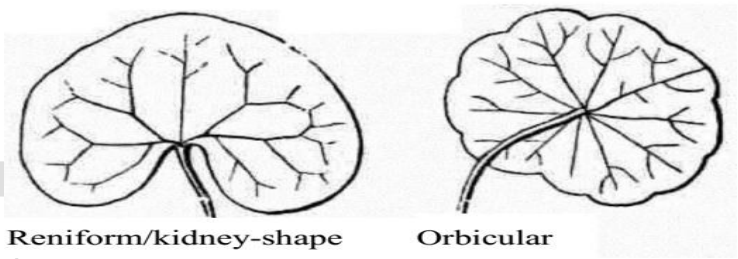
Types of leaf margins

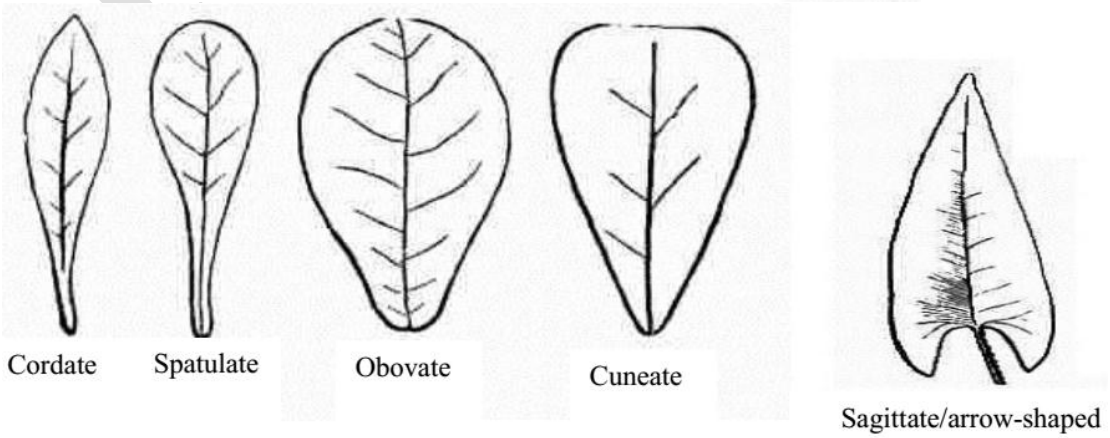
Leaves can be classified according to the leaf margins.

1. **Entire margin:** The margin is smooth and without indentation of any kind. E.g. mango leaves.
2. **Serrate margin:** The margin is with indentations pointing towards the apex.
3. **Crenate margin:** The margin has round indentations.
4. **Dentate margin:** The margin has indentations pointing towards the petiole.
5. **Lobed margin:** The margin has relatively few and shallow indentations.

Types of leaf shapes







Assignment:

*You are provided with specimens **P, Q, R, S** and **T**, which are plant organs of various plants.*

a) *Examine each specimen carefully and then using only external morphological features, construct a dichotomous key which can be used to identify them. **(Leaves of beans, hibiscus, sweet potato, maize and mango)***

b) *Which specimens, with reasons, are from*

i) Monocotyledonous plants

ii) Dicotyledonous plants

Functions of leaves to plants

Primary functions:

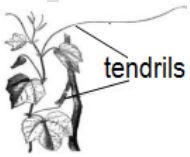
- The major function is to manufacture food for the plant during photosynthesis.
- Leaves have stomata which allow exchange of gases i.e. O_2 and CO_2.
- Leaves facilitate transpiration which sometimes helps the removal of excess water within the plant.

Modification of leaves

Leaves of some plants have become modified to perform other functions other than photosynthesis.

1. Leaf tendrils

These are slender wire like coil structures used as climbing organs in climbers for support. The leaf may be partly modified into a tendril.



2. Scale leaves

These are thin, dry membranous structures usually brown in colour and sometimes colourless. Their main function is to protect the axillary bud from mechanical injury and drying out. They are commonly found on underground stems. E.g. scale leaves of onions, rhizome and garlic.

3. Insectivorous leaves

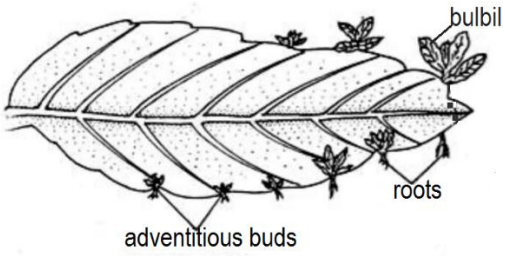
These are modified leaves whose function is to capture and digest insects. Such plants are called insectivorous plants. Pitcher plants grow in soil with a deficiency of nitrogen/nitrates. They obtain nitrogen from insects. E.g. Venus fly trap, butter wort, sundew, bladder wort, etc.

