PRECISE

O'LEVEL BIOLOGY

PRACTICAL WORK BOOK

By

ALLAN KATUNGUKA

Name: .....

School: .....

Year: .....

PREFACE

This text was designed to meet most of the requirements in Biology Practical for students preparing for Ordinary Level Biology Practical Examination.

It consists of simplified revision notes with questions and answers based on the requirements of Uganda Certificate of Education and cover all that is required for S.1 to S.4 teaching syllabus.

All topics handled are logically arranged according to the teaching follow up with related UNEB questions to enable the readers acquire skills and technique during examination times.

Osmosis experiments, soil and its properties, plus practical experiments of classification which are always ignored but are essential have been fully discussed and given their prominence. Other areas like insects, flowers, fruits and seeds, enzyme catalyse and bones have been presented in details.

Illustrations have been fully done. Therefore, it is my sincere hope that students who will use this text will obviously find Biology practical examinations easier to handle.

Note: It is always important that practical teaching be done from S.1 term 3 and followed according to the theory teaching which is not always met by most teachers. This book has tried to give direction to the teachers, thus it is ideal for both teachers and students.

ACKNOWLEDGEMENT

I hereby put my indebted thanks to the **Katunguka** family members who have exceedingly given me advice, care support and whole some love as their beloved son and brother. Special thanks go to my sister Mrs. Merynah Bagira for the financial support she offered to my work. And my beloved sister Prudence Katunguka for the printing services she endeavoured to give.

DEDICATION

I dedicate piece of work to my beloved daughter; **Shallon Evelyn Katunguka,** a precious gift that God placed in my life.

Senior One, Term Three:

CHAPTER 1: BIOLOGICAL DRAWINGS

A Biological drawing is a simple plan diagram of part or the whole specimen and does not require fine art skills. It is a permanent record of what has been observed. This is an important part of training of the Biologist.

Basic Requirements:

A student preparing for Biology practical must equip him or herself with the following:

- A transparent ruler 30cm long for measuring and drawing label lines.
- A sharp HB pencil for drawing.
- A rubber
- Razor blade.
- A piece of thread for measuring curving features on specimens and for tying.

Hints to Biological Drawings

- ✓ Always use a sharp lid pencil preferably HB grade. This is hard enough and therefore gives the drawing uniform thickness.
- ✓ Draw what you see not what you think.
- ✓ Always draw reasonably large drawings. Leave enough space at either side for labels.
- ✓ Always draw the right view or section i.e. Only that view or section asked for. Note that no marks are given for drawing a wrong view or section.
- ✓ Do not shade or colour your drawing.
- ✓ Keep your drawing neat by avoiding excessive rubbing. Use a clean white rubber where necessary.
- ✓ Make complete outlines of the whole drawing and its individual components. Avoid dotted or broken lines or half hinted scratches.
- ✓ Where a large number of small structures are present on the specimen draw only a few to show their arrangement e.g. fish scales.
- ✓ Always label your drawings unless otherwise stated.
- ✓ State the full title of the drawing. This is written above the drawing. It should include the name of the specimen or part, view and or type of section.
- ✓ Always make sure that you include the magnification written at bottom right corner of the drawing.
- ✓ All drawings must be proportional. Size of the features of specimen should be relative ratios of the actual size of the specimen.

LABELING:

Labelling is one area where students lose marks from on biological drawings.

In labeling carefully note following:

- ✓ Labelling lines should be horizontal, straight drawn using a ruler and pencil and preferably on the left side of the drawing and must never cross each other.
- ✓ The label lines should be exactly at the centre of structure labelled and the label i.e. should touch the structure being labelled.
- ✓ Always use a line in labelling. Do not use arrows i.e. ⟶ Or ⟵ on the label. Arrows indicate direction.
- ✓ Use correct spelling as wrong spelling may form another word of Biological meaning e.g. acne for achene.
- ✓ Do not label in plural for a single structure e.g. leg not legs.

MAGNIFICATION

This should be stated on the bottom right hand corner of the drawing stated with a multiplication sign before resulting figure e.g. x5 and not 5x. Decimals are unacceptable instead use fractions.

The basic formula used is:

$$\text{Magnification} = \frac{\text{Size of drawing}}{\text{Size of specimen}}$$

Magnification is a ratio and therefore has no units. However, problems arise when the student fails to choose whether to measure the length or the width of the specimen. Always measure the length for specimens that are just long i.e. longer than they are wide e.g. a cockroach. For those that are round e.g. Orange measure the width (or diameter)

Activity 1

a). You are provided with specimen A, make a clear drawing of the specimen in the space provided. Do not label, indicate your magnification *(**specimen A is a bean seed**)*

b). You are provided with specimen B, make a labelled drawing of the specimen in the space provided. Include your magnification. (***Specimen B is a simple leaf***)

Activity 2

a). You are provided with specimen K (***K is a fleshly killed cockroach***). Remove the hind leg of the specimen, draw and label.

b). You are provided with specimen W, **which is a flower**. Carefully remove the petals and anthers and draw the female part of the specimen.

Activity 3

a). You are provided with specimen M, make a clear drawing of the specimen in the space provided to a magnification of X2. Do not label. *(**Specimen M is an Irish potato**)*

b). You are provided with specimen N, make a clear drawing of the specimen in the space provided. (***Specimen N is a small herbaceous plant***)

DRAWING OF VIEWS AND SECTIONS

A candidate sometimes is asked to draw a specimen in a specific view but the terms for such views may be technical. The list below gives the most common views and the technical terms used.

Note that *no marks are awarded for drawing a wrong view*

a. **Transverse section:** Viewed from a section cut across. Also called cross-section. i.e. for a fruit; leaving a scar up and the other scar on the second section.
b. **Longitudinal section**: Viewed from a section cut along the length. It cuts through two scars.
c. **Dorsal view:** Side as seen from the back.
d. **Ventral view**: Side as seen from the bottom part of the organism. (Belly side).
e. **Lateral view**: Viewed from the side part of the specimen. Also called side view.
f. **Anterior view**: As seen from the front of the organism. Always the top part of the organism.
g. **Posterior view**: As seen from the rear or hind part of the organism. e.g. a cow's tail is on the posterior.
h. **Side**: The side can be the left side or the right side. Your right side is the left of the specimen and your left side is the right of the specimen that directly faces you.
i. **Trunk:** Part of the body of the body of an organism, without appendages such as limbs, tail and the head in animals and roots and branches in plants.
j. **Interior:** Inner part of the specimen.
k. **Exterior:** Outer part of the specimen.
l. **Proximal end**: Upper part or top part of the specimen.
m. **Distal end**: Bottom part or lower end of the specimen.

Activity 4

You are provided with specimen C and D and a knife. (***Specimen C is an orange fruit, specimen D is a mango fruit).***

a). Cut specimen C transversely using a knife and make a drawing of one section. State your magnification. Do not label.

b). Cut specimen D longitudinally using a knife and make a drawing of one section. Do not label.

Activity 5

You are provided with specimen M. (***specimen M is a freshly killed cockroach***)

a). Make a drawing showing the dorsal view. Do not label.

b) Remove the antenna and make a clear drawing of it putting to magnification of X5 to X10. Do not label.

Activity 6

a) You are provided with specimen P. (***specimen P is a freshly killed grasshopper / locust***)

Make a drawing showing the lateral view.

b) You are provided with specimen T which is a plant. Carefully cut off the shoot and draw the remaining part to show the root nodules. **(specimen T is a bean plant)**

Senior two, first term:

CHAPTER 2: STORAGE ORGANS.

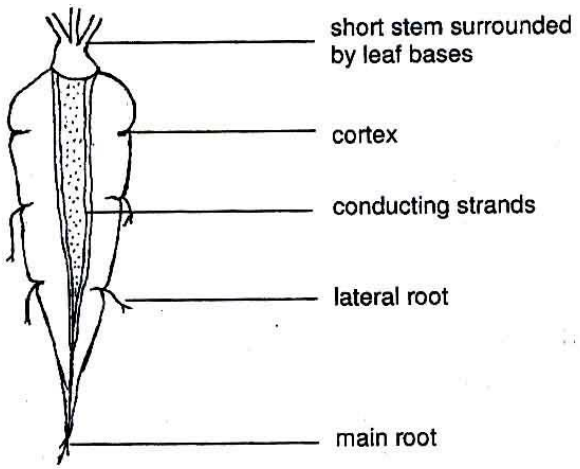
ROOTS

Modified tap root for food storage:

Roots are mod

Modified Tap root: Is a swollen main root with a very short stem at top e.g. carrot. The food reserves are sugar mainly glucose which are stored in the cortex of the carrot.

Vertical section through the tap root of a Carrot



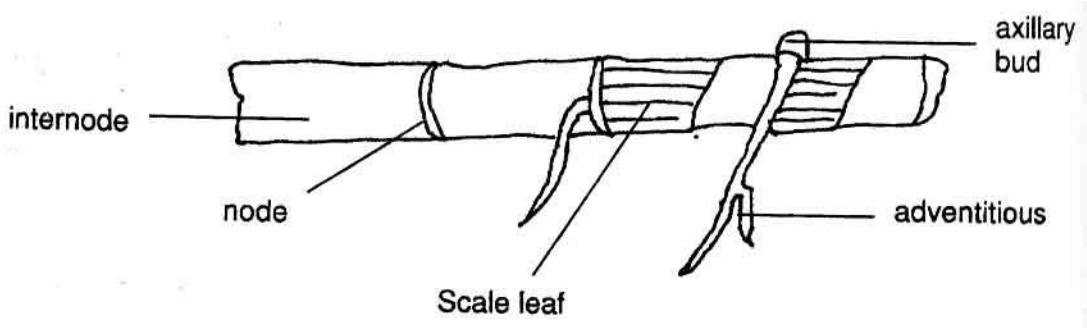
STEMS

Modified stems for storage

Rhizome;

A rhizome is a horizontal underground stem e.g. ginger and coach grass.

Rhizome of a Coach Grass



Characteristics

i) Has scale leaves or scars where leaves were attached.

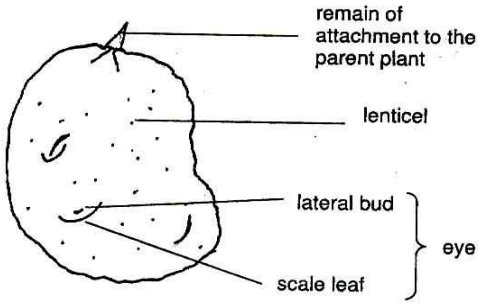
ii) Has buds growing in the axial of leaves.

iii) Has adventitious roots growing from the nodes.

Stem tuber.

Stem tubers are the swollen ends of underground stem e.g. Irish potato.

Stem tuber of Irish potato.



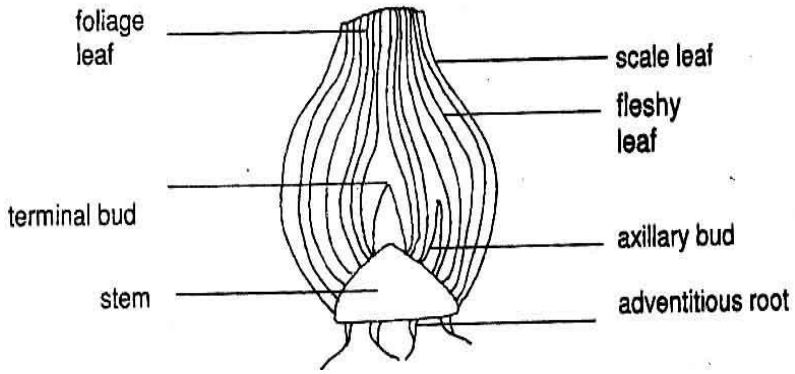
Characteristics

i) Have scaly leaves.
ii) Presence of buds.
iii) It is swollen

Bulb e.g. Onion.

A bulb is condensed underground shoot. It consists of short conical stem covered by fleshy leaves on the inside and dry leaves on the outside.

Vertical section of an Onion bulb



Characteristics

i) It has scale leaves
ii) It has fleshy leaves
iii) It has auxiliary bud
iv) It has adventitious roots

Advantages of food storage to plants

i) It permits survival of the plant in harsh conditions in that the plant has enough food reserves.
ii) It ensures rapid growth since the plant has enough food reserves.
iii) The reserves of the seed are used in the rapid growth of the plant embryo when environmental conditions are at their best.

UNEB QUESTIONS TO BIOLOGY PAPERS 553/2/3

Activity 7

Study specimens U ***(Onion***) and V (***Ginger***) and answer the questions that follow:

a) Identify specimens U and V and give reasons for your identity.

Specimen U……

Reasons: i) ……

ii) ……

iii)……

Specimen V ……

Reasons: i) ……

ii) ……

iii)……

b) Outline the similarities between the specimens.

……

……

……

c) State the differences between the Specimens.

SPECIMEN U	**SPECIMEN V**

d) Cut specimen U longitudinally into two halves. Draw and label one half.

Activity 8

You are provided with specimen D which is a plant organ. **(D is an Irish potato tuber).** Observe carefully and answer the questions below.

(a) Identify which plant part the specimen is giving reasons.

……

Reasons

i) ……

ii) ……

iii) ……

(b) Make a large well labelled drawing of specimen D

Activity 9

You are provided with specimens P **(Irish potato**) and Q **(Ginger**), which are similar plant parts. Study the specimens and answer the questions that follow:

(a) Using two common features, state what plant parts the specimens are?

Plant part: ……

Reasons:i)……

ii)……

(b) What is the importance of the specimens to plant, using observable features?

……

……

……

……

(c) From the structure of Q, suggest what enabled the plant from which the specimen was obtained to be successful in its habitat.

……

……

……

……

(d) Make a clear drawing of specimen Q including two nodes and one complete internode.

(e) Make a clear drawing of specimen P. Do not label. Make it to a magnification of X2.

Activity 10

You are provided with specimen L which is a modified part of a plant. **(specimen L is an onion)**

(a) Cut specimen L transversely into two parts. Using the bottom part, describe how the leaves are arranged.

.....

.....

.....

(b) Giving reasons suggest the great importance of the top most part.

Importance

.....

.....

Reason

.....

.....

(c) Giving reasons suggest the great importance of the bottom part.

Importance	Reason

(d) Carefully make a clear drawing of the lateral view of the bottom part of the specimen in the space provided.

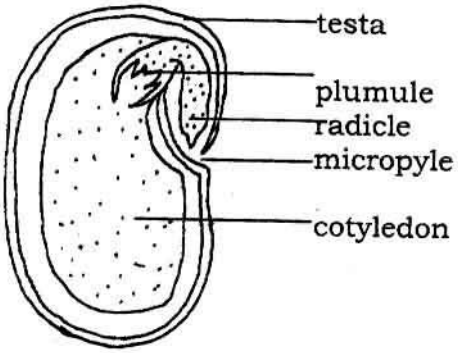
FRUITS AND SEEDS

Seeds

A seed is a mature fertilized ovule. A seed consists of the following basic parts. The testa (seed coat), the embryo (plumule and radicle), the cotyledon (food reserves). Seeds are divided into Monocotyledonous and Dicotyledonous.

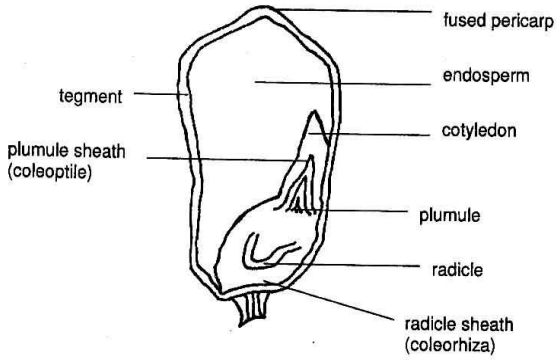
a) Dicotyledonous seed e.g. Bean seed.

Longitudinal Section of Bean seed



b) Monocotyledonous seeds e.g. cereals.

Vertical section through maize grain



FRUITS: A fruit is a fertilized ovary.

Classification of fruits.

1. Simple fruits.
2. Aggregate fruits
3. Multiple fruits.

1. SIMPLE FRUITS.

Classification of simple fruits

Simple fruits include;

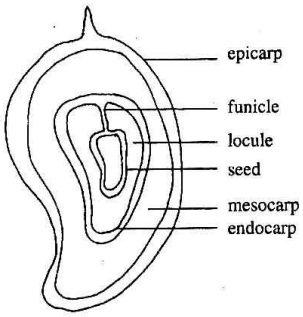
(a) SUCCULENT FRUITS

These are fruits which have whole or part of their pericarp fleshy and juicy. Their pericarps consist of three layers. The outer layer (epicarp), the middle flesh layer (mesocarp) and the inner layer (endocarp)

They include: -

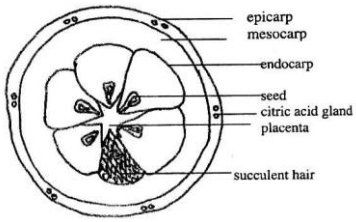
i). Drupe: These have part of their pericarp fleshy. The inner layer (endocarp) forms a stone like material enclosing the seed e.g mango, avocado.

Longitudinal section through mango

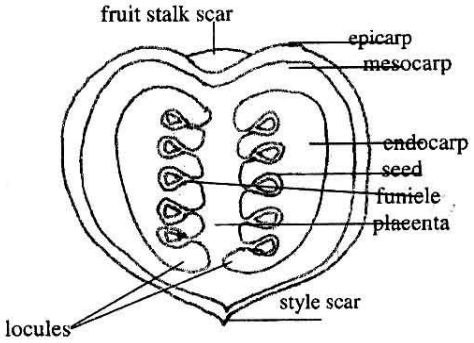


ii). Berries: Here the pericarp is divided into three layers; both the mesocarp and endocarp are fleshy, they have many carpels with many seeds e.g. Tomato, oranges, guava, banana.

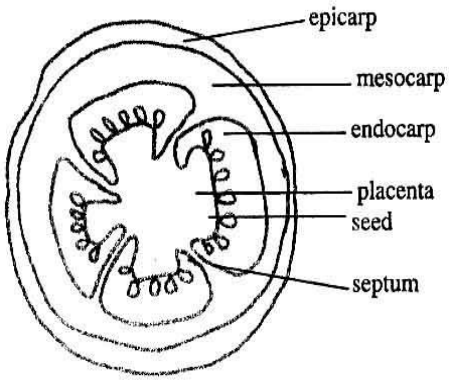
Transverse section through an orange



Longitudinal section through tomato



Transverse or cross section through tomato



(b) DRY DEHISCENT FRUITS

These are dry fruits whose pericarps dehisce (i.e. split open) to release the seeds when mature and dry.

They are further sub divided into several groups according to dehiscence lines (i.e. lines of weakness called sutures) along which the fruit opens.

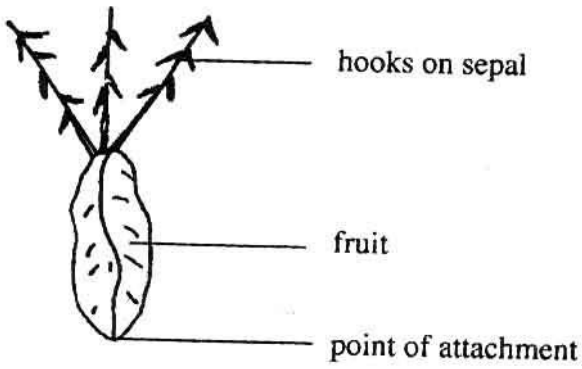
- **Legume** – has two longitudinal lines of weakness along which it splits e.g. the bean, peas, g. nuts etc.
- **Follicle** - has one line of weakness along which it splits e.g. cassia, Sodom apple, etc.
- **Capsule** – splits longitudinally along more than two sutures e.g. castor oil frit, tobacco etc.
- **Schizocarp** – breaks up into several parts each containing a seed e.g. desmodium.

(c) DRY INDEHISCENT FRUITS:

These are fruits whose pericarps do not split to release seeds when mature and dry. They are further categorized as follows:

- **Achene** – single seeded fruit surrounded by a dry pericarp e. g. sunflower r and bidens pilosa (Black jack)

A drawing of an Achene of the Black Jack



- **Nut** – single seeded fruit surrounded by a very hard pericarp e.g. cashew nut, coconut etc.
- **Samara** – a fruit whose pericarp is extended to form wings e.g. the elim and African rose wood
- **Cypsela** –single seeded fruit whose calyx has persisted forming a parachute of hairs called a pappus e.g. tridax.
- **Caryopsis** –a fruit in which the pericarp and testa are fused together e.g. maize

Note: when fruits are set as specimens in practical tests identifying them is one area where students lose marks .When asked to state the type of a fruit, do not use common names, strictly use biological groupings. For example do not identify an orange as orange or even write two answers like orange (berry) or as, orange or berry. This indicates that you are not sure of the answer. The student should also be equipped with enough theory on characteristic features of fruits because you may be required to specify or state reasons for the identity.

Correct identification of common fruits and seeds

Fruit/Seed	Identification
Tomato	Berry
Mango	Drupe
Avocado	Drupe
Black jack	Achene
Tridax	cypsela
Desmodium	Schizocarp
Maize grain	Caryopsis
Bean Pod	Legume
Orange	Berry
Cassia fruit	Follicle
Castor oil fruit	Capsule

Advantages of food storage in fruits and seed

i) It permits survival of the plant in that the seeds remain dormant over dry season or even for several years if they are in a dry stage.

ii) After dispersal, the seed may reach an unfavourable habitat but even so, growth can proceed for a while until all the reserves have been used or until favourable conditions return,

iii) The food reserves of some fruits are used as food by animals

PLACENTATION:

Is the arrangement of the ovules within the ovary or seeds within a fruit.

Types of Placentation

1. Axile placentation: Here the ovules are situated around a common axis in the middle of the ovary e.g. banana, tomato, orange etc.

2. Free central placentation: the ovules are situated on a column arising from a base in the middle of the ovary e.g. Avocado etc.