The venus fly trap

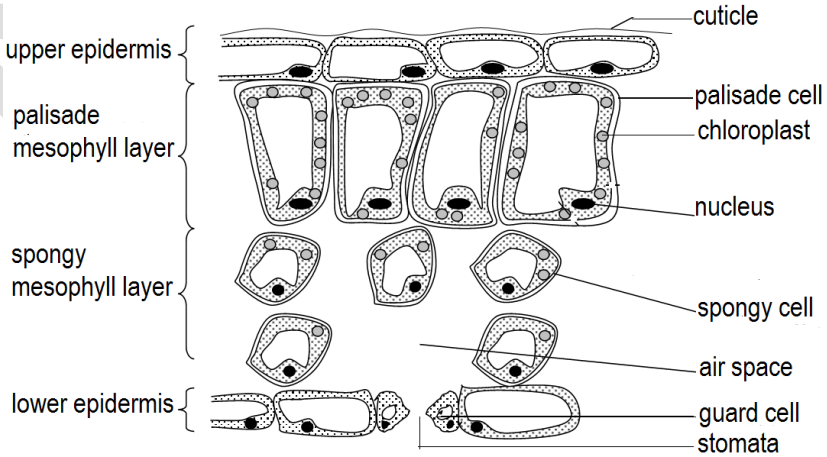
4. Leaf spines: These are sharp pointed structures of certain plants modified for defense.

5. Bryophyllum leaves

These leaves are thick and succulent. They have series of buds at the end of veins. These buds grow into new plants (plantlet) called bulbils when the leaf is mature.



INTERNAL STRUCTURE OF A LEAF



1. Epidermis:

This is the outer most layer of a leaf. It's covered by a transparent water porous layer of cutin called cuticle. This cuticle allows light penetration into the leaf and prevents excess moisture loss from the leaf surface. The cuticle also protects the

plant from disease-causing organisms and mechanical injury. The epidermal tissue is divided into 2, i.e. upper and lower epidermis.

The major function of this epidermis is to prevent evaporation of water from the leaf cells and protection of the inner cells.

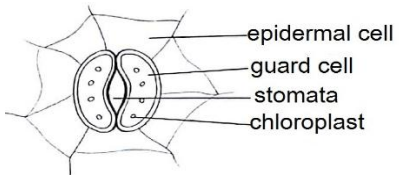
The lower epidermis is usually made up of one layer of cells and contains numerous openings called **stomata**.

Stomata:

These are small openings found in the epidermis of a leaf. They are surrounded by 2 guard cells. Plants growing on land have more stomata located in the lower epidermis than in the upper epidermis. (The reverse is true for aquatic plants). The function of the stomata is to allow entry and exit of important gases like O_2 and CO_2 into the leaf.

The stomata also regulate the loss of water vapour from the plant i.e. they control transpiration.

Structure of the stomata



2. Mesophyll:

This is located between the upper and the lower epidermis. It's differentiated into two layers. i.e.

i) Palisade mesophyll layer

It's found just below the upper epidermis. It's made up of cylindrical shaped cells. The cells are closely packed together with numerous chloroplasts.

The chlorophyll absorbs maximum sun light for photosynthesis.

ii) Spongy mesophyll layer

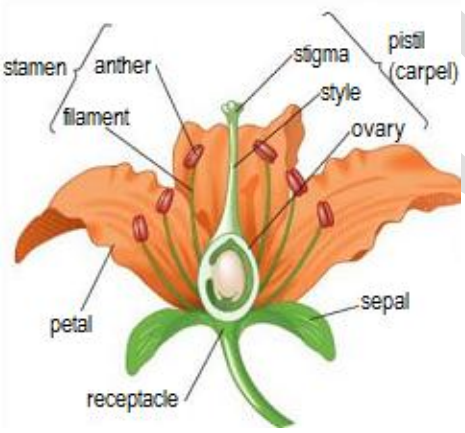
It's found under the palisade layer. It consists of cells called spongy cells which are irregularly arranged. These cells are not closely arranged, and therefore have large intercellular air spaces for gaseous exchange. Spongy cells contain fewer chloroplasts than the palisade cells hence they also carry out photosynthesis.

3. Vascular tissue

These are vascular bundles consisting of veins. Each vein has a phloem for transporting manufactured food and the xylem for conducting and distributing water and mineral salts. The veins also provide mechanical support to the leaf lamina.