3. Marginal placentation: The ovules are situated at or near the margin of the ovary e.g. bean, peas etc.

4. Pariental placentation: the ovules are situated at the inner margin of the fruit wall e.g. pawpaw, passion fruit, cucuber.

5. Basal placentation: The single ovule or seed is inserted on to the floor of the ovary and the seed or ovule cover a big proportion of the locule; e.g. Mango,

Activity 11

You are provided with specimens P, Q, R, S, T, U and V (P **is tridax, Q is desmodium, R is black jack, S is bean pod, T is orange, U mango V is cassia**)

(a) State the identity of each specimen giving reasons for your identiy.

P……

Q……

R……

S……

T……

U……

V……

Reasons

P……

……

Q……

……

R……

……

S……

……

T……

……

U……

……

V……

……

(b) Examine the exposed sections of specimens S, T and U. Describe the seed arrangement of the specimens.

S……

……

T……

……

U……

……

Activity 12

(a) You are provided with specimens P, Q, and S. Examine the specimens and answer the questions that follow. (**P is a bean pod, Q is a pawpaw, and S is a mango)**

Open up **P** longitudinally and also cut transverse sections of Q and S. Observe the sections of **P** and **S** and state three differences between them.

P	**S**

(b) Identify the type of fruit each of specimens Q and S, basing on their structure.

Q.....

Reasons.....

.....

S.....

Reasons.....

.....

(c) Describe the seed arrangement in the specimens, and in each case give the biological term.

Specimen P

.....

.....

Biological term

.....

Specimen Q

.....

.....

Biological term

.....

Specimen S

.....

.....

Biological term

.....

(d) Make clear drawings of the cut sections of the specimens Q and S

Activity 13

You are provided with specimens M and N which are fruits. **(M is a desmodium, and N is Castor oil fruit)**

(a) State two observable features on the specimens to suggest that they are fruits

……

……

(b) State the identity of each specimen.

M……

N……

(c) state the differences and similarities between the specimens

Differences

M	N

Similarities

……

……

……

……

(d) Make a clear drawing of specimen N in the space provided. Do not label. State your magnification.

Activity 14

You are provided with specimen Q which is a plant organ. **(Q is bean fruit)**

(a) Observe clearly and identify the specimen giving three reasons for your identity.

Identity

.....

Reasons

.....

.....

.....

(b) Describe the seed arrangement in the specimen giving the biological description of the arrangement.

Seed arrangement

.....

.....

.....

Biological description.

.....

(c) Make a large well labelled drawing of specimen Q

Activity 15

You are provided with specimens M and N, which are fruits. (**M is a black jack, N is a tridax)**

(a) Suggest two observable features on the specimens that suggest that they are fruits.

.....

.....

(b) State the type of fruit the specimens are, giving reasons for your answer.
Type of fruit

.....

Reasons

.....

.....

.....

(c) Observe the specimens carefully and outline the differences between the specimens.

Specimen M	Specimen N

(d) Make a large drawing of specimen N in the space provided. Include your magnification. Do not label.

Senior two, second term

FRUIT AND SEED DISPERSAL

Dispersal is the scattering of fruits and seeds from the parent plant.

Agents of dispersal:

1. **Wind dispersal**

Characteristics of seeds and fruits dispersed by wind

i) They must be small and light e.g. orchids and Begonia.
ii) They may have winged like structures e.g. Jacaranda
iii) They may have modified: (persistent) calyx, which form parachute like puff of hair called pappus e.g. cypsela of tridax,
iv) They may have hair like structure called floss e.g. cotton and silk cotton.

2. **Animals dispersal**

Characteristics of seeds and fruits dispersed by animals

(i) They have hooks on their coats so that they become attached to the hair coat of mammals e.g. Bidens pilosa.
(ii) They possess sticky hairs which attach on the body of animal e.g. desmodium.
(iii) Some are succulent fruits, only part of the fruit is eaten and the rest containing the seeds are thrown away e.g. mango and orange.
(iv) Ability of certain seeds to resist digestion when swallowed by animals and later released in faeces e.g. guava, passion fruit.
(v) Possession of brightly coloured epicarp in ripe succulent fruits which attract the animals especially man, monkey, birds which eat them and disperse the seeds e.g. mango, tomato, oranges.

3. **Dispersal by water**

(i) The seeds of certain water lilies have hair spaces which make them to float in water.
(ii) The coconut fruits float and are known to be carried many hundreds of miles by sea currents. They can still germinate after they have been in salt water for over one hundred days.

4. **Dispersal by an explosive mechanism (Self dispersal)**

(i) The pods formed by the flowers of the beans dry in the sun or dry wind and shrivel, shrink and set up tension. When the carpel splits into half down two lines of weakness, the two halves twist up trapping the seeds between the coils. As the coils tighten, the seeds are suddenly squeezed out and projected away from the parent.
(ii) The fruit of balsam is an explosive capsule. When it is ripe, its wall splits along one or more of its lines of fusion. The inner wall of fruit is so tense that when it is released, the top and bottom of the fruits are pulled together suddenly and the seeds are sprayed around the plant.

Fruits, agents of dispersal and descriptions

Fruits	Agent of dispersal	Description
Tomato, Guava, Passion fruit	Animal	The fruit is edible, succulent and juicy. It has attractive colour (bright colour). When eaten by animals, the seeds resist digestion and are later passed with faeces.
Mango, Orange, Pawpaw	Animal	The fruit is edible, it is succulent or fleshy and has attractive colour. When animals eat fleshy part, the seeds are thrown away.
Desmodium fruit	Animal	The fruit has sticky hairs which attach onto the animal body, cloth/ Fur / hair and is removed elsewhere and thrown away.
Biden Pilosa	Animal	The fruit has hooks which attach onto animal body or fur/hair/cloth and is removed and thrown away from the parent plant.
Bean	Self disposal /self explosive	When the fruit is dry, they split or burst open along two lines of weakness. The seeds are then discarded or thrown out.
Coconut fruit	Wind	The fruit has air space, it floats in water and is carried away.
Tridax	Wind	The fruit has a modified calyx which form parachute hair-like pappus. When the wind blows, it is carried away from the parent plant.
Cotton and Silk	Wind	The fruit has hair-like structures called floss. The blowing wind carries the fruit from the parent plant.
Jacaranda fruit	Wind	The fruit has wing-like structures when dry. The blowing wind carries it away from the parent plant.

Activity 16

Candidates are provided with specimens **H_1** and **H_2**. Examine the specimens and answer the following questions. **(H_1 is bean pod and H_2 is desmodium fruit).**

a) Identify each specimen.

Specimen H_1.....

Specimen H_2.....

(b) State the mode of dispersal for each specimen.

Specimen H_1

Mode of dispersal.....

Reasons

.....

.....

Specimen H_2

Mode of dispersal.....

Reasons

.....

.....

(c) Outline similarities and differences between the specimens.

Similarities

.....

.....

.....

.....

Differences

H_4	H_5

Activity 17

You are provided with specimens **P and Q** which are fruits. (**P is orange fruit and Q is mango fruit)**

a) What is the biological type of the specimens **P and Q?**

P……

Q……

b) Cut a cross specimens **P,** Make a labelled drawing of the interior of the specimen. State your magnification.

Cut specimen Q, observe carefully and state how it differs from P.

P	Q

e) State the point of similarities between P and Q

……

……

……

f) State the reasons how you would believe specimen P and Q are dispersed

……

……

Activity 18

Study and examine specimens P (**Bean pod**), Q (**Tomato fruit**) and S **(Orange fruit)**

a) What is the biological nature of P?

.....

b) What type of fruit are Q and S biologically?

.....

c) Giving reasons identify specimen P

.....

Reasons

.....

.....

c) Outline the differences between S and P

Specimen S	Specimen P

e) Cut a vertical section of Q. Make a labelled drawing of One half of the specimen.

ii) How is the structure in P dispersed?

……

……

f) State the type of placentation observed in each specimen.

S……

P……

Activity 19

You are provided with specimen **K,** examine the specimen and answer the following questions**. (K is Biden pilosa)**

a) What is the biological nature of **K?**

……

b) Describe briefly how the dispersal of specimen K is brought about.

……

……

……

b) Make a large labelled drawing of specimen K. State the magnification of your drawing

Activity 20

Study specimens **W** and **X** provided carefully. Answer the questions that follow. (W is tridax fruit and **X** is Biden Pilosa)

(a) List the structural differences between **W** and **X**

SPRCIMEN W	**SPECIMEN X**

b) State the similarities between the specimens

……

……

c) Suggest with reasons how W and X are dispersed.

Specimen W……

Reasons

……

……

Specimen X……

Reasons

……

……

Activity 21

Specimens J, K, L, M and N are fruits. **(Specimen J is desmodiun fruit, K is black jack, L is orange specimen is bean pod and N is mango).**

a) State what type of fruit each specimen is:

J……

K……

L……

M……

N……

(b) Describe how each specimen is dispersed:

Specimen J

……

……

Specimen K

……

……

Specimen L

……

……

Specimen M

……

……

Specimen N

……

……

(c) Cut cross section of specimens **L**. Draw and label a cross section of specimen in the space provided. State your magnification.

Activity 22

You are provided with specimens **P** and **Q** which are plant structures. Study the specimens and use them to answer the questions that follow (**Note that specimen P is green tomato fruit and Q is mango or avocado fruit)**

(a) Giving three reasons, identify what plants parts the specimens are;

.....

Reasons

.....

.....

(b) State structural differences between **P** and **Q** in the table below

Specimen P	**Specimen Q**

(c) Cut open the specimens transversely, describe the arrangement of seeds in each specimen

(i) Seed arrangement in **p**

.....

.....

(ii) Seed arrangement in **Q**

.....

.....

(d) Using observable features, describe how each specimen is dispersed

(i) Specimen P

.....

.....

.....

(ii) Specimen **Q**

.....

.....

.....

(e) Draw and labelled the transverse section of **P**

(d) Draw the cut section of specimen **Q** in the space provided.

Activity 23

Your are provided with specimens **O, P, Q, R** and **S** which are fruits (**Note that specimen O is orange, P is black jack, Q is bean R is desmodium and S is mango)**

(a) What type of fruits are specimens Q and R?

……

Cut a transverse section of specimen **O**

Examine the specimens and give two characteristics features of each specimen

Specimen	**characteristics features**
O	
P	
Q	
R	
S	

(b) For each of the specimens **O, P, Q, and R** state the agent of dispersal and described how each specimen is adapted to being dispersed by the stated agent

(i) specimen **O**

Agent of dispersal……

Adaptations

……

……

……

(ii) Specimen **P**

Agent of dispersal……

Adaptations

……

……

……

(iii) Specimen **Q**

Agent of dispersal……

Adaptations

……

……

……

(iv) Specimen **R**

Agent of dispersal……

Adaptations

……

……

……

(v) Specimen **S**

Agent of dispersal……

Adaptations

……

……

……

(i) In the space provided, make a clear drawing of specimens **P**. State your magnification.

Activity 24

You are provided with specimens **K,L** and **M. (K is a mango, L is a tomato, M is an orange)** Examine the specimens and answer the questions that follow.

(a) Cut specimen P longitudinally and also cut transverse sections of Q and S. Observe the cut sections of P and S and state three differences between them.

K	M

(b) (i) Identify the type of fruit of the specimens L and M basing on their structure.

Type of fruit……

Reasons

……

……

(ii) State the mode of dispersal for specimen K

……

(iii) Describe how each of the specimens is dispersed.

Specimen K

……

……

……

Specimen L

……

……

……

Specimen M

……

……

……

(c) Draw the cut section of specimen K.

Activity 25

You are provided with specimens **P, Q, R** and **S** which are fruits. **(P is mango, Q is orange, R is bean pod, S is desmodium)**

Cut specimen P longitudinally and specimen Q transversely.

(a) Basing on observable features, state the type of each specimen is.

Specimen	**Type of Fruit**	**Observable feature**
P		
Q		
R		
S		

(b) (i) Observe specimen Q and describe the arrangement of seeds.

……

……

(ii) Describe the pericarp of specimen P.

……

……

……

(c) Describe how the following specimens are dispersed.

Specimen P

……

……

……

Specimen S

……

……

……

(d) Basing on the features of the pericarp only, construct a dichotomous key to identify the specimens P, Q, R and S.

(e) Draw and label the longitudinal section of specimen P

Senior Two, Term Three

THE LEAF

This is a flat lamina usually green made of thin walled cells supported by veins.

Leaf modifications

Leaves are modified in different ways in order to achieve different adaptations. The adaptations include:-

i) Leaves modified for reproduction. They bear buds on them e.g. Bryophylum leaf.

ii) Leaves modified for protection. They bear thorns on their lamina e.g. leaves of Sodom apple.

iii) Leaves modified for water loss reduction. They have divided lamina which reduces the surface area for water loss.

Types of leaves

1. Simple leaves.

These are leaves with single lamina and the lamina is not completely divided into leaflets e.g. hibiscus, etc.

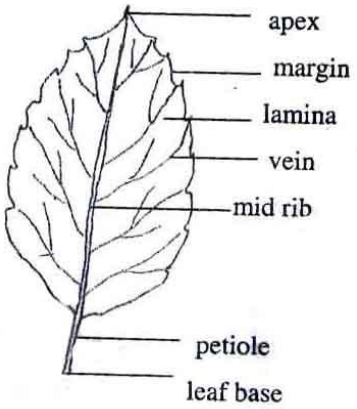
Types of simple leaves

(a). Dicotyledonous leaf.

This consists of:

- Broad lamina.
- Network veins.
- Petiole.

Structure of a dicot leaf e.g. hibiscus

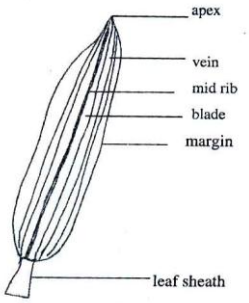


(i) **Monocotyledonous leaf.**

This consists of:

- Narrow lamina.
- Parallel veins.
- Leaf sheath.

Structure of a monocot leaf e.g. maize



2. Compound leaves

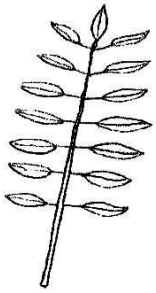
These are leaves in which the lamina is completely divided into leaflets e.g. soya bean, silk cotton, jacaranda etc.

Types of compound leaves

a) Compound pinnate leaf

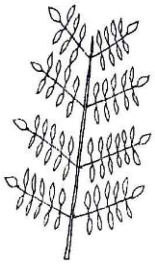
Compound pinnate leaves have leaflets arranged in pairs opposite to one another along the main stalk e.g. cassia.

Structure of pinnate leaf



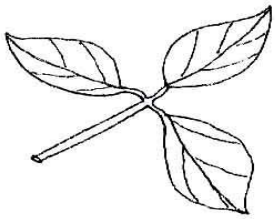
b) **Compound bi-pinnate leaves:** are those in which each pinnate leaflet is itself divided into pinnate leaflets e.g. jacaranda, acacia etc.

Structure of bi-pinnate leaf



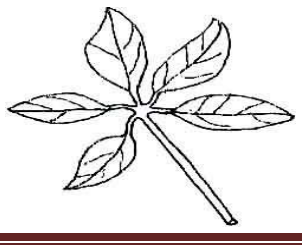
b) **Compound Trifoliate leaves:** are those in which each leaf consists of three leaflets e.g. bean, pea etc.

Structure of trifoliate leaf



4. Compound digitate leaves: are those in which the leaflets radiate out from the end of the stalk like the fingers of a hand e.g. silk cotton.

Structure of compound digitate leaf



Leaf description

Description of the leaf can be done according to the parts of the leaf.

1. **Leaf apex:**

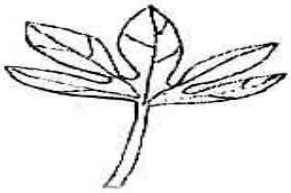
The leaf apex may be round or pointed.

2. **Leaf margin.**

Structure	**Type**
Serrated leaf margin	
Crenated leaf margin	
Wavy leaf margin	
Entire leaf margin	
Spiny leaf margin	
Toothed leaf margin	

3. Leaf lamina.

The leaf lamina may be divided into leaf lets or undivided.

Type	Description	Structure
Simple leaf	The lamina is not divided into lobes	
Simple lobed leaf	The lamina is divided into lobes, but each has a continuous margin from the neighbouring lobe.eg. simple trifoliate of passion fruit	
Simple palmate leaf	The lamina is divided and is arranged in radiating series from a common point	

It may be smooth or rough.

It may be hairy or not hairy.

4. Lea stalk.

- The leaf stalk may be solid, spongy or hollow.
- It may be smooth, hairy or rough.
- It may be round or grooved.

5. Leaf stalk base.

It may be straight or clubbed.

6. Leaf venation

Venation is defined as the arrangement of veins in the leaf.

Type	Description	Structure
Net-work or reticulate venation	Shows network of veins	
Parallel venation	Here the veins run parallel along the axis of the leaf	
Pinnate venation	This is the type of venation whereby the main vein has veins that arise from it and are arranged opposite each other.	
Palmate venation	Here the petiole has several main veins arising from its end and spreading fanwise.	

THE DICHOTOMOUS KEY

A dichotomous key is constructed using characteristic features of organisms. Basing on these features organisms are dived into successive pairs of groups where those with similar characteristics are placed in the same group. Each pair of a group is called a **couplet.**

The groups are further subdivided into two groups until a single organism is left in a group and it is the classified.

HINTS TO FOLLOW IN CONSTRUCTION OF A DICHOTOMOUS KEY

- State the title of a dichotomous key e.g. as a dichotomous key of fruits
- Lay the specimens in front of you on the table in one group. This is called a whole collection.
- Look for some body part or characteristic present in some of the specimens but absent in others and then divide them into two. e.g.

(i) In fruits some may have a dry pericarp and others a fleshy pericarp.

(ii) In insects some may have wings and others without.

(vi) In leaf lamina may be divided or undivided. This is the first division. You now have one couplet.

(vii) Now choose another characteristic and divide each of your smaller groups into two more groups. You will now have two more couplets.

- Now take each group again (where there are two or more specimens) and go on to divide them using another characteristic until you are left with one specimen in each group. Here it is said to be classified.

Note:

- Each characteristic is used only once.
- Number of your couplets as you divide. The number of couplets on the key or branches on flow chart is always less by one the number of Specimens to be classified. Use the formula (n-1) where n is the number of specimens.
- Use short and precise statements or descriptions in your key.
- Characteristics used to separate or group organisms are strictly those that are structural. Do not use features like size and colour.

A dichotomous key can be generated from either

- A flow chart
- Table of characteristic / identification table or
- List of characteristic features

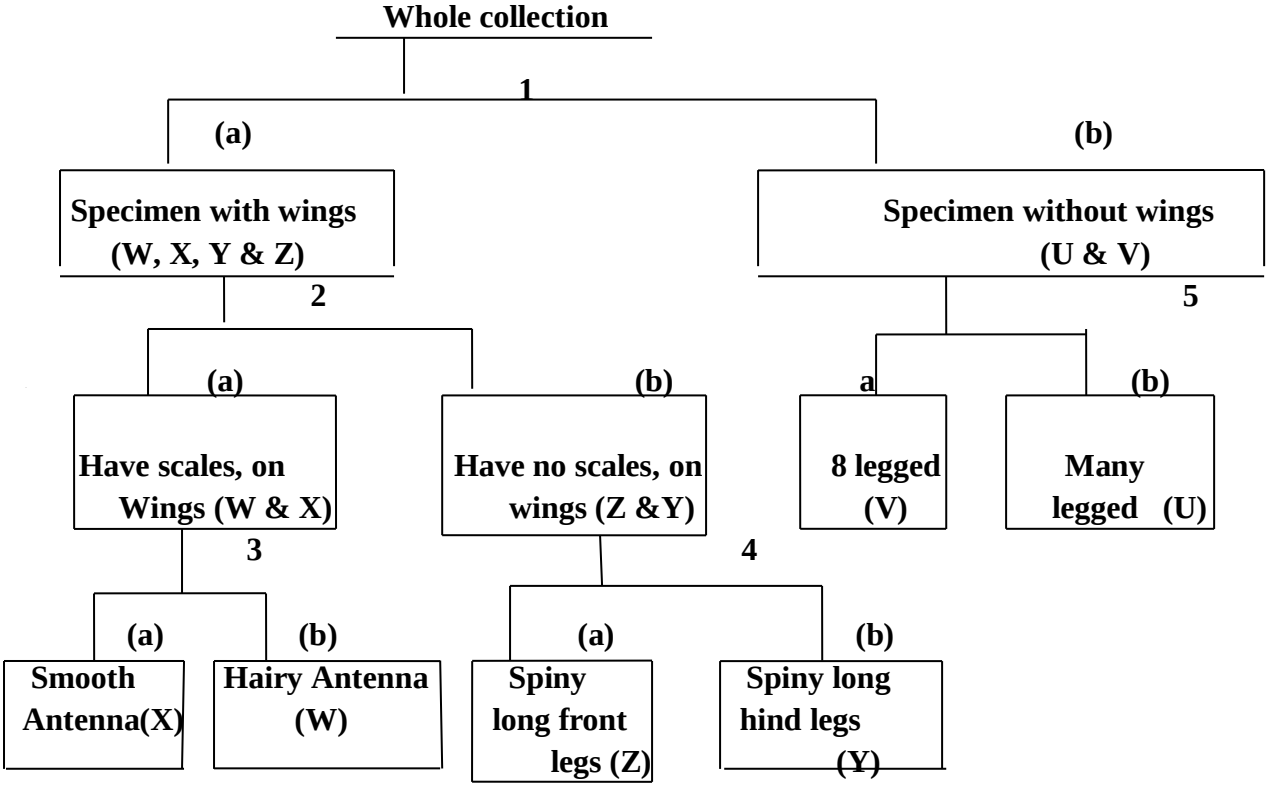
The table of characteristics gives detailed information of characteristics of each specimen. The table is occasionally given or the student is asked to tabulate one from which a dichotomous key is generated. Note that more often only space for the key is provided.