THE FLOWER

General structure of a flower



The flower is part of the shoot specialized for reproduction. Most flowers have male and female reproductive organs though some are of a single sex. A group of flowers on a single stalk is called an ***inflorescence*** e.g. maize flower.

Parts of a flower

The floral parts are arranged in rings, spirals or whorls with short internodes. The end of a flower stalk may be expanded to form a receptacle. The stalk of the flower where floral parts grow is called pedicel.

The four floral whorls are ***Calyx, Corolla, Gynoecium and Androecium.***

The calyx is the outer most floral whorl of the flower made up of sepals. The calyx protects the inner whorls of a flower during the budding stage.

The corolla is the second floral whorl of a flower made up of petals.

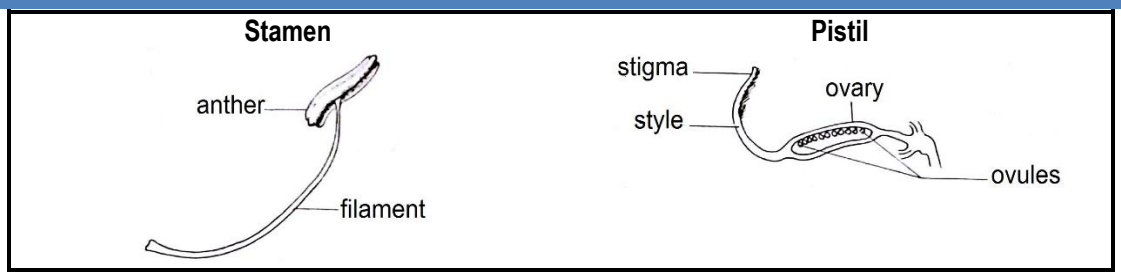
Most flowers have scented petals. The calyx and corolla are collectively known as ***Perianth.***

Androecium is the male part of the flower consisting of ***stamen***. Each stamen is made up of filament and head called anther. Anthers contain pollen grains which develop to form male reproductive cells called gametes.

N.B: an infertile or sterile stamen is called ***staminode.***

Gynoecium (pistil) is made up of female reproductive parts called ***carpels***. The pistil occupies a central position in the flower. Each carpel is made up of;

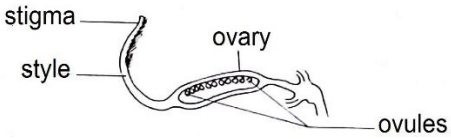
- ✓ **Ovary** which contains ovules or female gametes. The wall of the ovary develops into the pericarp of the fruit. At the base of the ovary on the receptacle is a ***nectary*** which produce a sugary solution called ***nectar***.
- ✓ **Style** which connects the ovary to the stigma
- ✓ **Stigma** which receives the pollen grains



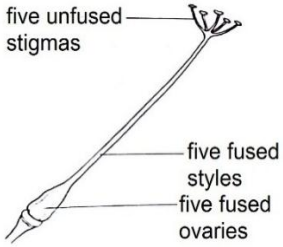
Types of pistils

Three main types of pistils are:

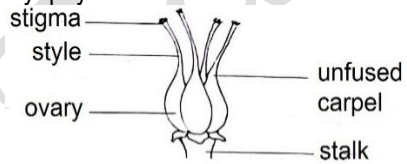
1. Monocarpous:
This is a pistil with only one carpel e.g. morning glory and crotalaria.



2. Syncarpous pistil:
This is a pistil with carpels fused together e.g. hibiscus.



3. Apocarpous pistil:
This is a pistil with several carpels which are not fused i.e. as distinct carpels e.g. butter cap and Bryophyllum.