Example 1

Given that the following arthropods, centipedes, spider, moth, butterfly, grasshopper, and preying mantis labeled U, V, W, X, Y and Z respectively. Carefully observe them and use observable features of each specimen to construct a dichotomous key to classify them.

Solution

Step I: Write down characteristic features of each specimen. You may use a chart or a table of Characteristics or both.



Step II: **Dichotomous key of arthropods specimens (U, V, W, X, Z).**

1 (a) Winged……2
(b) No wings……5

2 (a) Wings have scales……3
(b) Wings have no scales……4

3 (a) Smooth antenna……X
(b) Hairy antenna……W

4 (a) Spiny long front legs……Y
(b) Spiny long hind legs……Z

5 (a) 8 legged ……V
(b) Many legged……U

Example 2

Give the following fruits; **mango, pawpaw, orange, bean pod and castor oil fruit** labeled as **A, B, C, D** and **E** respectively. Using observable features of each specimen, construct a Dichotomous key.

Solution:

Table of characteristics

Characteristics of specimen	Pericarp	Number of seeds	Number of sutures	Placentation
A	FLESHY	One	None	Central
B	Fleshy	Many	None	Parietal
C	Fleshy	Many	None	Axile
D	Dry	Many	Two	Marginal
E	Dry	Many	Many	-

Using the characteristics in the table, a dichotomous key can be written as below;

Dichotomous key of fruits (specimen A, B, C, D and E):

1 (a) Specimens with dry pericarp ……go to ……2
(b) Specimens with fleshy pericarp……go to……3
2 (a) Has two sutures……D
(b) Has more than two sutures……E
3 (a) Has one seed……A
(b) Has many seeds……go to……4
4 (a) Has axile placentation……C
(b) Has parietal placentation……B

Note:

Each character has been used once.

Number of couplet are 4 = (n=5) since five specimens were given.

Construct your own dichotomous of only specimens A, D and C using your own characteristics.

Activity 26

Leaves of cassava, beans, cassia, Commelina, jacaranda and Tridax procumbens labeled **K, L, M, N, O** and **P** respectively.

(a) Write down the characteristics of each specimen.

K.....

.....

.....

L.....

.....

.....

M.....

.....

N.....

.....

.....

O.....

.....

.....

P.....

.....

.....

From the characteristics listed in (a) above, construct a Biological key to indentify the specimens.

Activity 27
Requirements:
Leaves of lantana camara, mango, bean, jacaranda, pawpaw, cassava, cassia and hibiscuss labeled **A, B, C, D, E, F** and **G** respectively.

List the characteristic features of each specimen.

A.....
.....
.....
B.....
.....
.....
C.....
.....
.....
D.....
.....
.....
E.....
.....
.....
F.....
.....
.....
G.....
.....

(b) From the characteristics in (a) above, construct a simple identification key classifying the Specimens.

Activity 28

Your are provided with specimens **O, P, Q, R** and **S** which are fruits **(Specimen O is orange, P is black jack, Q is bean R is desmodium and S is mango)**

(a) What type of fruits are specimens P and R?

……

(b) Cut a transverse section of specimen **O** longitudinal section of S

Examine the specimens and give two characteristics features of each specimen

Specimen	**characteristics features**
O	
P	
Q	
R	
S	

(c) Using the characteristics in (b) to construct a dichotomous key to identify the specimens.

Activity 29

You are provided with specimens **C1, C2, C3, C4** and **C5** which are **(hibiscus, morning glory, bean, cassia, bougainvillea flowers respectively)**

(a) List the characteristic features of each specimen

C1 .....

.....

C2 .....

.....

C3 .....

.....

C4 .....

.....

C5 .....

.....

(b) From the characteristics in (a) above, construct a simple identification key classifying the specimens.

Activity 30
You are provided with specimens D1, D2, D3, D4 and D5 which are flowers.
(identify any four flowers around your school)
(a) List the characteristic features of each specimen.

D1.....

.....

.....

D2.....

.....

.....

D3.....

.....

.....

D4.....

.....

.....

(b) From the characteristics in (a) above, construct a simple identification key classifying the specimens.

Activity 31
Requirements

(a) Five arthropods labelled V**, W, X, Y** and **Z** (**centipede, grasshopper, butterfly, spider, millipede respectively)**

(b) Outline at least three characteristics in each case.

(c) State the order to which each of the specimens V, X, Y, and Z belong.

Specimen V

……

……

……

Specimen X

……

……

……

Specimen Y

……

……

……

Specimen Z

……

……

……

(d) Using observations of each specimen, construct a Biological key to identify the specimens.

Activity 32

You are provided with Specimen **K, L, M, N, O, and P.** (**K is cassava leaf, L is bean leaf, M is jacaranda leaf, N is cassia leaf, O is commelina leaf and P is tridax leaf)**

a) State the type of leaf of each specimen and give one Characteristic feature on each specimen. Record in the table below

Specimen	**Type of leaf**	**Characteristic feature**
K		
L		
M		
N		
O		

b) Using information you have given in (a), construct a dichotomous key to identify the specimens.

Activity 33

You are provided with specimen **M, N O, P, Q** and **R (Note that M is Lantana leaf, N is Bougainvillea leaf, O is elephant grass, P is Pumpkin leaf, Q is Bryophyllum leaf and R is Castor oil leaf).**

a) Observe specimen P, Q and R and record their characteristic features in reference to petioles, surfaces and veins

Specimen	**Characteristic Features**		
	Petiole	**Lamina**	**Vein**
P			
Q			
R			

(b) Observe specimen M and P. For each specimen state the ways in which the specimen is adapted for the habitat in which it grows.

(i) Adaptation of M

……

……

(ii) Adaptation of P

……

……

c) Observe specimens **M, N, O, P, Q** and **R** and construct a dichotomous key to identify the specimen.

Activity 34

You are provided with specimens P, Q, R and S which are leaves. **(P is Bryophylum leaf, Q is pea leaf, R is lantana leaf, S is desmodium leaf)**

(a) Give two observable features which show that the specimens are leaves

……

……

(b) (i) Specimens P and Q perform other special functions in addition to their usual functions.
Describe how each of these specimens P and Q is adapted for its special function(s).
Specimen P.

……

……

Specimen Q.

……

……

(ii) Basing on the observable feature, state one function carried out by all the specimens.

Function;

.....

Observable feature;

.....

(c) Describe specimen S.

.....

.....

.....

.....

(d) Using characteristic features of the lamina only, construct a dichotomous key to identify the specimens

.....
.....
.....
.....
.....
.....
.....

(e) Draw and label specimen P. State your magnification.

Activity 35

You are provided with specimens V, W, X, Y, and Z which are plant leaves. (**V, W, X, Y, and Z are labelled as leaf of cassava, pumpkin, jacaranda, pawpaw and commelina respectively)**

a) State two observable characteristics of the specimen that qualify them to be leaves

.....

.....

b) Using observable feature state how the specimens are adapted to perform their function

.....

.....

(c) From the structure of specimen W suggest the habitat in which it grows best and why.

Habitat.....

Reasons

.....

.....

(d) Examine the petiole of the specimens and state three characteristics of the petiole of each specimen

Leaf V.....

Leaf W.....

Leaf X.....

Leaf Y.....

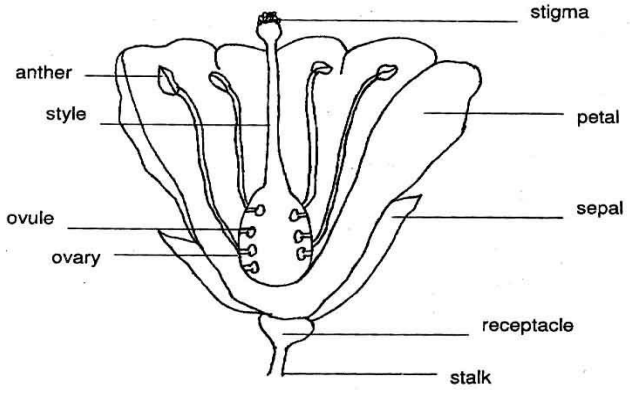
Leaf Z.....

(e) Using characteristics of the petioles stated in (d) (i) , Construct a dichotomous key to identify the specimens

FLOWERS

A flower is a reproductive part of a plant. It develops from seeds and fruits.

Longitudinal section of a flower



Function of the parts

i. The Sepals: are collectively known as calyx. Sepals protect the inner whorl of the flower during bud stage.

ii. The Petals: arc collectively known as corolla. They are

iii. most conspicuous and scented to attract insects for pollination.

iv. The Anther: produces pollen grains. The pollen grain contains male gametes.

v. The Stigma: receives pollen grains during pollination.

vi. The Ovary: bears the ovules.

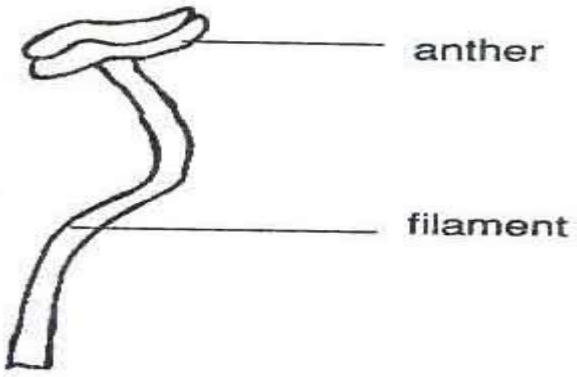
vii. The Ovules: develop into seeds.

Note: The ovary wall develops into fruit.

The Androecium

The androecium consists of stamen or male organ which lies inside the corolla.

A typical stamen



The anther has a role to produce pollen grains

The Gynoecium

Gynoecium or pistil is the female organ of a flower and consists of one or more carpels. A Carpel is usually made up of three parts.

(i) **The ovary:** containing ovules,

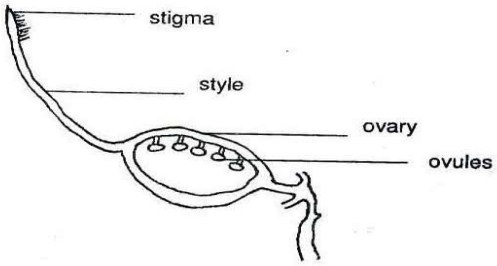
(ii) **The style**: containing ovary

(iii) **The stigma:** receives the pollen grains

Types of Pistil

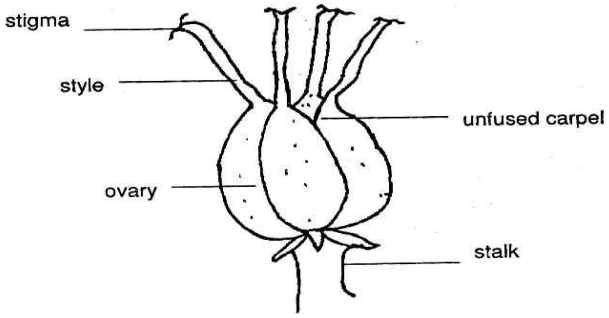
(a) Monocarpous pistil: is one in which consists of only one carpel e.g. in crotalaria.

Amono carpous pistil with ovary cut open e.g. crotalaria



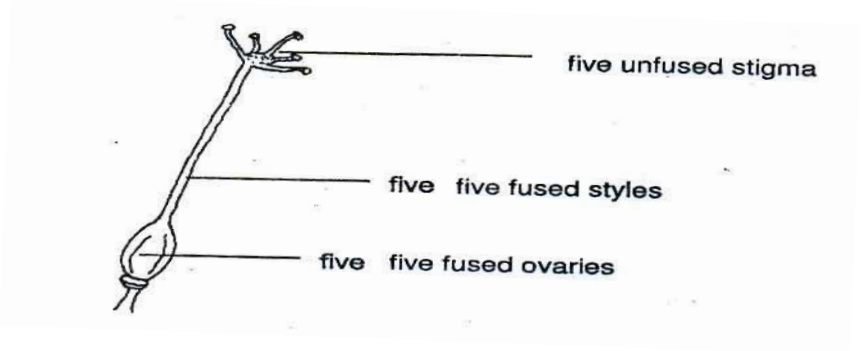
(b) Apocarpous pistil: is a pistil with more than one carpel in an apocarpous Pistil, the carpels remain entirely separated from one another e.g. Bryophyllum.

Apocarpous pistil e.g. Bryophyllum



(c) Synocarpous pistil: is a pistil with all its carpels or ovaries fused together. A pistil is synocarpous when all its carpels or at least three ovaries are fused e.g. in hibiscus.

Asynocarpous pistil e.g. hibiscus.



Some terms used in describing flowers

a. **A complete flower** is one in which all four floral whorls are present i,e. gynoecium, androecium, calyx and corolla.

b. **An incomplete flower** is one in which one or more of the floral Whorls are absent.

c. The **non-essential** organs of a flower are the **calyx and corolla.**

d. The essential organs of a flower are the reproductive organs namely the androecium and gynoecium.

e. Regular flower is a flower which can be divided into two parts so that the halves are similar e.g. orange, sweet potatoes, hibiscus etc regular flower is said to be **actinomorphic.**

f. **Irregular flower** is a flower which can not be divided into two similar parts in more than one way e.g. cassava, beans flower. This flower is said to be zygomorphic.

g. **Unisexual flower** is a flower having one type of sex. Unisexual flowers are said to be **pistillate** if they are female or **staminate** if male.

h. **Bisexual or hermaphrodite** are flowers with both sex i.e. both pistil and stamen are present on the same flower.

i. Flowers in which both **pistillate** and **staminate** flowers are borne on the same plant are called **monoecious** e.g. the palms, maize and castor oil plant.

j. A plant in which the pistillate and staminate flowers are borne on separate plants is called **dioecious** e.g. pawpaw.

k. An ovary is **superior** if it is arranged above the other floral parts of the receptacle e.g. cassia, hibiscus and crotalaria.

l. An ovary is **inferior** if the other floral parts arise above it on the receptacle e.g. guava, canna lily and sunflower.

POLLINATION

Pollination is the transfer of pollen grains from the anther to the stigma.

Types of pollination

1. **Self pollination:** Is the transfer of pollen grains from the anther to the Stigma of the same flower.
2. **Cross pollination:** Is the transfer of pollen grains from the Anther of one Flower to the stigma of another flower on a different plant of the same species.

Agents of pollination:

i) Wind
ii) Insects

Characteristics of wind pollinated flowers

a. The flowers are brightly coloured and the perianth is usually, small and inconspicuous.
b. They have no scent
c. They do not secrete nectar
d. They produce large quantities of pollen grains and the pollen grains produced are light and smooth.
e. The stigmas are usually large and feathery and the styles are long, so .that the stigmas project from the flower and catch any pollen grain floating in the air.
f. Pollen grains distribution are not hindered by the leaves because the flowers are either arranged in long stalked inflorescences or they mature before leaves come out.

Characteristics of insect pollinated flowers

a. They have large, brightly coloured corolla (e.g. crotalaria) or small florets grouped into a head (e.g. sunflower) or some other conspicuous feature like coloured bracts (e.g. bougainvillea)
b. They are often scented.
c. They secrete nectar
d. The pollen grains have rough, spicy surfaces and easily become stuck to the body of insect.
e. The surface of the stigma is sticky so that once pollen grain has been caught on it, it cannot be easily brushed off.
f. The flower may be specially shaped to make it easy for particular insects to visit it. The petals may form a landing platform.
g. The nectar is so situated that in order to reach it, an insect becomes dusted with pollen.

Activity 36

You are provided with specimens O and P. Examine them and answer the questions that follow. **(Specimen O is hibiscus flower and P is morning glory flower)**

(a) Outline the differences and similarities between O and P

Specimen O	**Specimen P**

Similarities between O and P

(i) ……

(ii) ……

(iii) ……

(iv) ……

(b) State characteristics that indicate that P is exclusively insect pollinated

(i) ……

(ii) ……

(iii) ……

(iv) ……

c) Cut the specimen O longitudinally in order to obtain two identical halves. Draw and label. State the magnification.

Activity 37

You are provided with specimen **A_2**, and **B_2** and **C_2** study them carefully and answer the following questions **(note that Specimen A_2 is hibiscus flower, & B_2 is maize inflorescence, and C_2 is Crotalaria flower)**

a) (i) List the observable structural differences between **A_2** and **B_2**.

Specimen A_2	**Specimen B_2**

ii) List the observable structural adaptations which specimen **A_2** and B_2 have for pollination.

Adaptations of specimen A_2 for pollination

i.....

i) .....

ii) .....

iii) .....

Adaptations of specimen B_2 for pollination

i .....

ii.....

iii.....

d) Cut the specimen C_2 longitudinally into two halves, draw and label one half.

Activity 38

Candidates are provided with specimen H (**note that H is hibiscus flower**)

(a) Describe the sepals and petals of the specimen.

Sepals;

.....

Petals:

.....

(b) Suggest with reasons the agent of pollination of specimen H.

Agent of pollination:

.....

Reasons:

.....

.....

.....

.....

(c) Observe specimen **H** and suggest with reasons the type of pollination of the specimen.

Type of pollination

.....

Reasons

.....

.....

.....

.....

(d) Using a razor blade cut specimen H (hibiscus flower) longitudinally.

Draw and label one half of the specimen. State your magnification.

Activity 39

You are provided with specimens **L** and **M** which are flowers. **(L is Hibiscus flower, M is sweet potato flower).** Examine them and answer the questions that follow.

(a) Giving reasons, state the type of pollination in specimens L and M

Type of pollination

.....

Reasons

.....

.....

.....

.....

(b) Describe the following parts of specimen L

(i) Calyx

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.....

(ii) Corolla

.....

.....

(iii) Androecium

.....

.....

(iv) Gynoecium

.....

.....

(c) Give four structural differences between L and M on the corolla, and calyx.

Specimen L	Specimen M

(d) Give the importance of corolla arrangement of specimen L

……

……

……

(e) Using a razor, cut specimen M longitudinally, starting from the flower stalk through the ovary and petals.
Draw and label a longitudinal section of specimen M and state your magnification.

Senior Three, First Term

CHAPTER 3: FOOD TESTS

The major types of food eaten by animals are of two forms, these are; **Organic** and **inorganic compounds.**

The main organic compounds are carbohydrates, proteins and Lipids (fat and oils); meanwhile the main inorganic compounds are water and mineral salts.

Carbohydrate contains the followings:-

Monosaccharide e.g. glucose, fructose and galactose.

Disaccharides e.g. sucrose, maltose and lactose.

Polysaccharide e.g. starch, cellulose in plants and glycogen in animals, chitin in exoskeleton of arthropods.

Sugars like glucose, fructose, galactose, maltose and lactose have reducing group. Therefore, all monosaccharide or simple sugars and disaccharides or complex sugar except sucrose are reducing sugars because they have active reducing group. Sucrose is a non reducing sugar.

The major food substances tested for at ordinary level are:-

- Starch
- Reducing sugars
- Non reducing sugars
- Proteins
- Lipids (fats and oils)
- Vitamin C (Ascorbic acid)

Food tests by definition therefore are tests that can determine whether specific food substances are present or absent in a given food sample either in solution or in solid state.

In a Food test, you should note the followings:-

- The test reagents
- The test procedure
- The appropriate colour change

Food type and test reagent

FOOD TYPE	**TEST REAGENT**
STARCH	Iodine Solution
REDUCING SUGAR	Benedict's or Fehling's Solution
NONREDUCING SUGAR	Benedict's or Fehling's Solution, Dilute hydrochloric acid and Dilute Sodium hydroxide or Sodium hydrogen carbonate
PROTEIN	Millon's reagent or Copper (II) sulphate solution and Sodium hydroxide
LIPIDS	Ethanol and Water
VITAMIN C	DCPIP(Dichlorophenolindophenol) solution

Testing for the food substances

1. **STARCH**

Reagent: Iodine solution

Procedure.

To 1cm^3 of the test solution, add 2-3 drops of iodine solution.

Observation

Colourless solution/ Milky/ cloudy /white suspension turned to blue or blue black or black solution (depending on the concentration of starch in a given solution).

When absent; a colourless solution turned to a brown solution.

2. **REDUCING SUGARS**

Reagent

Benedict's solution or Fehling's solution

Procedure

To 1cm3 of test solution in a test tube, add Benedict's solution and boil for 1min.

Observation

Colourless solution turned to blue solution, on boiling it turned to green solution, to yellow solution, to orange solution and then brown precipitate.

When absent; a colourless solution turned to a blue solution, on boiling the blue colour remained.

Note: The extent of colour change shows the amount of food substance present. Where green colour, shows little concentration, while brown colour shows a higher concentration.

3. **NON REDUCING SUGARS**

Reagents: Dilute Hydrochloric acid, dilute Sodium hydroxide solution and Benedict's soluti

Procedure.

To 1cm3 of the test solution add 1cm3 of dilute hydrochloric acid and boil. Cool under tap water and then add 1cm3 of dilute sodium hydroxide solution followed by 1cm3 of Benedict's solution and boil again.

Observation: As in reducing sugars.

Note.

- Dilute hydrochloric acid is added to hydrolyse non reducing sugars to reducing sugars.
- Dilute sodium hydroxide is added to neutralise the acid, providing a correct ph for action of Benedict's solution.
- We cool for clear observations

4. PROTEINS

(a) **Reagents:** Copper(ii)sulphate solution and dilute sodium hydroxide solution.

Procedure

To 1cm^3 of the test solution, add 1cm^3 of dilute sodium hydroxide solution followed by 5 drops of copper (ii) sulphate solution.

Observation

A colourless solution turned to a blue solution, and then to a purple solution.

When absent; a colourless solution turned to a blue solution and the blue colour persisted.

(b) Reagent: Millon's reagent.

Procedure

To 1cm^3 of the test solution ion the test tube, add 1cm^3 of Millon's reagent and boil.