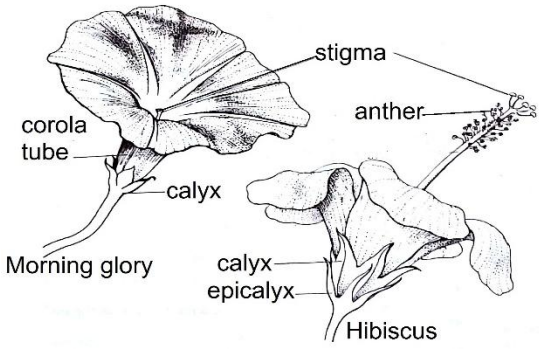
Types of ovaries

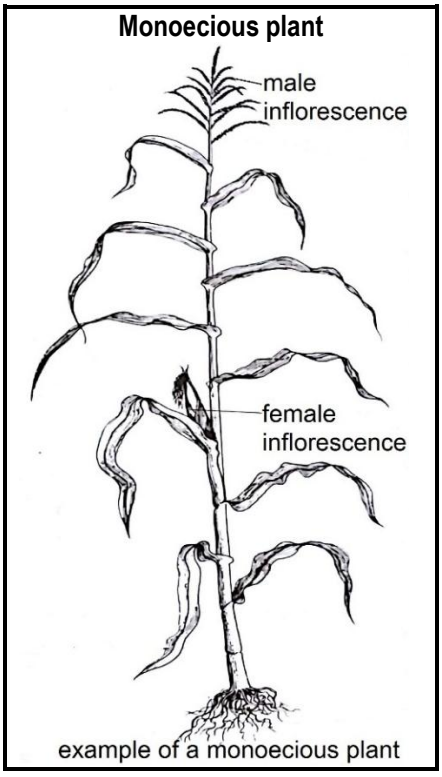
The two types of ovaries include the following

1. **Superior ovary:** Is the one that arises above the other floral parts e.g. hibiscus, cassia, mimosa pudica, etc.
2. **Inferior ovary:** Is the one which arises below the rest of the floral parts e.g. morning glory.

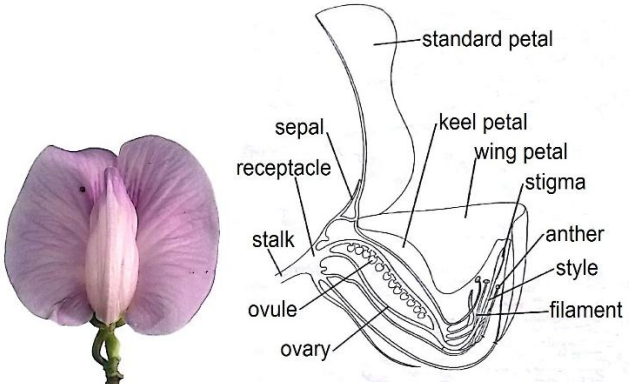
Terms used

1) **Complete flower:** A flower having all the four whorls or floral parts i.e. calyx, corolla, stamen and pistil.
2) **Incomplete flower:** A flower lacking one or more of the four floral parts.
3) **Unisexual flower:** Has only one of the sexual parts i.e. staminate (when the flower has stamens only). Pistillate (when it has carpels only).
4) **Staminode:** sterile stamen.
5) **Petaloid:** Sepals resembling petals and have the same colour.
6) **Sepaloid:** They are petals which resemble sepals and are green in colour.
7) **Bisexual (hermaphrodite) flower:** is one that contains both male and female organs and parts.
8) **Monoecious plant:** Is one that has the pistillate and staminate that are born on the ***same plant*** but at different points on the plant e.g. maize and castor oil plants.
9) **Dioecious plant:** is a plant that bears only one form of flower .i.e either pistillate or staminate flower only e.g. pawpaw.
10) **Regular (actinomorphic) flower:** a flower which can be divided symmetrically (equally) in different planes. E.g. hibiscus and morning glory flowers.





11) Irregular (zygomorphic) flower: is one which can be divided into 2 similar halves in only one plane. E.g. crotalaria



POLLINATION

Pollination is the transfer of pollen grains from the anther to the stigma of a flower. There are two types of pollination.

1. **Self-pollination**. This is the transfer of pollen grains from the anther to the stigma of the same flower or between two flowers on the same plant.
2. **Cross-pollination**. This is the transfer of pollen grains from the anthers of one flower to the stigma of another flower on a different plant but of the same species.

Agents of pollination

These are things that aid the process of pollination. The agents of pollination include.
Animals, Water, Wind and Artificial pollination
There are however two major agents that is wind and insects. Pollination can therefore be described as wind pollination and insect pollination.

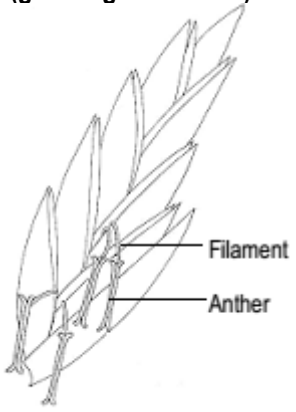
Characteristics of insect pollinated flowers

- They have brightly coloured petals to attract insects.
- They have a scent to attract insects
- They have large conspicuous petals, which act as landing sites for insects.
- They have sticky pollen grains, which stick to the insects' body.
- They have sticky stigmas, which hold pollen grains.
- They produce few sticky pollen grains.
- They produce heavy pollen grains.
- They produce nectar from nectarines to attract insects.

Characteristics of wind pollinated flowers.

- They have dull coloured petals.
- They have small petals.
- They produce light pollen grains, which can easily be carried by wind.
- They do not produce nectar.
- They have feathery stigmas to trap pollen grains carried by wind.
- They produce big quantities of pollen grains.
- They have no scent.
- They have long stamens and pistils hanging outside the petals to release and receive respectively pollen grains easily.

Drawing of a wind pollinated flower (guinea grass flower)



Long stamen hanging out side

Differences between insect and wind pollinated flowers.

Insect pollinated flower	Wind pollinated flower
Have brightly coloured petals	Have dull coloured petals
Have a scent	Have no scent
Produce nectar from nectarines	Produce no nectar

Have large petals	Have small petals
Produce few pollen grains	Produce a lot of pollen grains
Have sticky stigmas	Have feathery stigmas
Produce heavy pollen grains	Produce light pollen grains
Stigmas often deep in corolla	Stigmas long and protrude above petals.
Stamens may be within corolla	Stamens long and protrude above petals

Characteristics of flowers pollinated by nocturnal insects

Nocturnal insects are those insects, which are active at night. Flowers pollinated by such insects have the following characteristics.

1. They have light coloured petals mainly white and pink.
2. They produce a strong scent.
3. They open their petals at night and close them during daytime.

Modifications of flowers to prevent self-pollination

1. ***Dichogamy:*** Is a condition in which the male and female parts of a flower mature at different times. There are 2 types;
   - Protandry: This is a situation where stamens ripen before the stigma such that when pollination occurs, the pollen grains cannot germinate on the immature stigma.
   - Protogyny: This is a condition where the stigma ripens before the anthers.
2. **Dioecious condition**. This is a condition where a plant bears either pistillate or staminate flowers but not both.
3. **Self-incompatibility**. This is where pollen grains from the same flower fail to fertilize the stigma of that flower.
4. **Structure of the flower**. Sometimes the carpel is taller than the stamens of the same flower and in some flowers the corolla covers the stamens preventing self-pollination.

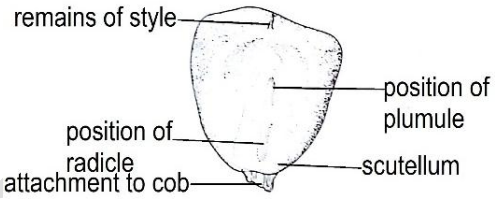
SEEDS

A seed is a fertilized mature ovule. It has one scar called hilum which is a spot where it was attached to the pod inside a fruit.

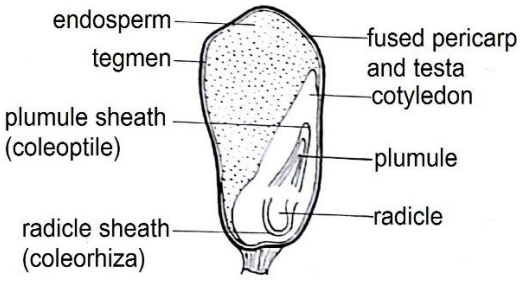
Types of seeds

1. **Monocotyledonous seeds:** These contain only one seed leaf or cotyledon. E.g. cereals like maize.

External view of a maize seed

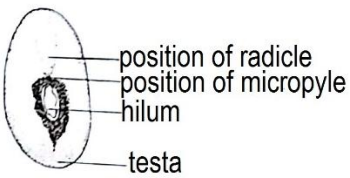


Internal structure of a monocot seed (maize seed)

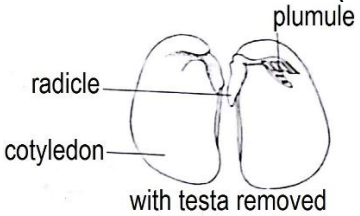


2. **Dicotyledonous seeds:** These contain 2 cotyledons e.g. legumes like beans, peas and G. nuts.

External view of a dicot seed (bean)



Internal structure of a dicot seed (bean)



Testa: It protects the inner parts of the seed from mechanical injury, heat from the environment and from fungal and bacterial attack.

Tegmen: It is the inner membrane of the seed coat and it's also used for protection.

Micropyle: It is a narrow opening into the seed through which water, mineral salts and oxygen enter during germination. It is also the opening through which the radicle comes out of the seed.

Radicle: It develops into primary root of the plant.

Plumule: it develops into the shoot of a plant.
Hilum: It's a scar of attachment left by the seed to the fruit wall. *It is the feature that distinguishes seeds from fruits.*
Endosperm: Stores food especially starch for the embryo.
Scutellum or cotyledon: It provides food to the whole seed. It contains stored food like starch, proteins and liquids for the initial growth of the embryo during germination.
Coleorhiza: It is the radicle sheath that offers protection to the radicle.
Coleoptile: It is the plumule sheath that offers protection to the plumule.