Observation

A colourless solution turned to white coagulant, on boiling it turned to a coagulated pink mass.

When absent, a solution remained clear.

5. VITAMIN C.

Reagent: DCPIP (Dichlorophenol indophenol

Procedure

To 2cm^3 of DCPIP in a test tube, add test solution drop by drop until in excess.

Observation

A dark blue solution turned to a colourless solution.

When absent, a dark blue solution remains.

Note: The number of drops used indicates the amount of Vitamin C present. The more the number of drops used, the less vitamin c present and the less the number of drops, the more concentrated the solution is.

6. LIPIDS.

(a) Emulsion test

Reagents; Ethanol and distilled water.

Procedure

To 1cm^3 of test solution, add 2cm^3 of ethanol, shake and add 2cm^3 of distilled water.

Observation: A white emulsion is observed.

When absent, the solution remains clear.

(c) Translucent spot test.

Procedure

Squeeze a lipid sample on a white sheet of paper and let it to dry, the view it against light.

Observation

A translucent spot is observed where the sample was squeezed.

When absent; the spot remains opaque.

Example

FOOD TEST	PROCEDURE	OBSEVATION	DEDUCTION
STARCH (iodine test)	To 1cm^3 of the test solution, add 2-3 drops of iodine solution	Colourless solution turned to a dark blue solution.	Starch present.
		Colourless solution turned to a brown solution.	Starch absent.
REDUCING SUGARS	To 1cm^3 of test solution, add 1cm^3 of Benedict's solution and boil.	A colourless solution turned to a blue solution, on boiling; it turned to a green solution, to yellow solution, to an orange solution finally to a brown precipitate.	Reducing sugars present.
		Colourless turned to blue solution, on boiling the blue colour persisted	Reducing sugars absent
NON REDUCING SUGARS	To 1cm^3 of test solution in a test tube, add 1cm^3 of dilute hydrochloric acid and boil. Cool under tap water and add 2cm^3 of dilute sodium hydroxide, followed by 1cm^3 of Benedict's solution and boil for 1 minute	As in reducing sugars	Non reducing sugars present
		As in reducing sugars	Non reducing sugars absent
PROTEINS (Biuret's test)	To 1cm^3 of the test solution in a test tube, add 1cm^3 sodium hydroxide solution followed 5 drops copper (II) sulphate solution.	A turbid solution turned to blue then to purple solution	Proteins present.
		A turbid solution turned to blue solution	Proteins absent

PROTEINS **(**Millon's test)	To 1cm^3 of the test solution in a test tube, add Millon's reagent and boil.	A turbid solution turned to White precipitate, on boiling, a coagulated pink mass was formed.	Proteins present
		A turbid solution turned a colourless solution on boiling	Proteins absent
VITAMIN C (ascorbic acid)	To lcm3 of DCPIP in a test tube, add the test solution drop by drop until in excess.	A dark blue solution turned to Colourless solution	Vitamin C present
		The solution retained the dark blue colour of DCPIP	Vitamin C absent
LIPIDS (emulsion test)	To 1cm^3 of the test solution in a test tube; add 1cm^3 ethanol and shake vigorously, and then add equal volume of distilled water	A turbid solution turned to white emulsion	Lipids present
		A turbid solution turned to a colourless solution.	Lipids absent
LIPIDS (Sudan (III) test)	To 1cm^3 of the test solution in the test tube add 3 drops of Sudan (III) reagent	Red droplets are observed in the solution.	Lipids present
		The solution remains clear	Lipids absent
LIPIDS (translucent spot)	Put a drop of the solution on a white sheet of paper / squeeze the solid substance on a white sheet of paper and allow to dry, then observe through light.	A transluscent spot is observed	Lipids present
		The spot remained opaque	Lipids absent

Note: In testing for Vitamin C, it is the reagent put first in the test tube and then the test solution.

Activity 40

You are provided with solutions A, B, C, D, E and F. Carry out the following test to identify the food substances present in the solutions. **(All solutions are positive for all the food substances)**

	Procedure	Observation	Deduction
I	To 1cm^3 of solution A in a test tube, add 2-3 drops of iodine solution		
Ii	To 1cm^3 of solution B in a test tube, add an equal volume of Benedict's solution and boil for 1 minute		
iii	To 1 cm^3 of solution C in a test tube, add 3-4 drops of dilute hydrochloric acid and boil for 1minutes, cool and add 3-4 drops of sodium hydroxide and add Benedict's solution and boil		
Iv	To 1cm^3 of solution D in a test tube, add sodium hydroxide solution followed 5 drops copper (II) sulphate.		
V	To lcm3 of DCPIP in a test tube, add the solution E drop by drop until in excess.		
VII	To 1cm^3 of the solution F in a test tube; add ethanol and shake vigorously, and then add equal volume of distilled water		

(b) What is the purpose of adding dilute hydrochloric acid in experiment (iii)

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(c) What is the purpose of adding dilute sodium hydroxide in experiment (iii)

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Activity 41

You are provided with solution X which contains a mixture of food substances. **(*Solution X is a mixture of starch and glucose*)**

(a) Carry out the following tests to identify the food substance in solution X.

Procedure	Observation	Deduction
To 1cm^3 of solution X in a test tube, add 2-3 drops of iodine solution		
To 1cm^3 of solution X in a test tube, add an equal volume of Benedict's solution and boil for 1 minute		
To 1 cm^3 of solution X in a test tube, add 3-4 drops of dilute hydrochloric acid and boil for 1minutes, cool and add 3-4 drops of sodium hydroxide and add Benedict's solution and boil		
To 1cm^3 of solution X in a test tube, add sodium hydroxide solution followed 5 drops copper (II) sulphate.		
To lcm3 of DCPIP in a test tube, add the solution X drop by drop until in excess.		
To 1cm^3 of the solution X in a test tube; add ethanol and shake vigorously, and then add equal volume of distilled water		

(b) Outline the importance of food substance present in X to the body.

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Activity 42

You are provided with solution W which is a mixture of **(sucrose, egg albumen and orange juice)**

(d) Carry out the following tests to identify the food substance present in the solution. Record your observations and deductions in the spaces provided.

Procedure	Observation	Deduction
To 1cm^3 of solution W in a test tube, add 2-3 drops of iodine solution		
To 1cm^3 of solution W in a test tube, add an equal volume of Benedict's solution and boil for 1 minute		
To 1 cm^3 of solution X in a test tube, add 3-4 drops of dilute hydrochloric acid and boil for 1minutes, cool and add 3-4 drops of sodium hydroxide and add 1cm^3 of Benedict's solution and boil		
To 1cm^3 of solution W in a test tube, add Millon's reagent and boil		
To lcm^3 of DCPIP in a test tube, add the solution W drop by drop until in excess.		

(e) (i) Which food substances are present in solution W?

……

(ii) Outline the functions of the food substance named to the body.

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(iii) Discuss the deficiency of the food substances named in b(i) above.

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Activity 43

You are provided with specimen D (***D is a ripe Orange***). Remove the epicarp and the mesocarp. Squeeze the endocarp to obtain the juice and use it to carry out the following test to identify the food substance present in the specimen.

(i) To 1cm^3 of the solution in another test tube, add a few drops of Iodine

Observation

……

Deduction

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(ii) To 1cm^3 of the solution in a test tube, add an equal volume of Benedict's solution and boil for 1 minute

Observation

……

……

Deduction

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(iii) To 2cm^3 of the solution in a test-tube, add 1cm^3 of dilute hydrochloric acid and boil for 1 minute. Cool and add equal amount of dilute sodium hydroxide followed by 1cm^3 of Benedict's solution and boil.

Observation

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Deduction

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(iv) To 2cm^3 of the solution in a test tube, add 1cm^3 of dilute sodium hydroxide followed by few drops of 5% copper (II) Sulphate

Observation

……

Deduction

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(v) . What conclusion do you draw from your test about the role of| Specimen D?

……

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Activity 44

You are provided with solution S (**S is egg solution and sugar cane extract**).

(a) Carry out the following tests on the nutrients contained in it. Record your observation and deduction in the table below.

	Test	**Observation**	**Deduction**
	To 1cm^3 of S in a test tube add 3 drops of iodine solution		
	To 1cm^3 of solution S in the test tube, add 1cm^3 of Benedict's solution and boil		
	To 1cm^3 of solution S in the test tube, add 1cm^3 of dil. HCI, boil and allow to cool; then add 1cm^3 of dil. NaOH solution followed by 1cm^3 of Benedict's solution and boil		
	To 1cm^3 of solution S in the test tube, add 1cm^3 of dil. NaOH solution followed by **4** drops. of copper (II) sulphate solution		
	To 1cm^3 of DCPIP in a test tube, add solution **S** drop by drop until in excess.		
	To 1cm^3 of solution **S** in the test tube, add 1cm^3 of ethanol, shake, then pour the mixture in another test tube containing 2cm^3 of water		

i) For every food nutrient contained in solution **S** according to your results, state the function and the result of its deficiency in the body.

Function of nutrients

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……

……

Result of deficiency

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……

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Senior Three, Term Two.

1. EFFECT OF DILUTION (CONCENTRATION)

Examples.

1. You are provided with solutions A_1 A2 and A_3 which are of different concentrations. You are required to carry out the following tests to determine the order of increasing contrations.

	Test procedure	observation	Deduction
(i)	To 1cm^3 of DCPIP in a test tube, add solution A_1 drop wise until in excess.	The dark blue solution was decolourised by 7 drops of solution A_1	Moderate vitamin C present
(ii)	Repeat the test with A_2	The dark blue solution was decolourised by 3 drops of solution A_2	Much vitamin C present
(iii)	Repeat the test with A_3	The dark blue solution was decolourised by 12 drops of solution A_3	Little vitamin C present

Arrange the solutions in order of increasing concentration.

A_2, A_1 then A_3

1. You are provided solutions B_1 and B_2 and Benedict's solution. You are required to determine the difference in concentrations.

Procedure	**Observation**	**Deduction**
To 1cm^3 of solution B_1 in the test tube, was added 1cm^3 of Benedict's solution and the solution boiled	A colourless solution turned to a blue solution, on boiling; it turned to a green solution, to yellow solution, then to an orange solution	Much reducing sugars present
To 1cm^3 of solution B_2 in the test tube, was added 1cm^3 of Benedict's solution and the solution boiled	A colourless solution turned to a blue solution, on boiling; it turned to a green solution.	Little reducing sugars present

Activity 45

You are provided with specimen X peel it carefully and cut it into 4 equal parts. Crush each part in a mortar and produce 4 different extracts in the beakers and label them X_1, X_2, X_3, and X_4 solutions. And $5cm^3$, $15cm^3$, $25cm^3$ and $50cm^3$ to solutions X_1, X_2, X_3, and X_4 respectively. Use the solutions to carry out the following tests.

Procedure	**Observation**	**Deduction**
To $1cm^3$ of DCPIP in a test tube, add solution X_1 drop wise until in excess.		
To $1cm^3$ of DCPIP in a test tube, add solution X_2 drop wise until in excess.		
To $1cm^3$ of DCPIP in a test tube, add solution X_3 drop wise until in excess.		
To $1cm^3$ of DCPIP in a test tube, add solution X_4 drop wise until in excess.		

(b) Explain the results obtained the tests

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(c) Which principle is being investigated?

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Activity 46

You are provided with specimens A and B **(A is an onion and B is a ginger).**

Using a mortar and a pestle crash specimen A, add 10cm^3 of water and obtain an extract. Label it A_1. Repeat the same procedure using specimen B and label the extract B_2. Carry out the following tests to determine the food substance contained in each specimen. Record your observations and deductions in the table below.

Test	**Observation**	**Deduction**
To 1cm^3 of A_1 in a test tube add 3 drops of iodine solution		
To 1cm^3 of B_2 in a test tube add 3 drops of iodine solution		
To 1cm^3 of solution A_1 in the test tube, add 1cm^3 of Benedict's solution and boil		
To 1cm^3 of solution B_2 in the test tube, add 1cm^3 of Benedict's solution and boil		
To 1cm^3 of solution A_1 in the test tube, add 1cm^3 of dil. HCI, boil and allow to cool; then add 1cm^3 of dil. NaOH solution followed by 1cm^3 of Benedict's solution and boil		
To 1cm^3 of solution B_2 in the test tube, add 1cm^3 of dil. HCI, boil and allow to cool; then add 1cm^3 of dil. NaOH solution followed by 1cm^3 of Benedict's solution and boil		

b)Giving a reason, suggest which specimens A_2 and B_2 would sprout first if favourable conditions for growth were provided.

……

……

2. EFFECT TEMPERATURE ON FOOD SUBSTANCE

Temperature as one of factors affecting many metabolic processes in the body, affect in one way or the other some food substances e.g. proteins. When subjected to high temperatures, proteins are destroyed and thus may be absent in a food sample which tested positive previously. This phenomenon explains to us why some foods are better eaten raw or half cooked than when fully cooked.

Activity 47

Procedure.

a) You provided with solution X. Get $1cm^3$ of solution X in the test tube, add $1cm^3$ of dilute sodium hydroxide solution followed by 5 drops copper(ii) sulphate. ***(solution X is an egg albumen***)

Observation

……

Deduction

……

b) To another part of solution X, first boil the part for about 2min, and then carryout the same test as in (a) above.

Observation

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Conclusion

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Explanation

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……

(f) How is the principle in (a) and (b) be applied by the nutritionists?

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……

3. DISTRIBUTION OF FOOD SUBSTANCES

Food in food storage organs is distributed differently in different parts, e.g. the bottom part of the fruit compared with the top part using a pineapple and in storage organs of different developmental stages e.g. using a young orange, mature raw one and a mature ripe.

Activity 48

You are provided with specimen p (***p is a pineapple***). Cut it into small longitudinal slices. Using one slice, measure 4cm from the top and cut a portion, crush it in a mortar and make an extract. Label it A_1. Measure another 4cm from the bottom part, and also make an extract from it. Label it A_2.

To $1cm^3$ of DCPIP in the test tube, add A_1 drop wise until in excess.

Observation

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Conclusion

……

To $1cm^3$ of DCPIP in the test tube, add A_2 drop wise until in excess.

Observation

……

Conclusion

……

Explanation

……

……

Activity 49

You are provided with specimen Q (***Q is a sugar cane***). Cut one internode from the bottom, using a knife divide it into small slices, using a mortar and a pestle make an extract by adding $10cm^3$ of distilled water, label it Q_1. Repeat the same procedure using one internode from the top most part. Label it Q_2.

(a) To $1cm^3$ of Benedict's solution in the test tube, add $1cm^3$ of Q_1 and boil.

Observation

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Conclusion

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(b) To $1cm^3$ of Benedict's solution in the test tube, add $1cm^3$ of Q_1 and boil.

Observation

……

Conclusion

……

Explanation

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……

Activity 50

(a) You are provided with specimens W and X. **(*W is a raw orange,* X is ripe orange).**

Using a mortar and a pestle crash specimen W, add 10cm^3 of water and obtain an extract. Label it W_1. Repeat the same procedure for W with specimen X and label the extract X_1. Carry out the following tests to determine the food substance contained in each specimen and the amount present. Record your observations and deductions in the table below.

Procedure	**Observation**	**Deduction**
To 1cm^3 of solution W_1 in the test tube, add 1cm^3 of Benedict's solution and boil		
To 1cm^3 of solution X_1 in the test tube, add 1cm^3 of Benedict's solution and boil		
To 1cm^3 of W_1 in a test tube add 3 drops of iodine solution		
To 1cm^3 of X_1 in a test tube add 3 drops of iodine solution		
To 1cm^3 of DCPIP in a test tube, add solution W_1 drop wise until in excess.		
To 1cm^3 of DCPIP in a test tube, add solution X_1 drop wise until in excess.		

(b) Sarah has a problem for her wounds taking long to heal. Which of the above fruits would you advise Sarah to take?

……

Which of the two specimens can someone with diabetes problem be advised to take?

……

CHEMICAL TESTS INVOLVING STARCH DIGESTION OR HYDROLYSIS

In the laboratory, starch is digested in the test tube by enzymes diastase and salivary amylase or ptyalin. Salivary amylase is collected from the mouth.

Preparation of salivary amylase

First wash the mouth with distilled water and collect the saliva in a test tube. Dilute the saliva in the test tube with equal amount of distilled water this is called the salivary amylase.

The digestion of starch is possible in the laboratory test tube under the following conditions:

i) The P^H that is slightly alkaline or nearly neutral.

ii) Water bath maintain at 37°C - 40°C for 15 - 20 minutes.

The digestion of starch is not possible in the laboratory test tube under the following conditions:

- First, boil the salivary amylase or diastase before use. This is because boiling or heating denatures the enzyme rendering it ineffective. Acidic p^H inhibits the effectiveness of the enzyme's activity.

EXPERIMENTS SHOWING CHEMICAL TESTS FOR STARCH

Digestion /hydrolysis (Using solution Q and note, that Q is starch solution)

Experiment No. 1 (effect of salivary amylase on starch)

(a). To $1cm^3$ of Q in a test tube, add 2 drops of iodine solution.

Observation

A colourless solution turned to a dark blue solution.

Deduction

Starch present

(b). To $1cm^3$ of Q in a tube, add $1cm^3$ of saliva solution and shake. Incubate under the water bath maintained at a temperature between 37^0c to 40^0c. Leave the test tube for 20 minutes. Remove the test tube after 20 minutes and add 3 drops of Iodine:

Observation

A colourless solution turned to a brown solution.

Deduction

Starch absent.

Explanation

Q has been hydrolysed by salivary amylase.

Experiment No.2 (effect of temperature on the enzyme)

(a) To $1cm^3$ of Q in a test tube, add $1cm^3$ of saliva solution and shake. Incubate the mixture in the water bath maintained between 5-10^0C for 20 minutes. After 20 minutes, remove the test tube and add 3 drops of iodine solution.

Observation

Colourless solution turned to dark blue solution.

Deduction

Starch present.

Explanation

Q has not been hydrolysed. The enzyme was inactivated by very low temperatures.

(b) To $1cm^3$ of Q in a test tube, add $1cm^3$ of saliva solution and shake. (Do not incubate). Leave the experiment for 20 minutes. After 20 minutes, remove the test tube and add 3 drops of iodine solution.

Observation

Colourless solution turned to blue solution.

Deduction

Starch present in little amounts.

Explanation

Q has not been hydrolysed completely. The enzyme was not provided with optimum temperature.

(c) To $1cm^3$ of Q in a test tube, add $1cm^3$ of the salivary amylase and shake. Leave the test tube for 20 minutes (do not incubate). After 20 minutes, remove the test tube and add 5 drops of Benedict's solution and boil.

Observation

Colourless solution turned to blue solution, to green solution.

Deduction

Reducing sugar present in small amounts.

Explanation

Q has been hydrolysed slowly by salivary amylase to reducing sugar

(d) To $1cm^3$ of Q in a test tube, add $1cm^3$ of boiled salivary amylase and shake. Incubate the mixture in the water bath maintained at 40^0C for 20 minutes. After 20 minutes, remove the test tube and add 3 drops of iodine solution.

Observation

Colourless solution turned to dark blue solution.

Deduction

Starch present.

Explanation

Q has not been hydrolysed by boiled salivary amylase. The enzyme was denatured by boiling.

(e) To $1cm^3$ of Q in the^5 test tube, add boiled salivary amylase. Incubate the mixture in the water bath maintained at 40°C for 20 minutes. After 20 minutes, remove the test tube and add 5 drops of Benedict's solution and boil.

Observation

Colourless solution turned to blue solution.

Deduction

Reducing sugar absent.

Explanation

Q has not been hydrolysed by boiled salivary amylase. The enzyme was denatured by boiling.

Experiment no.3 (effect of ph on the enzyme salivary amylase)

(a) To $1cm^3$ of Q in the test tube, add $1cm^3$ of salivary amylase and shake, followed by 3 drops of dilute hydrochloric acid. Incubate the mixture in the water bath maintained at 40^0C leave the experiment for 20 minutes. After 20 minutes, remove the test tube and add 3 drops of iodine solution.

Observation

Colourless solution turned to dark blue solution

Deduction

Starch present.

Explanation

Q has not been hydrolysed by salivary amylase. Salivary amylase does not work in acidic medium.

(b) To $1cm^3$ of Q in a test tube, add $1cm^3$ of salivary amylase and shake. Add 3 of dilute hydrochloric acid. Incubate the mixture in the water bath maintained at 40°C for 20 minutes. After 20 minutes, removed the test tube a id 5 drops of Benedict's solution and boil or heat.

Observation

Cloudy suspension turned to blue solution.

Deduction

Reducing sugar absent

Explanation

Solution Q has not been digested by salivary amylase. The acidic medium provided by hydrochloric acid lowers the P^H and this inhibits enzymes activity.

(c) To $1cm^3$ of Q in the test tube, add $1cm^3$ of salivary amylase and shake, followed by 3 drops of distilled water. Incubate the mixture in the water bath maintained at 40°C for 20 minutes. After 20 minutes, remove the test tube and add 3 drops of Iodine solution.

Observation

Colourless solution turned to a brown solution.

Deduction

Starch absent.

Explanation

Q has been hydrolysed by salivary amylase. The enzyme was subjected to the correct ph and temperature range.

(d) To 1cm^3 of the food sample solution Q in the test tube, add 1cm^3 of salivary amylase shake. Incubate the test tube in the water bath maintained at 40°C for 20 minutes. After 20 minutes, add drops of Benedict's solution and boil.

Observation

Colourless solution turned to blue solution, on boiling it turned to a green solution to yellow solution, to orange precipitate.

Deduction

Reducing sugar present

Explanation

Solution Q has been hydrolysed by salivary amylase to reducing sugar. The narrow P^H range and the body temperature as provided by the water both activate the enzyme.