Adaptations of the seed

Has a hard seed coat for protection against chemical injury, bacterial and fungal infection.
Has food reserves used by the embryo during drought.
Has a micropyle to allow in water and air.
Note: the maize grain is both a seed and a fruit. It's a fruit because it has two scars, i.e. the remains of the style and remains of the stalk.

FRUITS

A fruit is a fully grown fertilized ovary containing one or more seeds. A fruit has 2 scars, one where it was attached to the receptacle and the other, the remains of the style or stigma.
During a fruit formation, the wall of the ovary becomes a fruit wall called pericarp. In some fruits such as banana and pine apple, the fruits develop without fertilization. Such fruit are said to be ***parthenocarpic*** fruits. Therefore ***parthenocarpy is the development of fruits without fertilization.***

Classes of fruits

True fruits: develop only from the ovaries of a flower e.g. beans, tomatoes, etc.
False fruits: develop from the association of ovaries and other floral parts such as receptacle. Examples include; pineapples and apples.

Classification of fruits

There are 3 groups of fruits namely;

i) Simple fruits

These are formed from one flower in which the pistil consists of either one carpel (monocarpic) or of several fused together (syncarpous) e.g. legumes, ground nuts, peas, tomatoes, mango, beans, etc.

ii) Aggregate fruits

These are formed from one flower in which the pistil consists of several free carpels (apocarpous) e.g. apples and rose.

iii) Multiple fruits

These are formed from several flowers and the ovaries become fused after fertilization e.g. jackfruit and pineapple.

SIMPLE FRUITS

There are either dry or succulent according to whether the pericarp becomes dry or juicy as the fruit ripens.

Types of simple fruits

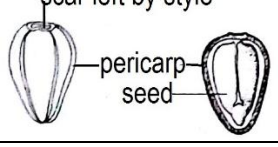
Simple fruits are further divided into three categories.

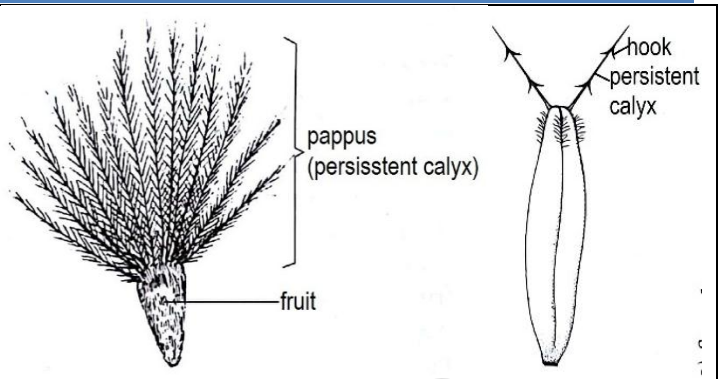
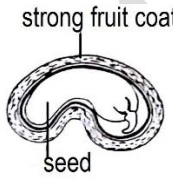
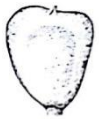
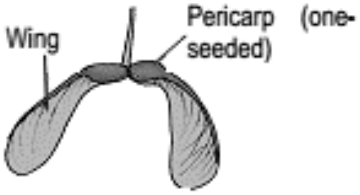
1. Dry indehiscent fruits
2. Dry dehiscent fruits
3. Succulent fruits.

Dry indehiscent fruits

These are fruits with a dry pericarp that does not split up (dehisce) to release seeds. This category contains five types of fruits. These are Achene, Nut, Caryopsis, Cypsela and Samara.

The table below shows the different types of dry indehiscent fruits.

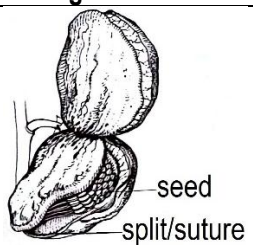
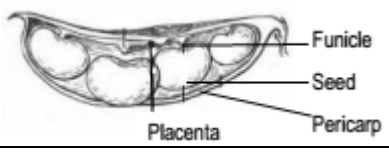
Type of dry indehiscent fruit	Description	Illustrative diagram
Achene	This is a one seeded fruit covered by a dry pericarp, which does not split open, e.g. sunflower	**An achene of sunflower** 

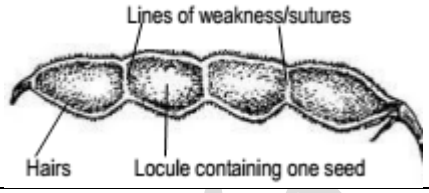
Cypsela	They have a persistent calyx which forms a parachute of hairs called a pappus. E.g. Tridax and black jack.	 Tridax black jack
Nut.	It has one seed and has a dry hard and tough pericarp which does not split open, e.g. cashew nut. Note; coconuts and groundnuts are biologically not nuts.	**Section through a cashew nut** 
Caryopsis.	The testa and pericarp are fused together. These are mainly in grasses and maize.	**Caryopsis of maize** 
Samara.	The pericarp is extended to form one or more wing-like structures, e.g. African rose wood. 	**Samara of the African rose wood** 

Dry dehiscent fruits

These are fruits with a dry pericarp that splits (dehisces) to release seeds. The fruits split at particular lines of weakness known as sutures. These fruits are categorized into the following different groups depending on the number of splits that occur on the pericarp. These fruits include, Follicles, Legume, Capsule and Schizocarp.

The table below shows the different types of dry dehiscent fruits

Type of dehiscent fruit	Description	Illustrative diagram
Follicle	This is a dry fruit with many seeds and splits open along one suture, e.g. Sodom apple	
Legume.	This is a dry fruit with many seeds and splits open along two sutures, e.g. beans, peas, flamboyant, jacaranda fruit and Barbados pride.	**Legume of a bean** 

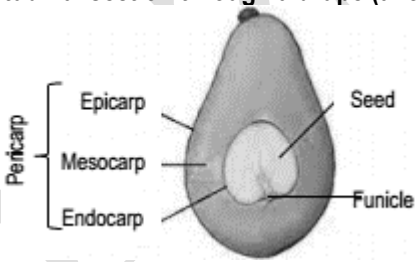
Capsule	This is a dry fruit with many seeds and splits open along many vertical slits. It is formed from an apocarpous flower, e.g. Dutchman's pipe, balsam, cotton, etc.	
Schizocarp.	This is a dry fruit that splits into single-seeded parts (loments) when ripe. e.g. desmodium, sweet hearts and some cassia.	

Succulent fruits

These are fleshy fruits. They are either entirely fleshy or have part of it fleshy. They are further divided into 2 types.

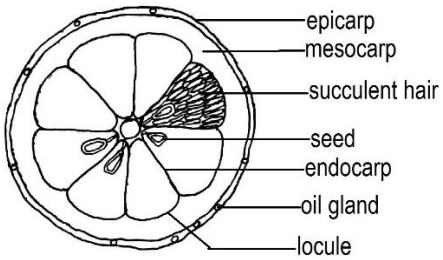
1. **Drupes.**
   These are fruits with only one seed and only part of it fleshy (epicarp and mesocarp). The endocarp is fibrous and hard, e.g. mango and avocado.

Longitudinal section through a drupe (avocado)

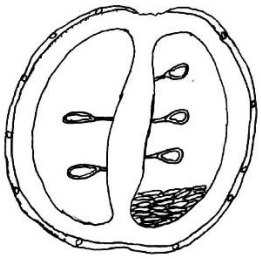


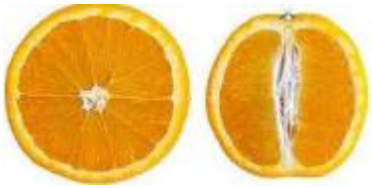
2. **Berry.**
   This is a fruit with many seeds and the whole of it fleshy, e.g. tomatoes, guavas, oranges, bananas etc.

A drawing of the transverse section through a berry (orange)

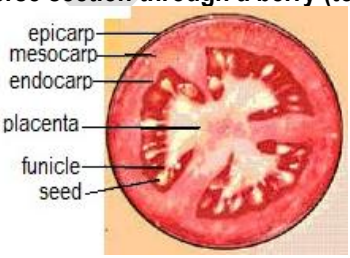


A drawing of the longitudinal section through a berry (orange)

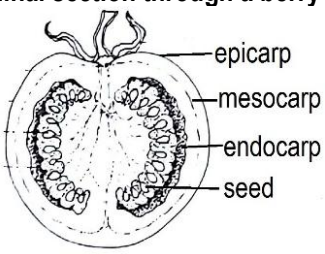




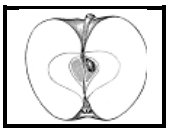
Tranverse section through a berry (tomato)



Longitudinal section through a berry (tomato)