Summary of the experiments involving chemical test for starch digestion or hydrolysis

Test	Observation	Deduction
Q + saliva + Iodine solution	Colourless solution turned to light blue solution	Starch present in small amount
Q + boiled saliva + water bath + Iodine	Colourless solution turned to blue black solution.	Starch present.
Q + saliva + dil HCI + water bath + Iodine solution	Colourless solution turned to blue black solution.	Starch present.
Q + saliva + water bath + Iodine	Colourless solution turned to brown solution	Starch absent
Q + saliva + Benedict's solution + boiling	Colourless solution turned to blue to green then yellow	Reducing sugar present.
Q+ boiled saliva + water bath +Benedict's +boiling	Colourless solution turned to blue solution	Reducing sugar absent
Q+ saliva+dilute HCI+water bath+Benedict's +boiling	Colourless solution turned to blue solution	Reducing sugar absent
Q+ saliva+ water bath+Benedict's +boiling	Colourless solution changed to blue to green to yellow to orange to red ppt	Reducing sugar present

Activity 51

1. You are provided with suspension W **(note that** W **is starch solution)**

(a) Carry out the tests on the suspension W for the presence of starch and reducing sugar. Use the reagent provided. Record the test, observations and deduction in the table below.

Solution

FOOD TYPE	TEST	OBSERVATION	DEDUCTION
STARCH			
REDUCING SUGAR			

(b) Rinse your mouth with clean water and obtain 5 cm^3 of saliva in clean test tube. Add 5 cm^3 of distilled water to prepare a saliva solution

- Add 2 cm^3 of solution W to each test tube labelled 1 to 5
- Add 2 cm^3 of saliva solution to test tube 1 to 5. Boil the content of the test tube 5 for two minutes
- To test tubes 3 and 4, add 1 cm^3 of dilute sodium hydroxide an dilute hydrochloric acid respectively
- Incubate the test tubes in a water bath at 40^0c for 20 minutes
- Add 2 drops of iodine solution to test tube labelled 1 to 5
- Record your observation and deduction in the table below

Test tube	Observation	Deduction
1		
2		
3		
4		
5		

(i) Explain the results in each test tube.

Test tube 1

……

……

Test tube 2:

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……

Test tube 3:

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Test tube 4:

……

……

Test tube 5:

……

……

(c) (i) state two properties of the active substance investigated in (b) above

……

……

(ii) State one other factor which would affect the rate of the active substance in saliva

……

……

Activity 52

You are provided with solution X and Y, test tube, heat source, thermometer, dropper; a water bath maintained at 35-40^{0}C, Benedict's solution, 0.1 M HCI, 0.1 NaOH (**solution X is 1% starch solution and Y is 5% glucose solution**)

(a) Using the reagents and apparatus provided, carry out the following test on the solution X and Y and record your results.

(i) And 1cm^3 of Benedict's solution to 1cm^3 of solution X and boil for 1 minute.

Observation

……

Deduction

……

(ii) To 1cm^3 of solution Y, add 1cm^3 of Benedict's solution and boil for 1 minute.
Observation

……

Deduction

……

(iii) To 1cm^3 of solution X, add 1cm^3 of hydrochloric acid and boil for 2 minutes cool in water and add 1cm^{3}of sodium hydroxide solution, shake and add 1cm^3 of Benedict's solution and boil for 1 minute.
Observation

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Deduction

……

(iv) To 1cm^3 of solution Y and 1cm^3 of hydrochloric acid and boil for 2 minutes. Cool in water and add 1cm^3 of sodium hydroxide. Shake and then add 1cm^3 of benedict's solution and boil for 1 minute.
Observation

……

……

Deduction

……

(b) Rinse your mouth with water and collect 2cm^3 of saliva in a test-tube, add 2cm^3 of water. Divide the solution into two parts 1 and 2. Add solution X to part 1 and solution Y to part 2. Put the two test tubes in a water bath maintained at 35-40^{0}C for 15 minutes. After 15 minutes, remove the test tubes, add 1cm^3 of Benedict's solution and boil for one minute.

(i) Test tube 1

Observation

……

……

Conclusion

……

(ii) Test tube 2

Observation

……

……

Conclusion.

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(c)(i) Explain what was responsible for the observations you made in (b) above

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…… ……

(ii). In (b), why was the solution with saliva placed in the water bath?

……

……

(d) (i) Name the food substances present in solution X and Y.

……

……

(iii) Name the natural sources of the food present in solution Y.

……

……

Activity 53

You are provided with solution D. Use it to carry out the following investigation (***solution D is 3%starch+0.5% glucose***)

(a) Test solution D as indicated in the table below and records your observation and deduction.

No	Test	Observation	Deduction
1	To $2cm^3$ of D in a test-tube, add 2-3 drops of iodine solution.		
2	To $2cm^3$ of D in a test tube, add $2cm^3$ of Benedict's solution and boil		

(b) Rinse the mouth with water, and then collect $2cm^3$ of saliva by spitting in a clean test tube. Add $2cm^3$ of solution D in a test tube; leave the mixture to stand in a water bath at 35^0C-40^0C for 10 minutes.

(e) To $2cm^3$ of D in a test-tube, add 2-3 drops of iodine solution

Observation

.....

.....

Conclusion

.....

Add $1cm^3$ of benedict's solution to $1cm^3$ of the mixture above and boil.

Observation

.....

.....

Conclusion

.....

(c) Explain the differences in results in (a) and (b)

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Activity 54

You are provided with solutions A, B, C and D. Solution A contains food nutrients. You are required to determine the food nutrients in A and investigate the action of solution B, C, and D on A (**Solution labelled A is 1% starch, solution labelled B is 2% amylase solution, solution labelled C i s hydrochloric acid, Solution labelled D is 1 M sodium hydroxide).**

(a) Carry out the following tests and record your observation and deduction in the table below

Test	Observation	Deduction
(i) To $1cm^3$ of A, add 2 drops of iodine solution		
(ii) To $1cm^3$ of A, add $1cm^3$ of Benedict solution and boil.		

(b) Label three test tubes as I, 2, and 3 and add contents in to each test tube indicated in the table 01.13 below

Test tube	Contents
1	1 cm^3 of B + 1 cm^3 of distilled water, shake to mix add 1 cm^3 of A
2	1 cm^3 of B + 1 cm^3 of C shake to mix then add I cm^3 of A
3	1 cm^3 of B + 1 cm^3 of D, shake to mix then add 1 cm^3 of A

Place the test tubes in a water bath at 35-40^{0}c for 15 minutes. After 15 minutes carry out Benedict's test on the contents of each test tube and record your observations and deductions in the table below

Test tube	Observation	Deduction
1		
2		
3		

(c) Explain your results in the test tubes 1-3

Test tube 1

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……

Test tube 2

……

……

Test tube 3:

……

……

(d) Giving a reason in each case, suggest the identity of;

i) Solution A……

Reason……

……

ii) Solution B……

Reason……

……

iii) Solution C……

Reason……

……

Solution D……

Reason……

(e) which principle is being investigated?

……

……

Activity 55

You are provided with solutions **X** and **Y. (X is an extract prepared by crushing 250g of Irish potato in 100mls of distilled water, Y is 5% amylase enzyme)**

(a) Carryout the tests in the table below to determine the food nutrients present in solution X. Record your observations and deductions in the table below.

Test	**Observation**	**Deduction**
To $1cm^3$ of solution X, add 3 drops of iodine solution		
To $1cm^3$ of solution X in the test tube, add $1cm^3$ of Benedict's solution and boil		
To $1cm^3$ of solution S in the test tube, add $1cm^3$ of dil. NaOH solution followed by **4** drops. of copper (II) sulphate solution		

(b) Put 3cm^3 of solution X into a test tube and add 2cm^3 of solution Y and incubate in water bath maintained at 35^{o}C – 40^{o}C for 20 minutes.

After 20 minutes, repeat the tests in table below.

Test	**Observation**	**Deduction**
(i) Iodine test		
(ii) Benedict's test		
(iii) Biuret's test		

(c) (i) State the effect of solution Y on solution X

.....

(ii) Give two reasons to support your answer in c(i) above.

.....

.....

.....

(d) Why was the solution:

(i) Incubated in water bath for 20 minutes.

.....

.....

(ii) Incubated in water bath at 35^{o}C – 40^{o}C.

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.....

(e) State the factor which is being investigated in this experiment.

.....

Senior Three, Term Three.

CHEMICAL TESTS INVOLVING SUCROSE DIGESTION OR HYDROLYSIS

[Using R where R is sucrose solution]

In the laboratory, sucrose is digested or hydrolyzed in the test tube by enzymes invertase and yeast extracts to reducing sugar.

Summary of the experiments involving chemical tests for the sucrose digestion or hydrolysis

Expt	Test	Observation	Deduction
1	R dilute HCI boil, cool + dilute NaOH + Benedict's solution + boiling	Colourless solution turned to blue to green to yellow to orange and finally red ppt	Non reducing sugars present
2	R Benedict's solution + boiling	Colourless solution turned blue solution	Reducing sugars absent
3	R + invertase + water bath at 40°C + Benedict's solution + boiling	Colourless solution turned to blue to green to yellow to orange and finally red precipitate.	Reducing sugars present
4	R + invertase +Benedict's solution + boiling	Colourless solution turned blue solution	Reducing sugars absent
5	R boiled invertase + water bath at 40°C +Benedict's solution + boiling	Colourless solution turned blue solution	Reducing sugars absent
6	R + yeast extract + water bath at 40°C +Benedict's solution + boiling	Colourless solution changed to blue to green to yellow to orange and finally red ppt	Reducing sugars present
7	R + yeast extract + Benedict's solution + boiling or heating	Colourless solution turned blue solution	Reducing sugars absent
8	R + boiled yeast extract + water bath at 40°C + Benedict's solution + boiling	Colourless solution turned blue solution.	Reducing sugars absent

Activity 56

You are provided with solutions S, dil. HCl, dil. NaOH, invertase solution Benedict's and distilled water (***solution S is sucrose solution)*** Use the solutions to carry out the following tests.

(a) (i) To $1cm^3$ of S in a test tube, add $1cm^3$ of dilute hydrochloric acid boil and cool. Then add $1cm^3$ of dilute sodium hydroxide followed by $1cm^3$ of Benedict's solution and boil or heat for one minutes

Observation

……

……

Conclusion

……

(f) To $1cm^3$ of S in a test tube, add $1cm^3$ of Benedict's solution and boil for one minute

Observation

……

……

Conclusion

……

(b) To $2cm^3$ of S in a test tube, and $1cm^3$ of invertase solution and shake. Keep the test tube in a water bath at 40°C for 15 minutes. After 15 minutes, remove the test tube and add Benedict's solution, boil for one minute.

Observation

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Deduction

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Explanation

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(c) To 1cm^3 of the food sample solution S in a test tube, add 1cm^3 of enzyme invertase. Leave the experiment for 15 minutes (do not incubate the test tube). After 25 minutes, remove the test tube and add 1cm^3 of Benedict solution and boil or heat for one minute.

Observation

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Deduction

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Explanation

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(d) To 1cm^3 of S in a test tube, add 1cm^3 of boiled invertase and shake. Keep the test tube in a water bath at 40°C for 15 minutes. After 15 minutes, remove the test tube; add Benedict's solution and boil or heat for one minute

Observation

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Deduction

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Explanation

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(e) To 1cm^3 of the food sample solution S in a test tube, add 1cm^3 of yeast extract and shake keep the test tube in a water bath at 40°C for 15 minutes. After 15 minutes, remove the test tube; add Benedict's solution boil or heat for one minute.

Observation

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Deduction

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Explanation

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CHEMICAL TESTS INVOLVING PROTEIN DIGESTION/HYDROLYSIS

In the laboratory, protein is hydrolyzed in the test tube by enzymes pepsin and trypsin**.**

Experiments showing chemical tests involving protein hydrolysis

(**Using solution S and note that S is egg white or egg albumen)**

Summary chemical tests involving protein hydrolysis

Expt	Test	Observation	Deduction
1	S + dilute NaOH + $CuSO_4$	milky solution changed to blue then purple solution	Proteins present
2	S + pepsin + dilute HCI + water bath + dilute NaOH+ $CuSO_4$	The milky solution turned to blue solution	Proteins absent
3	S + dilute HCI + water bath + dilute NaOH + $CuSO_4$	The milky solution changed to blue then purple solution	Proteins present
4	S + pepsin + dil. NaOH + water bath+ dil. NaOH + $CuSO_4$	The milky solution changed to blue then purple solution	Proteins present.
5	S + pepsin + distilled water + water bath+ dil. NaOH + $CuSO_4$	The milky solution changed to blue then purple solution	Proteins present
6	S + boiled pepsin + dilute HCI + water bath dilute NaOH + $CuSO_4$	The milky solution changed to blue then purple solution	Proteins present.
7	S + trypsin +dil. HCl+ water bath + dilute NaOH + $CuSO_4$ solution.	The milky solution changed to blue then purple solution	Proteins present
8	S + trypsin+ dil. NaOH + water bath + dil. NaOH + CuSO4 solution	The milky solution turned to blue solution	Proteins absent
9	S + trypsin+ distilled water + water bath + dil. NaOH + CuSO4 solution	The milky solution turned to blue solution	Proteins absent

Explanation of results in the table above

1. Solution S contained proteins since it turned purple which is a positive observation for proteins
2. Proteins were absent because the enzyme was subjected to the correct ph i.e. acidic ph.
3. Proteins were present because there wasn't any enzyme in the mixture.
4. Proteins were present because the enzyme was subjected to a wrong ph i.e. alkaline ph.
5. Proteins were present because the enzyme was subjected to a wrong ph i.e. neutral ph.
6. Proteins were present because the enzyme was denatured on boiling.
7. Proteins were present because enzyme trypsin was subjected to a wrong ph i.e. acidic ph.
8. Proteins were absent because the enzyme was subjected to a correct ph i.e. alkaline ph.
9. Proteins were absent since the enzyme can also work (but slowly) in neutral ph.

Activity 57

You are provided with **egg albumen**, four test tubes, dilute HC1 and enzyme pepsin. Read the procedure below carefully and answer the questions, which follow.

(i) Take a beaker of distilled water and warm to about 37°C.

(ii) Take four test tubes and into each place 5cm3 of egg albumen suspension. Label test tubes as A, B, C and D.

(iii) Add 1cm^3 of 1% boiled pepsin in test tube D and 1cm^3 of 1% unboiled pepsin in test tubes A and C.

(iv) Add 4drops of dilute HC1 acid to test tube B, C and D

(v) Place all the four test, tubes in a water bath maintained at 35-40°C

(a) After 10 to 15 minutes, remove the four test tubes from the water bath and place them in a test tube rack then examine the content of each test tube and record your observations it the table below.

expt	**Contents**	**Appearance at the beginning of experiment**	**Appearance at the end of experiment.**
A	Albumen + pepsin		
B	Albumen + HCI		
C	Albumen + pepsin +HCI		
D	Albumen + boiled pepsin + HCI		

b)i) In which test tube does the content have a different appearance after 10 minutes or more?

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ii) What has happened to the egg albumen suspension?

.....

b) i) How is the enzyme affected by boiling?

.....

ii) What evidence leads you to this conclusion?

.....

iii) What other hypothesis could you advance to account for the result in test tube C?

.....

d) What is P^H conditions in which the enzyme pepsin can act?

.....

Activity 58

You are provided with solutions Q, R and S (**solution Q is egg white and solution R is 5% pepsin and S is 5% trypsin solution)**

(a) Identify solution Q by carrying out the following tests. Record your observations and deductions in the table below.

Test	**Observation**	**Deduction**
To 2cm^3 of solution Q in a test tube, add 3 drops of Iodine solution		
To 2cm^3 of solution Q add 1cm^3 of Benedict's solution and boil		
To 2cm3 of solution Q in test tube, add 5 drops of dilute sodium hydroxide solution followed by 5 drops of copper sulphate solution		

(b) Get 4 test tubes labelled 1 to 4. Put 1cm^3 of Q in test tubes 1-4. Add 1cm^3 of R in test tubes 1 and 2. Add 1cm^3 of S in test tubes 3 and 4. . Add 1cm^3 of HCl in test tubes 1 and 3. Add 1cm^3 of NaOH in test tubes 2 and 4. Place the mixture in water bath maintained at about 35 - 40°c and leave for 15 minutes. After 15minutes, test the mixture for presence of proteins.

Procedure for test tube 1-4

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Test tube 1
Observation

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Deduction

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Explanation

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Test tube 2
Observation

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Deduction

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Explanation

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……

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Test tube 3
Observation

……

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Deduction

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Explanation

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Test tube 4
Observation

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Deduction

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Explanation

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ACTION OF ENZYME CATALASE WITH HYDROGEN PEROXIDE (H_2O_2) SOLN

Enzyme catalase is common in both plant tissue like potato tuber and animal tissue like liver etc. It can break down hydrogen peroxide to give out oxygen gas and water.

Equation.

$H_2O_2 \xrightarrow{\text{Catalase}} 2H_2O + O_2$

(Hydrogen peroxide) (Water) (Oxygen)

- When a piece of potato tuber or liver is dropped in a solution of hydrogen peroxide, gas bubbles will be seen coming out of the potato or liver surface. This gas can be collected and it will relight a glowing splint indicating that it is oxygen.
- If the tuber or liver is cut into small pieces and dropped in the solution, the reaction would be much faster as shown with faster evolution of gas bubbles. This is because small pieces of potato tuber or liver tissues have large surface area for enzymes reaction

  If boiled potato tuber or liver tissue is used instead of unboiled, no gas bubbles will be given out. This is because boiling denatured enzymes in the potato or liver tissue.

  Other plant materials and other animal's tissues can be used in the experiment. The tissues with the greatest concentration of enzymes catalase will react faster.
- **Note,** volume 40 hydrogen peroxide (HaO2) is more concentrated and volume is the least concentrated.

Table shows Effect of enzyme catalase with hydrogen peroxide using potato tuber

Procedure	Observation
Place $2cm^3$ of hydrogen peroxide in the first test tube, and place in it a fresh cube of unpeeled Irish potato. Note the gas bubbles in 3 minutes.	*Few gas bubbles formed.*
Place $2cm^3$ of hydrogen peroxide in the second test tube, and place in it $1cm^3$ of peeled Irish potato. Note the gas bubbles in 3 minutes.	*More gas bubbles than in test tube 1*
Put $2cm^3$ of hydrogen peroxide in the third test tube and put in a cube of Irish potato cut into four equal parts, Note the gas bubbles in three minutes.	*Much more bubbles than in test tube 2*
Put $2cm^3$ of hydrogen peroxide in the test tube four, and put in it a cube of Irish potato cut into eight equal parts. Note the Amount of gas bubbles formed.	*Vigorous gas bubbles formed.*
Put $2cm^3$ of hydrogen peroxide in the test tube five, and put in it a cube of Irish potato cut into sixteen equal parts. Note the volume of gas formed.	*Vigorous gas bubbles formed as in test tube four.*
Put $2cm^3$ of hydrogen peroxide in the test tube six, and put in it a cube of Irish potato cut into thirty-two equal parts .Note the volume of gas formed	*Vigorous gas bubbles formed as in test tube four.*
Put $2cm^3$ of distilled water in the test tube seven, and put into a cube of Irish potato cut into eight equal parts, .Note the gas formed.	*No gas bubbles*

Conclusion

i) As the surface area of Irish potato is increased, the amount of oxygen gas formed is also increased. Increasing surface area exposes more enzymes catalase.

ii) Increasing the amount or. Concentration of catalase enzymes directly increases the velocity of catalase-catalyzed reaction.

iii) After a certain amount of enzymes concentration, a further increase in enzyme amount does not have an increasing effect on the reaction rate as in test tube six because some enzymes will not be in contact with hydrogen peroxide?

iv) When distilled water is used instead of hydrogen peroxide,

there is no reaction. This is a control experiment.

Activity 59

You are provided with the following. Hydrogen peroxide solution, Solution X, Solution Z, pieces of liver tissues, litmus, dropper, test tubes **(Solution X is 0.1M NaOH (aq) solution Z is 0.1M HCI (aq)].**

(a) Carry out the following tests and record your observations and deductions in the table below. Label four test tubes I, 2, 3, and 4place a piece of liver tissues provided in each test tube.

Test tube		**Test**	**Observation**	**Deduction**
1	i)	Add solution X to completely cover the. piece of liver tissue and add 1cm^3 of hydrogen peroxide		
	ii)	Test the mixture with red and blue litmus paper		
2	i)	Add solution Z to completely cover the liver tissue and add 1cm^3 of hydrogen peroxide		
	ii)	Test the mixture with red and blue litmus paper		

3	i)	Add distilled water to cover the liver tissue, and add 1cm^3 of hydrogen peroxide		
	ii	Test the mixture with red and blue litmus paper		
4	i) Add distilled water to cover the liver tissue, boil and add 1cm3 of hydrogen peroxide			
	ii)Test the mixture with red and blue litmus			

(b) In which test tube was reaction most vigorous?

……

(c) What is the nature of

(i) Solution X?

……

(ii) Solution Z?

……

(d) In what medium is the active substance in the liver tissues most active?

……

(e) What is the effect of heat on the active substance in the liver?

……

(f) Identify the active substance in the liver tissue; give reasons for your identity.

……

Reasons.

i)……

ii)……

(g) Which factors are being investigated in this experiment?

……

……

Activity 60

You are provided with four unboiled pieces and-one boiled piece of liver and solutions P, X, Y and Z (P is 6% hydrogen peroxide, X is ZM HCL, Y is 2M NaOH, and Z is water).

(a) Carry out the following tests using the liver and the solution. Record your observations and deductions in the following table.

	Test	Observation	Deduction
i)	To 3cm^3 of solution P in a test tube, add one piece of unboiled liver		
ii)	To 2cm^3 of solution P in a test tube, add 1cm^3 of solution X and test the mixture with litmus paper then add one piece of unboiled liver.		
iii)	To 2cm^3 of solution P in a test tube, add 1cm^3 of solution Y. test with litmus paper then add one piece of unboiled liver		
iv)	To 2cm^3 of solution P in a test tube, add 1cm3 of solution Z, test with litmus paper then add one piece of unboiled liver		
	To 2cm^3 of solution P in a test tube, add one piece of boiled		

(b) From your results. Suggest the nature of solution P.