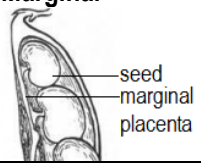
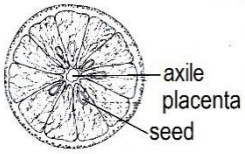
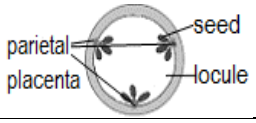
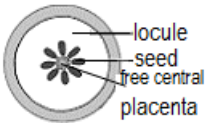
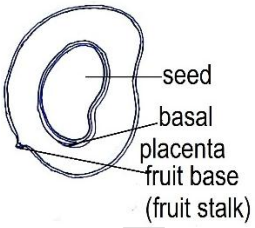
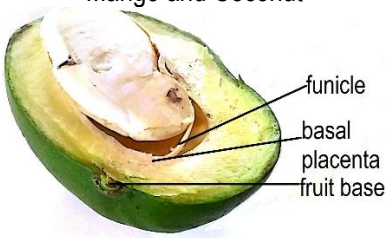
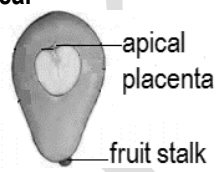


3. **Pome**
   This is a succulent fruit in which the outer fleshy (normally edible) part develops from the calyx and receptacle. The ovary forms a papery cover containing seeds e.g. apple and pears.



PLACENTATION

Placentation refers to the pattern of seed attachment in the fruit. There are six types of placentation i.e. marginal, axile, free central, parietal, basal and apical placentation as shown in the table below.

Type of Placentation	Description	Example
1. Marginal 	The seeds are attached along the margin of the fruit wall.	Beans, peas, cassia 
2. Axile/central 	The seeds are attached at the center of the fruit.	Orange and tomato 
3. Parietal 	Seeds are attached to the placenta at the inner wall of the fruit.	Passion fruits and pawpaw 
4. Free central 	Seeds are attached to a placenta that is free within the fruit. The placenta arises at the base of the fruit and projects centrally in the fruit.	Green pepper 
5. Basal 	The seed is attached at the base of the fruit by a pedicel. A fruit base is the point of attachment of the fruit to the stalk.	Mango and Coconut 
6. Apical 	Seed attached at the tip/apex of the inner fruit wall.	Avocado 

FRUIT/SEED DISPERSAL

This is the scattering or spreading/displacement of fruits and seeds from their parent plants. In some plants, only seeds are dispersed while in others, fruits are dispersed with seeds.

Importance of dispersal

i) It helps to prevent overcrowding among plants of the same species.
ii) It reduces competition between member plants of the same species.
iii) It helps to minimize the spread of epidemic diseases especially in seedlings if they are crowded.
iv) It helps plants to colonize new areas which may even be better for the species survival.
v) It enhances the chances of survival and continuity of the plant species.

Agents of dispersal include the following:

1) Water,
2) Wind

3) Animals
4) Self-dispersal/ explosive mechanism

Fruits and seeds possess specialized structure to aid their dispersal and are adopted to specific mode of dispersal.

Characteristics of fruits/seeds dispersed by wind

i) They are usually small, light and dry which enables them to easily be carried or flown by wind.
ii) Some fruits like elm and tecoma have wing like structures that increase their surface area. This helps in delaying the fall of seeds and fruits and increases chances of being blown away.
iii) Some fruits like tridax and clancletion have parachute-like hairs called pappus which enables them to fleet and fly by wind.
iv) Some seeds like silk cotton possess thread-like structures called floss which increase surface area enabling the seeds to float in air.

Characteristics of fruits/seeds dispersed by animals

i) Some fruits such as tomatoes, oranges and mangoes are usually large and brightly coloured especially when ripe. This helps to attract animals.
ii) Some fruits when ripe are scented e.g. jack fruit. This helps to lure/attract animals.
iii) Some usually possess edible parts which are succulent / juicy and the only part of the fruit that is eaten and the rest containing the seeds is thrown away e.g. mango and avocado.
iv) In some fruits, such as guavas, tomatoes, pepper and pawpaw. The whole fruit is eaten and the seed passed out in the faeces because of their resistance to digesting i.e. are indigestible.
v) Some fruits e.g. Biden pilosa and desmodium possess hooks and sticks in the hair of passing animals. They stick in the fur of animals or on clothing of people.

Characteristics of fruits/seeds dispersed by water

They are usually light and contain air space inside which reduces their relative density that enable them float on water easily like the coconut.

Self-dispersal

a) explosive mechanism

This happens with dry dehiscent fruits. The pericarp splits open along the sutures to release the seeds. This is made possible due to the tension that is built during the process of dying. E.g. legumes, capsule or follicles

b) ribbon fruits

These are succulent, may drop freely from the parent plant. The pericarp then rots, bearing the seeds that are enclosed within a hard protective testa so that it can begin germinating.

"You can have anything you want-if you want it badly enough. You can be anything you want to be, have anything you desire, accomplish anything you set out to accomplish-if you will hold to that desire with singleness of purpose" Robert Collier.

END OF S.1 WORK- CONGRATULATIONS