……

(c) What conclusion can you make from the results of tests (ii), (iii) and (iv)

……

(d) What is the importance of test in (i)?

……

(e) Explain the result in test (v)

……

……

Senior four term one

CLASSIFICATION

Biological classification refers to the sorting and grouping of organisms according to their similarities into biological groupings called **taxa** according to their common characterists. These biological groupings are **kingdom, phylum, class, order, family, genus ad species** in order of decreasing comprexity.

The biological groupings into which organisms are grouped should be recalled from theory work.

In classification, organisms are grouped into five major divisions called **kingdoms.** They include;

1. Kingdom Monera
2. Kingdom Proctista
3. Kingdom Fungi
4. Kingdom Plantae
5. Kingdom Animalia

1. KINGDOM MONERA

Organisms in this kingdom include; bacteria blue-green algae among others.

Note: *Organisms in this kingdom are not much of practical study since they are too small for any practical observation. Organisms are single celled and cannot be seen with naked eyes.*

2. KINGDOM PROCTISTA

Organisms in this kingdom include; Amoeba, paramecium, euglena, spirogyra, among others.

Note: *like monerans, organisms are also not of a practical study at ordinary level since they are also single celled.*

3. KINGDOM FUNGI

Organisms in this kingdom include; yeast, moulds, mashroom etc. They are made up of threadlike structures called **hyphae.**

(a) Pin Mould

Moulds are commonly found growing saprophytically on moist decomposing organic matter e.g bread, fruits etc.

Moulds consist of; spore capsule called **sporangium,** the stalk supporting the sporangium called **mycelium,** linking mycelium called **stolon** and rooting hyphae called **rhizoids.**

- **Habitat:** Its found on decomposing matter.
- **Mode of nutrition:** Saprophytic nutrition
- **Mode of reproduction:** Reproduce by means of spores.
- **Adaptation for survival:** Produce a large number of spores which increases chances of multiplication. Spores can stay dormant for a long time until the favourable conditions are achieved.

(b) Mushroom

Mushrooms are commonly found growing on dead organic matter. They consist of the cap, the gills, ring, stalk and the rhizoids.

- **Habitat:** Found on decomposing matter like cow dung and logs of trees.
- **Mode of nutrition:** Saprophytic nutrition.
- **Mode of reproduction:** Reproduce by means of spores found in the gills.
- **Adaptation for survival:** Produce a large number of spores which increases chances of multiplication. Spores can stay dormant for a long time until the favourable conditions are achieved.

Economic importances of mashrooms

- A variety of mashrooms are eaten as food.
- They act as herbal medicine for some diseases.
- They can be used as a remedy for simple burns.

4. KINGDOM PLANTAE

All plants are green in colour and thus contain chrollophyll. This enables them to make their own food by a process of photosynthesis.

Plants are divided into two main groups

(a) Gymnosperms (non flowering plants)

(b) Angiosperms (flowering plants)

(a) GYMNOSPERMS (NON FLOWERING PLANTS)

Examples of non flowering plants include; liverworts, mosses, ferns among others.

(iv) Liverworts

They are simple flat leaf-like plants growing in damp places of found floating on water. They reproduce by means of spores.

(v) Mosses

They are small green plants with simple stems and leaves.
They consists of two main parts ie gametophyte and sporophyte.
They posess rooting rhizoids, stalks and spore capsule.
They grow in damp places and shaddy places in dense coloies.
They reproduce by means of spores.

(vi) Ferns

They are more complex plants ith true roots and stems.
They reproduce by means of spores
They are mainly found in shaddy places

(b) ANGIOSPERMS (FLOWERING PLANTS)

Flowering plants belong to kingdom **plantae** and phylum **angiospermatophyta** hence are called **angiosperms.** They are divided into two classes.

(i) Class monocotyledonae; includes monocotyledonous plants, which are plants with one cotyledon e.g cereals, grasses etc.

- They have narrow leaves
- Their seeds bear one cotyledon
- Their leaves have leaf sheath instead of leaf stalk
- Their leaves have parallel leaves
- They have fibrous roots

(ii) Class dicotyledonae; includes dicotyledonous plants, which are plants with two cotyledons e.g legumes, herbs, shrubs etc.

- They have broad leaves
- Their seeds bear two cotyledons
- Their leaves have network veins
- Their leaves have leaf stalk
- They have a tap root system

Atypical flowering plant consists of two parts.

i. The part above the ground called **Shoot System**

ii. The part below the ground called **Root System.**

THE ROOT SYSTEM

The root system consists of the roots and root hairs. A root is a descending part of the plant growing underground and arises from the radical of the embryo. Roots that arise from other part other than the radical, are called; **adventitious roots.**

There are two main root systems; i.e the **tap root system** and **fibrous root system.**

Differences between tap root system and fibrous root system.

Tap root system	**Fibrous root system**
Has a main root	Has no main root
Has fewer roots	Has many small roots
Roots are not clustered	Roots form a cluster
Roots originate from different points	All roots originate from the same point
Roots are of different sizes	Roots have almost the same size

Advantages of tap root system over fibrous root system

- Tap root system can grow in deeper layers thus can provide more anchorage than fibrous.
- Can absorb water from deeper layers of the soil

Root Modifications

Roots may be modified to perform special functions other than normal functions of roots. The major root modifications include;

1. **Root tubers.** These are modified for food storage. They are usually swollen. E.g cassava (*Manihota utillisma)*, carrot, sweet potatoes (*Ipomoea batatus*), beet root etc.
2. **Prop roots.** These are modified to provide extra support. They originate from the nodes of the stem and fall downwards. Eg. Roots of maize *(Zea mays)*, sorghum etc.
3. **Claspiping roots.** They are modified for support around the log of the support plant. They are usually parasitic. E.g epiphytic roots.
4. **Breathing roots.** Modified for gaseous exchange. They are usually spongy and found in muddy places. E.g roots of white mangrove.
5. **Stilt roots.** modified for extra support. E.g roots of white mangrove.
6. **Buttress roots.** provide extra support. E.g roots of flamboyant.

THE SHOOT SYSTEM

The shoot is an ascending portion of the plant and arises from the plumule. It consists of the stem, branches, leaves, flowers and fruits.

THE STEM.

This is the part which connects the roots to the branches and leaves. A stem has the following characteristics. Consists of

- Leaves. Attached on the branches.
- Nodes. Points where branches or leaves originate.
- Buds. (terminal and axillary) They are vegetative parts on the stem.

Stem modifications.

Some plants have their stems modified to perform special functions hence they are called modified stems. These are grouped into three categories:

a) Underground stems; These grow permanently underground and they serve functions like food storage and vegetative propagation by the buds. Most of them are thickened with food reserves. Examples include **rhizomes, bulbs and stem tubers.**

b) Aerial stems. These grow permanently above the ground. They are modified into

(i) **Stem tendrils** as seen in passion fruit stems, morning glory (ipomoea), pumpkin (*Cucurbit maxima),* and ekyangwe *(Lufa cylindridrica).* Tendrils are modified for support in climbing stems. They may rise from terminal or axillary buds.

(ii) **Thorns.** As seen in lemon, thorn apple, bougainvillea and acacia. Thorns are hard, straight and pointed that develop on the nodes. Their main function is to provide defence against browsing animals. They can also be used in climbing like in bougainvillea.

(iii) **Pyllocodes.** As seen in cacti and pricky pear. These are usually green, thick and thorny. They store food and water and also carry out photosynthesis. These plants have reduced leaves and thus are modified for water loss reduction. They are mainly found in arid environments.

c) Sub aerial stems. These include.

(i) Runners e.g strawberry, star grass, sweetheart grass (*Cardiasa lovisa),* sweet potato *(Ipomoea batatus),* desmodium. Runners are long, thin stems which creep on the ground. They have the following features.

- Have long internodes
- Have numerous roots on nodes.
- Have many axillary buds.
- Have several aerial shoots.

(ii) Stolons e.g wondering jew. These resemble runners but have shorter internodes and fewer aerial shoots.

LEAVES

Other than the main functions of leaves of photosynthesis, gaseous exchange and excretion, leaves have other functions due to their modifications.

Leaf Modifications

1. **Reproduction:** Such leaves possess buds from which new plants can grow e.g Bryophylum (life plant), begonia. They exhibit a form of vegetative reproduction. Structurally such leaves develop
   - ✓ Buds on leaf margins
   - ✓ Sprouting shoots on the leaf margins
   - ✓ Adventitious roots
2. **Defence:** Such leaves are rough, possess thorns or spines on the margins and veins. Such structures protect them from browsing animals e.g lantana camara, thorn apple, *Lativa opontia* (amatojjo).
3. **Water loss reduction:** Such leaves have very thick lamina with shinny waxy cuticle and some are reduced to spikes e.g pricky pear.
4. **Food storage:** Such leaves are thick with food reserves e.g onions, cabbage.
5. **Nutrition:** e.g Venus fly trap and pitcher plant. The trap trap insects from which they obtain nitrogen compounds. They are usually found growing in nitrogen deficient soils. Such leaves possess the following structures;
   - ➢ Attractive colours, good scent and sweet secretions which attract the insects.
   - ➢ Tentacles on leaves with spiny and hairy margins.
     The hairs are sensitive when touched by the visiting insects.
     The tentacles swing together and close capturing the insect

Activity 61

You are provided with plant leaves A and B. Carefully observe them and answer the questions that follow. (**A is leaf of elephant grass*(Eleusine indica)* , B is mango leaf*(Mangifera indica)***)

(a) State five differences between specimen A and B.

SPECIMEN A	SPECICIMEN B

(b) Giving two observable features, state whether A and B were obtained from a monocotyledonous or dicotyledonous plant.

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Activity 62

Study the specimens U and V provided to answer the questions that follow **(Note that U is a small green monocot plan and V is a small green dicot plant).**

a) State the observable differences and similarities between U and V.

Specimen U	**Specimen V**

Similarities between Monocot plants and Dicot plant

(i) ……

(ii) ……

(iii) ……

(iv) ……

b) Which specimen would be better adapted if both of them were growing in soil with water shortage? Give a reason for your answer

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5. KINGDOM ANIMALIA

Kingdom Animalia is divided into the following phyla;

- Phylum Polifera
- Phylum Coelentrata
- Phylum Nematoda
- Phylum Platyhelmenthes
- Phylum Anelida
- Phylum Mollusca
- Phylum Arthropoda
- Phylum Chordatta

Phylum Polifera, Coelentrata, Nematoda may not be of a great practical study at ordinary level. Much emphasis has been put on Phylum Arthropoda and Chordatta.

(a) PHYLUM ANELIDA

Organisms in this phylum are called annelids. E.g earth worms. *(Lumbricus)*

Characteristics

- They are cylindrical in shape
- They are segmented
- They lack locomotory organs
- They have two sexes

Habitat

They are found in muddy places, usually seen after rain

Economic importance

They help in soil aeration by burrowing through the soil.
They enable water to reach deeper layers through the burrows
They improve on soil fertility when they die and decay.

Adaptation for survival

They possess both sexes which increases chances of fertilization.

(b) PHYLUM MOLLUSCA

Organisms in this kingdom are called Molluscs e.g Snails *(Helix espersa)*

Characteristics

- They have a hard covering (shell) for protection
- They have soft body
- They possess a stamp foot
- They possess a pair of antennae

Habitat

They are mainly found on the banks of water bodies and moist places

Economic importances

Their shells are used for decorations
They act as food in some cultures

Adaptations for survival

They possess a hard shell for protection
They possess a pair of antennae for sensitivity

(c) PHYLUM ARTHROPODA

These are the largest group of invertebrates.

Arthropods have the following characteristics

i) They have jointed limbs.
ii) They have segmented bodies usually not more than 20 segments,
iii) The hard outer skeleton known as chitin.

Classes of arthropods

Arthropods are divided into five main classes.

- **Crustacea** e.g. crabs, cray fish, barnacles, prawns etc.
- **Chilopoda** e.g. centipedes.
- **Diplopoda** e.g. millipedes.
- **Arachinlda** e.g. spiders, mites, scorpions, ticks.
- **Insecta** e.g. grasshoppers, butterflies, ants, bees etc.

Crustaceans are not of a great practical study at ordinary level.

i) Class Chilopoda e.g centipede

Characteristics of centipedes

- They have a flattened body
- Possess many segments
- Possess a pair of legs per segment
- Possess a pair of short antennae

ii) Class Diplopoda e.g millipede

Characteristics of millipedes

-They possess a cylindrical body
-Possess many segments
-Possess two pairs of legs per segments
-Possess a pair of short antennae

iii) Class Arachnida e.g Spider *(Tersilochus cotracheli),* ticks, mites etc

Characteristics of Arachnids

-They have 4 pairs of legs.
-They have 2 body parts,
-They have no antennae,
-They have no compound eye.

iv) Class Insecta eg. Grasshopper*(Gastri margus)*, butterfly *(Papilio demodocus)*, bees *(Apis melifera)*, tsetsefly *(Glossina palparis)*

Characteristics of Class Insecta

i) They have three main body parts.
ii} They have a pair of antenna on the head.
iii) They have compound eyes on the head.
iv) They have three pairs of jointed legs.

Orders of common insects

Order	Examples of Insects
Diptera	Housefly, tsetsefly, fruitfly, mosquito
Dictyoptera	Cockroach, mentid
Lepidoptera	Butterfly, moth
Orthoptera	Grasshopper, locust
Hymenoptera	Bee, wasp, ant
Isoptera	Termite,
Coleoptera	Beetle, weevil

1. The Housefly

Classification of the Housefly

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

Characteristics of the housefly

i) Has two large compound eyes
ii) Has one pair of short hairy antennae.
iii) Has three simple eyes '
iv) Has a sucking mouth made up of funnel shaped proboscis
v) Has three pairs of legs
vi) Has one pair of membranous wings, the other wing is reduced to halteres for balancing.

2. The cockroach

Classification of the Cockroach

Kingdom : Animalia
Phylum : Arthropoda
Class : Insecta
Order : Dictyopera
Genus : Periplaneta
Species : americana

Characteristics of the Cockroach

i. Has two large compound eyes.
ii. Has a pair of long slender jointed antennae.
iii. Has a pair of two mouth parts, maxillary for holding food and mandibles for chewing, labium and labrum for cutting
iv. Has a pair of spiracles on each of the abdominal segment
v. Has three pairs of jointed legs.
vi. Has two pairs of wings in the thorax, the outer wing is hard and opaque, for protection. The inner wings are large, soft and membranous and transparent and are mainly for flight

Note; The male Cockroach has both styles and anal cercus at the last abdominal segment, the female has anal cercus but no styles.

3. The mosquito

Classification of the mosquito

Kingdom : Animalia
Phylum : Arthropoda
Class : Insecta
Order : Diptera
Genus : Anopheles

Characteristics of a mosquito

i) Has a pair of compound eyes.
ii) The male has long and hairy antennae and female has short and slender antennae,
iii) Has proboscis for taking in liquid food which is equipped
iv) with piercing stylets, maxillae and mandibles,
v) Has a pair of membranous wings

4. The butterfly

Classification of the butterfly

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

Characteristics of the butterfly

i) Has a pair of large compound eyes.
ii) Has a pair of long clubbed antennae
iii) Has proboscis which is spirally coiled
iv) Has two simple eyes
v) Has three pairs of limbs.
vi) Has two pairs of large flight wings. . .
vii) Has segmented abdomen with spiracles in each.

5. The worker Bee

Classification of the Worker Bee

Kingdom : Animalia
Phylum : Arthropoda
Class : Insecta
Order : Hymenoptera
Genus : Apis
Species : melifera.

Characteristics of the worker bee

i) Has prominent compound eyes.
ii) Has short clubbed antennae. .
iii) Has three simple eyes
iv) Has mouth parts modified to proboscis which help in lapping during feeding and also nest building with the glossa being modified for sucking.

Activity 63

You are provided with specimens **W, X , Y and Z** which are animals. Using a hand lens, where necessary examine the specimens and answer the questions that follow. (**W is Housefly, X is Termite, Y is Cockroach and Z is Tick)**

a) State the class of each specimen.

W……

X……

Y……

Z……

b) Observe the specimens and complete the table below.

Specimen	**Number of Legs**	**Number of wings**
W		
X		
Y		
Z		

c) Using only the characteristics of the specimens in (b) above, construct a dichotomous key to identify the specimens.

d) Describe how specimen Y is adapted to its habitat.

……

……

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……

e) Draw outer wing of Y at a magnification of x2. Do not label

Activity 64

You are provided with specimens K (**Cockroach**) and L (**housefly)**

a) To which group of animals do K and L belong?

.....

.....

b) Examine the specimens K and L using a hand lens and list down its structural similarities and differences between them.

Similarities between K and L

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.....

.....

Differences between K and L

Specimen K	Specimen L

c) In what sort of habitat would you find specimens K and L?

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.....

d) State reasons why it is necessary to be aware of the life cycle of specimen K and L.

.....

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Activity 65

You are provided with specimens C, D, E. and F .Using a hand lens, examine the specimens and answer the questions that follow. **(C is Worker bee, D is Cockroach, E is Housefly and F is Soldier termite).**

a) Describe the mouthparts, wings and legs of each specimen.

Specimen	Mouth parts	Wings	Legs
C			
D			
E			
F			

b) State how;

i) The mouthparts of E and F are suitable for the modes of life of the specimens.

Mouthparts of E

……

……

Mouth parts of F

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……

ii) The wings of specimens C and D are suited for the modes of life of the specimens.

Wings of C

……

……

wings of D

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……

iii) The legs of specimen D and E are suited for the modes of life of the specimens.

Legs of D

……

……

Legs of E

……

……

c) Remove the inner wing of specimen D, draw and label the wing. State your magnification.

Activity 66

You are provided with specimens A, B, C, D and E. (**Specimen A is housefly, B is cockroach, C is termite, D is tick, E is worker bee).**

a) Examine the specimens and give five observable features of each specimen.

Specimen A .....

.....

Specimen B.....

.....

Specimen C.....

.....

specimen D.....

.....

Specimen E.....

.....

e) Using only the characteristics in (a) above, construct a dichotomous key to identify the specimens.

Activity 67

Specimens P, Q, R, S and T are animals belonging to the same class **(Note that P is a worker bee, Q is winged termite, R is a soldier termite, S is housefly and T is a cockroach)**

(a) State the observable common characteristics of the specimens.

.....

.....

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(b) Using a hand lens, examine the thorax of each specimen.

i) List the characteristic features of the thorax of each specimen

Specimen p

.....

Specimen Q

.....

Specimen R

.....

Specimen S

.....

Specimen T

.....

c) Using the characteristics of the thorax of the specimens listed construct a dichotomous key to identify the specimens.

Activity 68

You are provided with specimens F, G and H. **(F is a cockroach G is a housefly, H is a worker bee)**

(a) Examine the specimens and give three reasons for identification of the phylum to which it belongs.

Phylum;

.....

Reasons;

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(b) Observe the mouth parts of the specimens. Explain two ways in which each is adapted to its functions

Mouth parts of F

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Mouth parts of G

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Mouth parts of H

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(c) Observe the thorax of F and G and give four differences between them.

Specimen F	**Specimen G**

(d) With the aid of a hand lens, observe the lateral view of the head of specimen G. Draw and label. State your magnification of your drawing.

Activity 69

You are provided with specimens **D, E, F, G, H** which are animals **(D is soldier termite, E is tick, F is grasshopper, G is worker bee, H house fly.)**

Use a razor and cut off one hind limb of **F** as close to the body as possible.

c) Draw and label the last six segments from the tip/end of the limb.

(b) examine the wings of specimens **F** and **G** and give three differences between them.

Wings of specimen F	**Wings of specimen G**

(c) List three observable features common to all specimens.

.....

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(d) Using observable structures state how specimen **H** is adapted to its mode of life.

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(e) Examine the specimens and using the number of body parts, number of legs and number of wings, construct a dichotomous key to identify them.

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Activity 70

You are provided with specimens **P, Q, R** and **S. (P is a cockroach, Q is housefly, R is grasshopper, S is honey bee)**

(a) Examine the specimens and giving two reasons, state the class to which they belong.

Class;

……

Reasons;

……

……

(b) (i) Using a hand lens, examine one antenna of specimen P and describe it

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……

……

(ii) Measure the length of one antenna and length of the body o specimen P and calculate the ratio of length of antenna to length of the whole body

Length of the antenna……

Length of the body……

Ratio of length of the antenna to length of the body.

……

……

(iii) State the significance of the ratio obtained in b(ii) above.

……

……

(c) Place specimen P, Q, R and S ventral side uppermost and examine their limbs using a hand lens. Write down two characteristics of limbs of each specimen in the table below.

Specimen	**Characteristics of limbs**
P	
Q	
R	
S	

(d) Using the characteristics in the table above, construct a dichotomous key to identify the specimens.

.....
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.....

(e) Draw and label the ventral side of the head of specimen R. State your magnification.

(d) PHYLUM CHORDATTA

Classes under phylum Chordatta include;

- Class Pisces
- Class Aves
- Class Reptilia
- Class Amphibia
- Class Mammalia

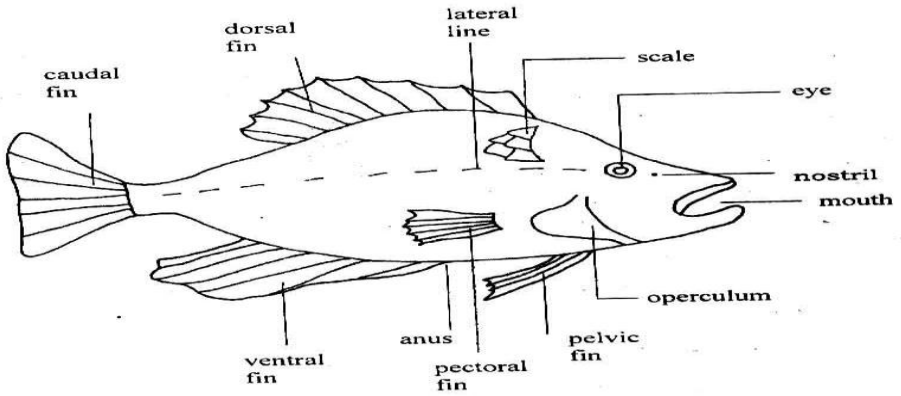
At ordinary level, we shall take emphasis on class Pisces only.

CLASS PISCES (FISH)

The ways in which the fish is adapted to live in water

1. Has streamlined body which enables it to move easily in water.
2. Has scales which overlap backwards and the slippery skin. This reduces friction while moving in water.
3. Has fins which enable it to move in water and stop it fromrolling.
4. Has gills for breathing in water.
5. Has lateral line under the skin containing sensory cells which enable the fish to sense vibration in water.
6. Has a wide mouth to allow water and food to enter easily.
7. Has scales that provide protection.
8. Has silvery colour below and dark colour above for Camouflage

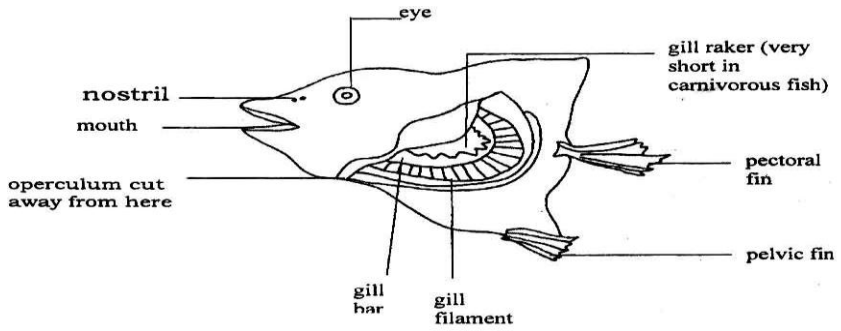
External structure



Uses of the structures in fish

1. **Mouth:** For taking in food and also for breathing in current of water.
2. **Operculum:** For breathing mechanism.
3. **Scales:** Overlap each other and give protective covering.
4. **Fins:** Give stability and control direction of movement during swimming.
5. **Dorsal and Ventral fins:** Help in providing stability to the fish
6. **The Lateral line**: It is to detect changes (vibrations) in water
7. **Caudal fin:** Helps in steering. The tail beats the water on either side; alternatively when the tail beats to the right, the fish moves its head to the right and when the tail beats to the left, it moves its head to the left.. The caudal fin is a muscular tail allowing swimming by side movement.

Structure of the head region with the operculum cut away to show gills



Activity 71

Observe specimen W provided carefully and answer the following questions **(Specimen W in fish).**

(a)(i) Identify specimen W

……

(ii) Give reasons for your answer in a (i) above.

……

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(b) (i) Suggest the habitat in which the specimen W would live.

……

(ii) Name the features on the body of the specimen, which enable the specimen to move easily in the habitat you have suggested.

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(iii) With the left side of the specimen W facing you, make a labelled drawing of the head region. State your magnification.

c) Cut away the operculum to show the gills of specimen W, Examine carefully using a hand lens.

i) State the function of the gills to the life of the organism in which it is found.

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d) What are the observable features of the gill that make it suited for its functions?

……

……

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ii) State how these features make the gill suited for its function.

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iii)How is the gill protected in living organism?

……

(e) Draw the gill in lateral view and label. Indicate on the drawing the anterior and posterior end of the gill.

Activity 72

You are provided with specimen B (**B is a small free swimming fresh water or marine bony fish. The fish should be at least 10 cm long)**

(a) make a drawing of

i) dorsal fin

ii) Caudal fin

(b) From the size, shape and possible movement of these three fins suggest the use to the fish in swimming.

i. Dorsal fin:

……

ii. Pectoral fins:

……

ii. Caudal fin:

……

(c) Write a brief statement of your observations on the skin of B, referring especially to the scales and pigmentation.

……

……

……

Senior Four, Term Two.

OSMOSIS AND DIFFUSION

Definition:

Osmosis is the movement of water molecules from a weak to a strong solution through a semi permeable membrane while diffusion is the process by which molecules of a substance present in a region of high concentration in a liquid or gas tend to move into a region of low concentration until they are evenly distributed

Osmosis on Irish potato (living tissue)

Procedure

i) Use a cork borer to cut uniform cylinders of yam {or Irish potato) tissues. Trim all to the same length not Experiment to show the effect of different solutions shorter than 5cm.
ii) Treat all the pieces with the range of sucrose solution prepared e.g. 5%, 15%, 25%, 35% etc.
iii) Submerge each cylinder in each sucrose solution and after a period of standing for I hour, remove the cylinder, dry and measure again.

Observation

It will be found that some are longer, others shorter than the original length, while one remains at the original length.

Explanation

The changes in length demonstrate whether water has been moving into and out of the cylinder by osmosis.

Cylinder in which water has been gained lengthened and are strong. Those, in which water has been lost shortened and are flabby/ soft. If water is lost, the cylinder becomes shorter and if water is gained the cylinder becomes longer.

The solution in which there is no change in the length of the cylinder has the same concentration of the cell sap and it is said to be an isotonic solution.

A cylinder becomes shorter if it is placed in a solution which is more concentrated than its cell sap hence a cylinder loses water from it by osmosis since its cell sap has the lower concentration than the solution surrounding it.. Such a solution is said to be hypertonic

The reverse is true when a cylinder is placed in a solution of low concentration than its cell sap and the cylinder gain water from the solution by osmosis and becomes turgid and longer. Such a solution is said to be hypotonic

Example 1

You are provided with Irish potato tissue, cork borer, sucrose solution of different concentrations and four beakers. Using the reagents and apparatus provided, read the experimental procedures below and answer the questions which follow.

Procedures

i. Use a cork borer to cut four uniform cylinders of Irish potato. Trim all four to the same length of about 5cm, record the initial length of the tissue in the table below.

ii. Treat the four pieces as follows:

Immerse the cylinder in water in the first beaker, immerse the cylinder in 5% sucrose solution in the second beaker, immerse the cylinder in 50% sucrose solution in the third beaker and leave the cylinder exposed to air in the fourth beaker.

ii. Leave the cylinders of tissue for one hour. Remove the cylinders and

measure their lengths. Record the final length in the table below.

Initial Length Of Cylinder in cm	Length after 20 minutes in cm	Difference In Length plus or minus in cm	Percentage Change in length cm.
5	5.7	0.7	
5	5.5	0.5	
5	4.4	-0.6	
5	4.6	-0.4	

a) Which of the pieces feel most likely to decrease in length?

Pieces in the third beaker and the forth beaker will have decreased in length because of loss of water from the cylinder by Osmosis and drying out which will make the cylinder to feel flabby.

b) What evidence is there that substances have entered or left the cells of Irish Potato?

Pieces in the first beaker increases slightly in length, pieces in second and third beaker decreases slightly in length. This must have happened due to the movement water into and out of the cylinder.

c) Which process investigated is involved in this experiment?

This is a process of Osmosis

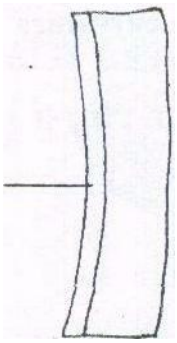
d) How could the experiment be improved to give more data?

More Cylinders could be used, say five in each liquid. The length of each cylinder could be measured before and after the experiment and the mean increase or decrease in length calculated. The multiple data ensure that multiple errors are reduced.

Example 2 (example 2 is partly an activity to do)

You are provided with flower stalks labelled F and sucrose solutions A,B,C,D,E and F, Obtain 3 flower stalks of 4-5 cm. Cut each stalk longitudinally to obtain six sections or trips. Note the normal curvature of the section. Make a labelled drawing of one of them in the space below. Label the epidermis. (**Note that F is flower stalk of dandelion or soft tissue of commelina, solution A is 1.0% sucrose, B is 2.0% sucrose, C is 3.5% sucrose, D is 1.5% sucrose, E is 2.5% sucrose and F is 3.0% sucrose).**

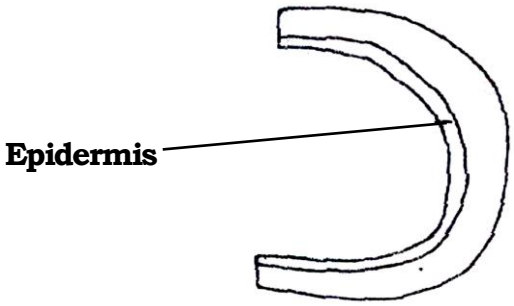
Normal curvature



Place each strip into solutions A, B C, D, E and F in a Petri dish and leave to stand for 30 to 45 minutes while a agitating or shaking.

(i) After making observation, draw, describe, and explain the nature of curvature of each of the stalk in each section. In each of the drawing label the epidermis

Solution A 1.0% sucrose The curvature



Description

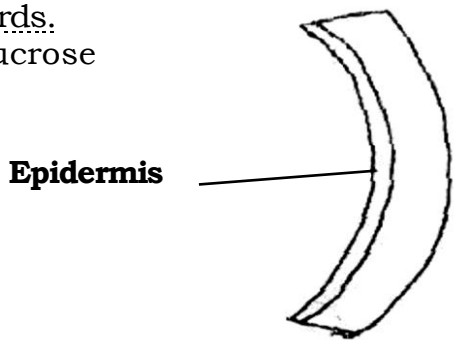
The strip in A greatly curved outwards with epidermis inside the curve

Explanation

The solution A is less concentrated or hypotonic to the cells sap allowing the inner strip of the cells to gain more water than the epidermal cells causing the strip to curve greatly outwards.

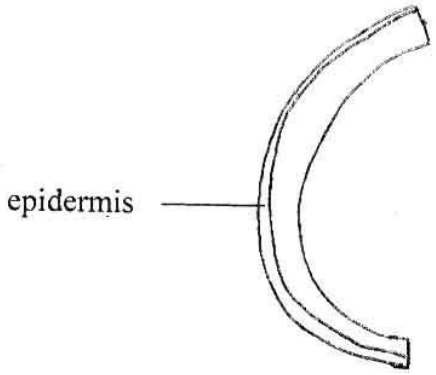
Solution B 2.0% sucrose

The curvature



(i) After making observation, draw, describe, and explain the nature of curvature of each of the stalk in each section. In each of the drawing label the epidermis

Solution A 1.0% sucrose The curvature



Description

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Explanation

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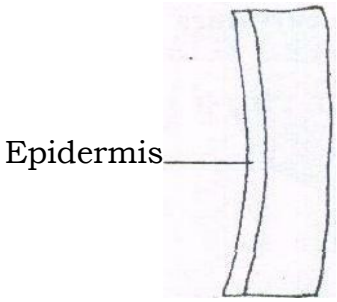
Solution B 2.0% sucrose

The curvature



Explanation

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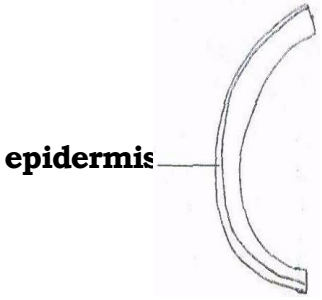
Solution C 3.5% sucrose the curvature



Description

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Explanation

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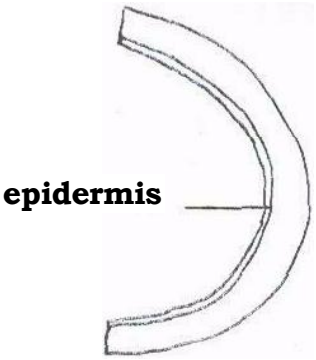
Solution D 1.5% sucrose solution

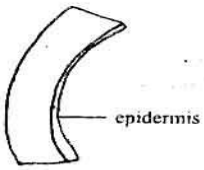
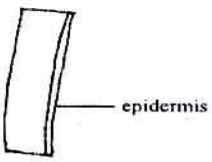
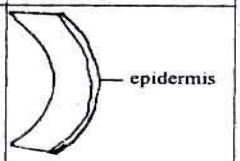
The curvature



Put one strip in each of the solution in the Petri dishes and leave for 20 minutes (a) After 20 minutes remove the strips from the solutions and

(i) Measure the distance between the ends of each strip and record Your results in the space provided in Table 1

(ii) Draw the structure of each strip in the space provided

	Strips after 20 minutes in solutions		
	A	B	C
Distance between ends (cm)	4.1-4.5	3.9-4.1	3.7-3.9
Drawing			

(b) Explain the effects of the solutions A, B and C on the strips

(i) solution A

……

……..

(ii) Solution B

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……

(iii) Solution C

……

……

Activity 73

You are provided with specimen P which is a plant tissue and sucrose solutions of varying concentrations of 0%, 1%, 5%, 10%, 15%, 20%, 25%, & 30% in different test tubes. **(P is a large irish potato)**

d) Peel specimen P and use a cork borer to bore the tissue to produce cylinders of uniform length of 4cm. Drop one cylinder in each test tube and leave to stand for 20 minutes.

(i) After 20 minutes, remove the cylinders and place them on a filter paper, then measure their length, record the results in the table below.

Length	**Sucrose concentrations(%)**							
Initial lengths(cm)	0	1	5	10	15	20	25	30
	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Final length(cm)								
Difference in lengths(cm)								

(ii) Obtain the differences in lengths of cylinders between the initial and final length, then record the results in the table above.

(iv) Plot a graph of concentration against difference in length.

e) Explain why;

(i) There may be a difference in length.

.....

.....

.....

(ii) there may be a difference in length of more than 0.0 cm

.....

.....

.....

(iii) there may be a difference in length of less than 0.0cm

.....

.....

.....

f) (i) Feel the texture and the stiffness of the cylinders and record your observations in the table below.

Sucrose concentration	**Texture of cylinder**	**Stiffness of cylinder**
0%		
1%		
5%		
10%		
15%		
20%		
25%		
30%		

(ii) explain why texture of some tissue is;

- Smooth

.....

.....

- Rough

.....

.....

(iii) explain why some cylinders are;

- Stiff

.....

.....

- Flabby

.....

.....

Activity 74

You are with specimen **M** and solution **X. (specimen M is irish potato, solution X is 5% glucose solution)**

(a) Carry out the following tests to establish the food nutrients in **X.**

Tests	**Observations**	**Deductions**
(i) To $1cm^3$ of X in a test tube, add 2 drops of iodine.		
(ii) To $1cm^3$ of X in a test tube, add $1cm^3$ of Benedict's solution and boil.		

(b) Label 3 test tubes as A_1 B_1 and C_1. Pour $5cm^3$ of distilled water in test tube A_1 and $5cm^3$ of solution X in each test tube B_1 and C_1.

Using a cork borer, cut out three cylinders from specimen M, each measuring 3cm long. Put one cylinder in each of the test tubes A_1 and C_1. Cut up the third cylinder into 5 smaller pieces then add them to test tube B_1. Leave the set up for 15 minutes.

Label 3 other test tubes as A_2, B_2 and C_2 and add $4cm^3$ of distilled water to each of them. After 15 minutes, remove the cylinder in A_1, dip it in distilled water and immediately remove it and transfer it to test tube A_2. Remove the pieces in test tube B_1, and drop them in distilled water and immediately remove them and transfer them to test tube B_2 and finally remove the cylinder in C_1, dip it in distilled water and immediately remove it and transfer it to test tube C_2. Leave the set up for 15 minutes.

After 15 minutes, remove the cylinders from the test tubes leaving the solutions. Carry out tests in the table below on solutions A_2, B_2 and C_2.

Tests	**Observations**	**Deductions**
(i) Take $1cm^3$ of the solution from test tube A_2, and put it into another test tube, add $1cm^3$ of Benedict's solution and boil.		
(ii) Repeat test (i) using the solution in test tube B_2		

(iii) Repeat test (i) using the solution in test tube B_2		

(c) Name the biological process investigated in (b).

.....

(d) Explain the results in tests (ii) and (iii)

Test (ii)

.....

.....

.....

.....

Test (iii)

.....

.....

.....

.....

(e) Explain the purpose of

(i) cutting up one cylinder of M into smaller pieces before adding to test tube B_1.

.....

.....

(ii) dipping the pieces of M from test tubes A_1, B_1 and C_1 into distilled water before transferring them to test tubes A_2, B_2 and C_2

.....

.....

Activity 75

You are provided with liquids **A** and **B. (liquid A is 10% sucrose solution, liquid B is distilled water)** You are required to carry out tests on the liquids using visking tubes, following the instructions provided, and then answer the questions that follow.

Tightly tie one end of each of the visking tubes provided using a thread.

Measure 30cm^3 of liquid **A** and transfer it into a boiling tube labelled A and 30cm^3 of liquid B and transfer it into a boiling tube labelled B.

Now measure 5cm^3 of liquid A and carefully transfer it to one of the visking tubes and tightly tie the remaining end of the visking tubes leaving the thread hanging. Similarly measure 5cm^3 of liquid B into the second visking tube and in the same way tie the remaining end of the visking tube.
Transfer the visking tube containing liquid **A** into boiling tube **B** and the visking tube containing liquid **B** into boiling tube **A** as shown below and leave the set-up for 30 minutes.

(a) After 30 minutes, remove and examine the visking tubes. Describe the condition of each visking tube.

(i) Visking tube from boiling tube A

.....

.....

(ii) Visking tube from boiling tube B

.....

.....

(b) Transfer the liquid in boiling tube **A** into a 10cm^3 measuring cylinder and record its volume in the table below. Repeat the procedure to measure and record the volume of liquid in boiling tube **B** and complete the table.

	Boiling tube A	Boiling tube B
Final volume (cm^3)		
Initial volume (cm^3)		
Difference in volume (cm^3)		

(c) Explain your results in the table above for boiling tubes A and B

(i) Boiling tube A

.....

.....

.....

.....

(ii) Boiling tube A

.....

.....

.....

.....

(d) (i) What process is being demonstrated in the tests?

.....

(ii) What was the role of the visking tube in the experiment?

.....

SKELETON

VERTEBRAL COLUMN

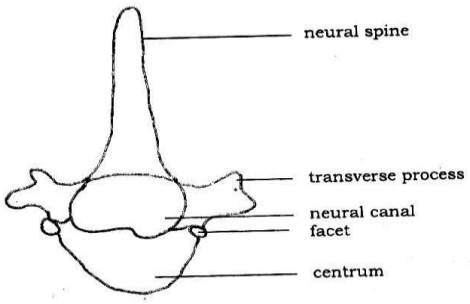
Vertebral column is made up of a number of small bones of vertebrae, each is called vertebra. The vertebra is separated from each other by cartilage and fibre or intervertebral disc. The vertebra is named according to the region of the vertebra where it is found.

In human, the vertebrae include:

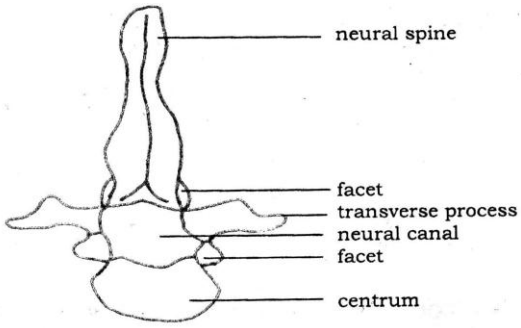
7 cervical vertebra (in the neck).
12 thoracic vertebra (in the thoracic region).
5 lumbar vertebra (in the abdominal region).
5 Sacral vertebra (in the lower abdomen).
4 caudal vertebra (in the lower abdomen).

1. THORACIC VERTEBRA

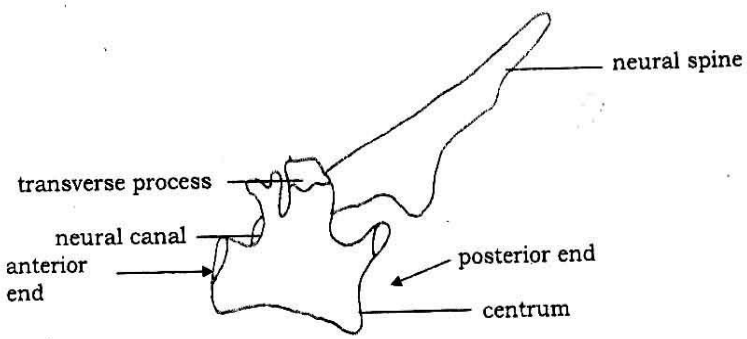
(anterior view)



Poterior view



Lateral view

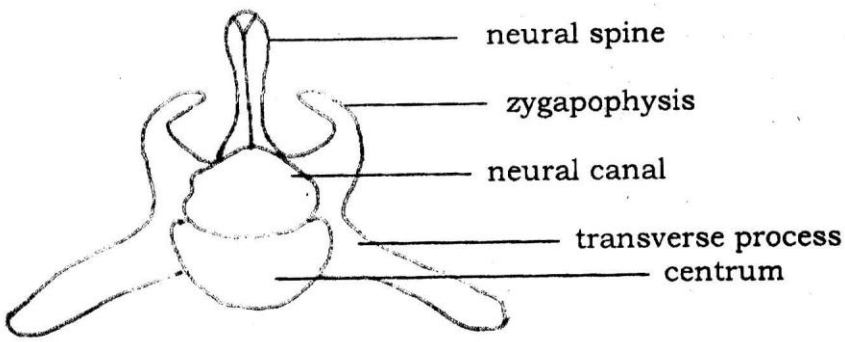


Characteristics of thoracic vertebra

(i) A long neural spine.
(ii) A pair of articular facets.
(iii) A pair of short transverse process.
(iv) A Large Centrum
(v) Tubercular facet on transverse process.
(vi) Fewer projections.

2. LUMBAR VERTEBRA

Anterior view of Lumbar vertebra



Differences between Thoracic and Lumbar vertebrae

Thoracic Vertebra	**Lumbar Vertebra**
Has long neural spine	Has short neural spine
Has small Centrum	Has large Centrum
Has short transverse process	Has long transverse process
Has fewer projections	Has many projections
Has wide neural spine	Has Narrow neural spine.
Narrow neural arch	Has wider neural arch

Similarities between Thoracic and Lumbar vertebrae

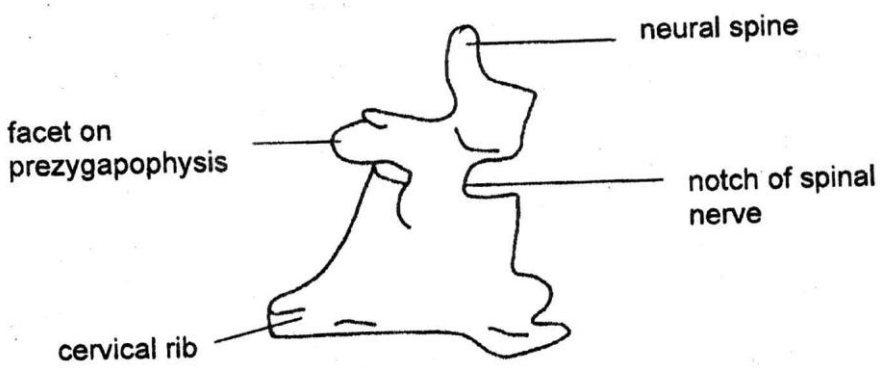
i) Both have neural spine
ii) Both have neural canal
iii) Both have transverse process.
iv) Both have arches, facets. Centrum.

3. CERVICAL VERTEBRA

The first two cervical vertebrae, called atlas and axis respectively differ from the rest. They are respectively shaped to allow the skull move freely on the vertebral column.

Anterior view of cervical vertebra

lateral or side view of cervical vertebra



Characteristics of Cervical Vertebra

i) It has a small neural spine
ii) It has a large neural canal.
iii) It has a small centrum.
iv) It has transverse processes form two parts called cervical rib.
v} It has the vertebraterial canal.

Functions of the parts of Vertebra

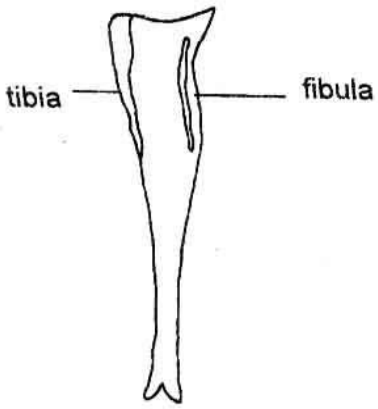
i) Neural spine:For muscle attachment.
ii} Transverse process: For muscle attachment and rib articulation,
iii) Centrum: Articulate with other vertebra.
(iv) Neural canal: For protecting spinal cord.
(v) Neural arch: For passage and protection of spinalCord.
(vi) Vertebraterial canal: For passage of blood vessels of the neck,
(vii). Facets: For articulation with other vertebrae and ribs in the **thoracic vertebrae.**

THE APPENDICULAR SKELETON

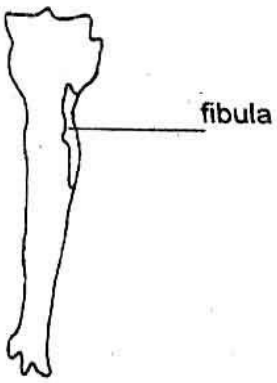
This is the skeleton of the limbs.

1. TIBIA

Anterior View

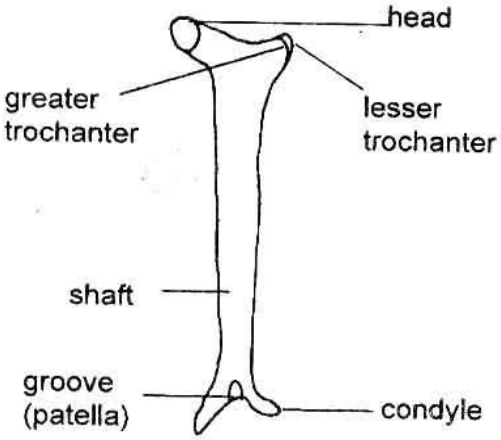


Lateral View

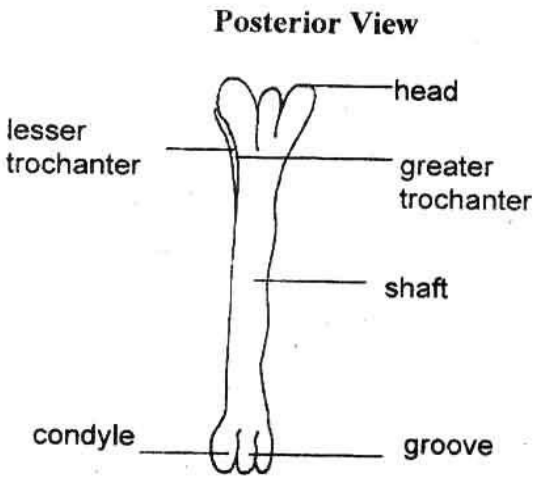


2. FEMUR

Anterior View



Posterior View



Note that, tibia articulates with femur and tarsal and femur articulates with tibia and pelvis bone.

Activity 76

You are provided with specimens A and B **(Specimen A is thoracic vertebra and B is lumber vertebra)**

(a) Outline structural **differences and similarities between A and B**

SPECIMEN A	**SPECIMEN B**

Similarities between specimen A and B

……

……

……

……

b) State the ways in which anterior of specimen B can be discovered.

……

c)What are the functions of the specimen A and B to the animals?

……

……

d) Make a well labeled drawing of the anterior view of specimen A

Activity 77

You are provided with specimens **A, B, C and D**. Observe the specimens and answer the questions that follow. (Note that the specimens include; Tibia, Femur, Thoracic vertebra, and Lumbar vertebra).

(a). Identify the specimen.

A……

B……

C……

D……

(b). State the two bones that each specimen A and B articulates with and the type of joints formed at each articulation

……

……

c)State the structural differences between specimens C and D.

Specimen C	**Specimen D**

d) Draw and label the anterior view of specimen C. State your magnification.

Activity 78

You are provided with specimens L and M. **(Specimen L isthoracic vertebra and M is lumbar vertebra. All from a goat)**

(a) Identify the specimens

L ……

M ……

(b) Suggest with reasons the part of the animal from which L and M were obtained.

SPECIMEN	**REGION**	**REASON**
L		
M		

(c) State two functions of L and M giving observable adaptations of each of the specimen to its function.

L

Functions

……

……

Structural adaptations

……

……

M

Functions

……

……

Structural adaptations

……

……

(c) State the structural differences between L and M

Structural differences between L and M

Specimen L	Specimen M

(e) State the **similarities between L and M**

Similarities between specimen L and M

……

……

……

(f) Draw the anterior view of specimen M in the space provided.

MAMMALIAN TEETH

Definition: Teeth are hard white, bone like structures found in the mouth sunk in the jaw bone.

Types of teeth

There are four different kinds of teeth in mammals.

(i) Incisor: For cutting lumps of food. Characteristics of Incisor

It has a crown which is chisel or wedge shaped. Has single root.

(ii) Canine: Found behind the Incisors and is used for tearing food.

Characteristics of Canine

Crown is pointed and sharp. Has single root.

(iii) Premolar, Premolar is next to Canine and is used for chewing and grinding food.

Characteristics of Premolar

Has wide crown with ridges and cusps. Has two roots.

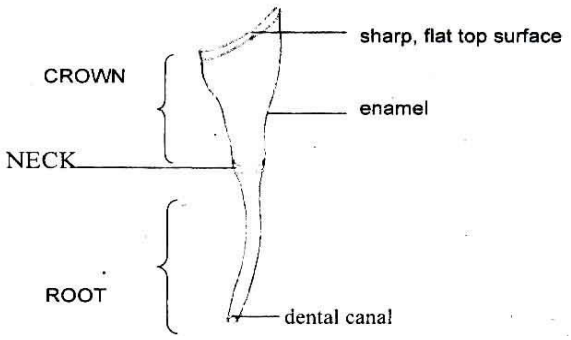
(iv) Molar: Molar is found behind premolar and is used for chewing and grinding food.

Characteristics of Molar

- Has wide crown with ridges and cusps
- Have three or more roots.

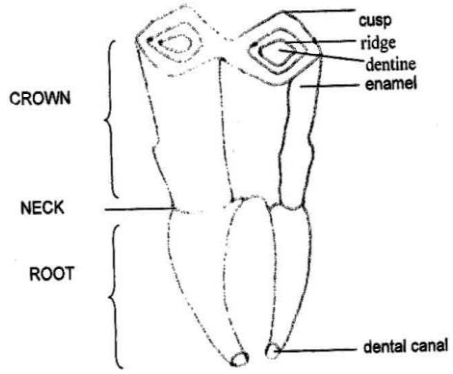
1. INCISOR TOOTH

lateral or side view of Incisor tooth



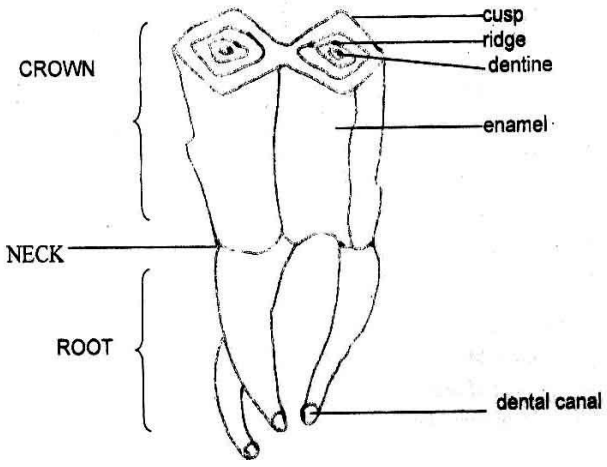
2. PRE-MOLAR TOOTH

Lateral view of a Pre-Molar Tooth



3. MOLAR TOOTH

lateral view of Molar Tooth



Function of the labelled parts

i) **The Crown**: For breaking food into smaller pieces i.e. During grinding, chewing and tearing.

ii) **Neck:** It separates the crown and the root at the level of the gum.

iii) **Root:** For fixing the tooth into the jawbone.

iv) **Enamel:** For strengthening the tooth and is made up of calcium phosphate.

Care of the teeth

Below are the cares to follow if life is to be maintained

i) Brush your teeth after every meal.

ii) Avoid sweet food as it tends to encourage growth of bacteria.

iii) Do not use teeth for biting hard things e.g. opening bottle tops.

iv) Visit dentist regularly to check on the state of your teeth.

Dental diseases

The most important dental diseases are: Dental caries and periodontal disease.

1. Dental caries is caused by:

i) Lack of hard food.

ii) Too much sweet food

iii) Lack of calcium in the diet

iv) Lack of vitamin D

v) Lack of cleanliness

vi) General ill-health.

2. **Periodontal**! **Disease** is caused by:

i) Lack of Vitamin A and C

ii) Lack of massage of the gum.

iii) Improper cleaning.

Fluoridation

Recent research has shown that fluoride salt in the drinking water may have some effect i**n** reducing dental caries.

Activity 79

Study specimens L and M which are structures from the same animal.

(Specimen L is Incisor tooth and M is Molar tooth).

a) With reasons, identify the specimen.

Specimen L.....

Reasons

……

.....

Specimen M.....

Reasons

……..……..

.....

b) Give reason and state the function of each specimen.

Function of L:

……

Reason:

……

Function of M:

……

Reason:

……

c) Outline differences and similarities between L and M

Differences between L and M

Specimen L	Specimen M

Similarities between L and M

i. ……..……

ii. ……..

iii. ……..

d) Suggest the diet of animal from which the specimen L and M were obtained. Use observable features on this specimen.

Feature of L……

Diet……

Feature of M……

Diet……

e) Make a labelled drawing of each as seen from the side.

Side view of L

Side view of M

Activity 80

You are provided with specimen D and E both obtained from the same animal.

(Specimen D is an incisor tooth, E is a molar tooth)

(a) Basing on the observable features, identify each specimen.

Specimen	**Identity of specimen**	**Observable features**
D		
E		

(b) Giving two reasons, suggest the class of the animal from which specimens D

and E were obtained.

Class;.....

Reasons;

.....

.....

(c) Explain how the features of the specimen E adapt it for its function.

.....

.....

.....

.....

(d) Observe the two specimens and state four structural differences between them.

Specimen D	**Specimen E**

(e) Draw and label the upper region of specimen E. State your magnification.

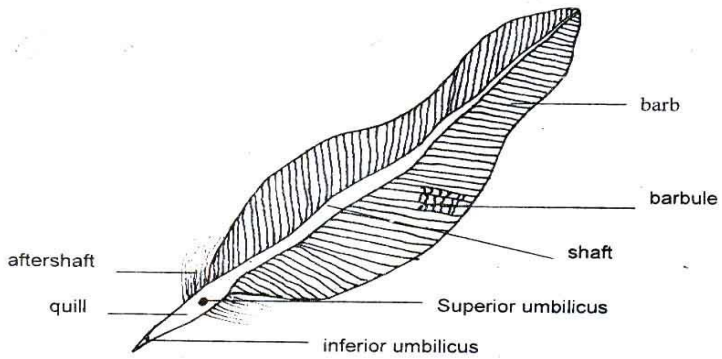
FEATHERS

Types, functions and location of birds' feathers

No	TYPES OF	FUNCTION	LOCATION
1.	Quill or flight feather	For flight and protection	Tail and wings
2.	Covert or contour feather	For insulating the body against heat loss and protection	Neck and upper side of the body
3.	Down feather	For insulating the body against heat loss and sensitivity	Abdominal region i.e. lower side of the body.
4.	Filoplume feather	For sensory function.	Found all over the body. '

1. Quill or flight feather

Structure of quill or flight feather

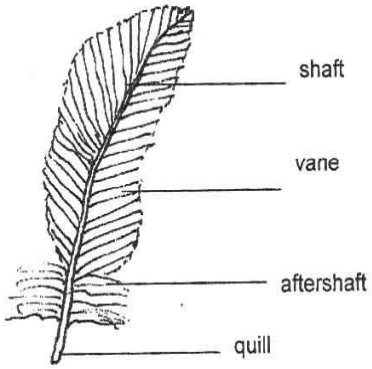


Characteristics of quill or flight feather

i. A large long hollow strong shaft.
ii. A large hollow strong quill
iii. A superior and inferior umbilicus on the quill.
iv. A large flat expanded vane
v. A vane consisting of barbs with interlocking barbules.

2. Covert or Contour feather

Structure of Covert or Contour feather



Characteristics of Covert feather

i) Has a short vane.
ii) Has a large after shaft.
iii) Small quill.

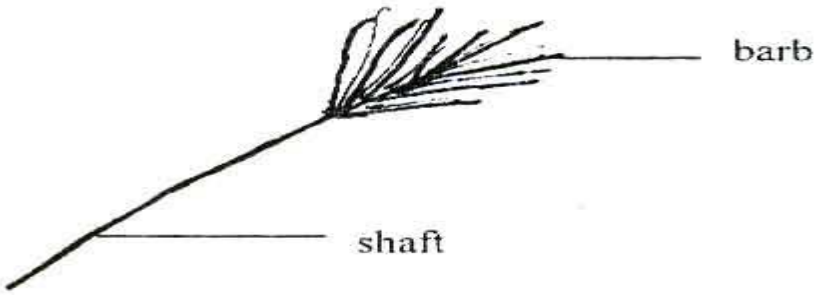
3. Down feather

Characteristics of down feather

i) It is soft
ii) Very small and short quill
iii) Very small and short shaft
iv) No vane
vi) Small quill.

4. FILOPLUME FEATHER

Structure of filoplume feather



Characteristics of filoplume feather

(i) No quill
(ii) Thread like in shape
(iii) Very free barbs.

Activity 81

You are provided with specimens M and N study them carefully and answer the questions that follow. **(M is Quill feather and N is Down feather)**

(a) Identify the specimens M and N

Specimen M

……

Specimen N

……

(b)(i) Name the possible functions of the specimen M

……

……

ii) List the observable features of specimen M which.make it suited for its function.

……

……

……

……

iii)List the observable features of the specimen N which make it suited for its function

……

……

……

(c) (i) In which parts of the bird were the specimen **M** and **N** taken?

Specimen **M**……..

Specimen **N**……..

(ii) Take the specimen **M** between your fingers. Brush them towards the base, what happen?

……..

(iii) Brush specimen **N** forward to the tip, what happen?

……..

(d)(i) Explain this by what you see when looking at the vane through the specimen M under lens.

……..

……..

……

(ii) Outline the adaptations of specimen M to its function.

……

……

……

……

(iii) Using a hand lens, study specimen M carefully, draw its base and label, state your magnification.

(e) How is the organism (bird) from which the specimen **M** and **N** are picked adapted for flight?

i. ……

ii. ……

iii. ……

iv. ……

v. ……

vi. ……

vii. ……

Activity 82

You are provided with specimen K and L**. (K is Quill feather and L is down feather)**

(a) Identify specimens giving reasons in each case

i) Specimen K.....

Reasons

.....

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(ii) Specimen L.....

Reasons

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.....

(b} From the structure of the specimens state the part of the animal's body each specimen was taken

{i) Specimen k.....

(ii) Specimen L .....

(b) i)Pour little water on the specimen one at a time and state what is Observed

.....

.....

(ii)What is the significant of your observation in

Specimen K

.....

Specimen L

.....

d) How were specimens suited for their function on the animal from which they were removed?

Specimen K

.....

.....

.....

Specimen L

.....

.....

Senior four term three

THE SOIL

Definition

This is a thin surface layer of material covering underlying rocks or is a mixture of mineral particles and humus.

Soil composition

Soil is composed of the following:

1. Humus (Organic matter),
2. Water.
3. Air,
4. Living Organisms.
5. Rocky Particles.

Soil Composition or Fractions, Constituents and their functions

Composition	Constituents	Function
Humus (Organic matter)	Decaying animal and plant matter	Give soil a darker colour. Absorb and retain larger amount of water for plant use. Avail mineral salts for use by the plants when it is completely broken down.
Water	Rain water seeping down - wards and capillarity water from underground source	The water dissolves all salts and, make them readily available to plants. Help in photosynthesis. Soil water dissolve carbondioxide produced by living organisms. Help in cooling of plant during transpiration
Air	Oxygen and Nitrogen	Oxygen helps in respiration of soil organisms and plant roots Nitrogen is for fixation of nitrogen fixing bacteria of the soil. Oxygen helps in seed germination in the soil.
Living organisms	Bacteria, fungi and other small organisms.	Bacteria help to break down of humus and play an important part in nitrogen cycle. Harrowing of soil animals improves aeration and drainage of the soil. Other organisms form complex food webs by feeding on plant and animal materials
Rocky particles (inorganic matter)	Soluble e.g. mineral salts, Insoluble e.g. gravel, clay, silt and chalk	Provide framework of the soil. Provide mineral salts to the soil. Have spaces in between them which are occupied by air and water.

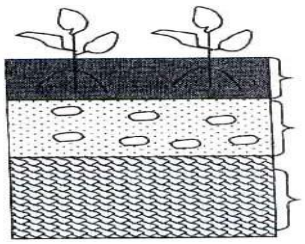
Note: Rocky Particles (Inorganic matter)

Constitute soluble mineral salts e.g. nitrogen, magnesium, potassium, etc and are insoluble matter e.g. gravel, coarse sand, silt, clay.

The rocky particles (inorganic matter) are different according to the diameter of the particle.

Soil profile

Soil profile is the section of soil that shows the different layers through the soil from the soil surface to the parent rock.



Soil profile consist of three zones:

(i) Zone A- Top soil
(ii) Zone B- Sub soil
(ii) Zone C- Parent rock and parent materials

Characteristics of each zone in soil profile

Zone	**Characteristics**
Zone A Top soil	- Has low clay content. - Contains most of the nutrients used by plants. - Contains soil animals, bacteria and fungi. - Contains humus. ~ Darker in colour.
Zone B Sub soil	- Contains much silt and fine sand than topsoil. - Contains little nutrient used by plants. - Contains less air than zone A

Soil classification

There are three classes of soil; these are, loam, clay and sandy soil. They are classified according to the sizes of the soil particles and is referred to as soil texture. The textures of soil describe the proportion of silt, clay and sand in the soil.

Characteristics of loam, clay and sandy soil

Class of soil	**Characteristics**
Loam soil	- Has good mineral content - Has good water holding capacity. - Has moderate high capillarity. When it is dry and squeezed in the hand it forms a cast that will not break. . . . . Has gritty feeling of particles between fingers when wet.
Clay soil	- Has poor aeration due to very small space, - Has poor drainage. - Has very high water holding capacity. - Has high capillarity. - Has-fine particles.
Sandy soil	- Has good aeration. - Has good drainage. - The soil is porous. - Has water holding capacity. - Has low capillarity. - It is light soil

Physical and chemical properties of soil
The physical properties of soil include:

(i) Drainage and porosity
(ii) Water retention
(iii) Permeability
(iv) Organic matter content
(v) Air content
(vi) Water content

The chemical properties of soil include:

(i) Soil PH i.e. acidity and alkalinity of the soil
(ii) Mineral content of the soil

The above physical and chemical properties of the soil can be determined by experiments.

a. Experiment to investigate the amount of air in the soil
Procedure

(i) Take a measuring cylinder and in it put a known volume of water,
(ii) Measure a known volume of soil using a tin and add it in a known volume of water in the measuring cylinder.
(iii) Note the level of water in the measuring cylinder (some bubbles will be seen; this shows that air is escaping from the soil).
(i) Stir the content well with a glass rod until there is no air bubble,
(v) Note the volume of water in the measuring cylinder.

Observation

The volume of water in the measuring cylinder falls. -

Explanation

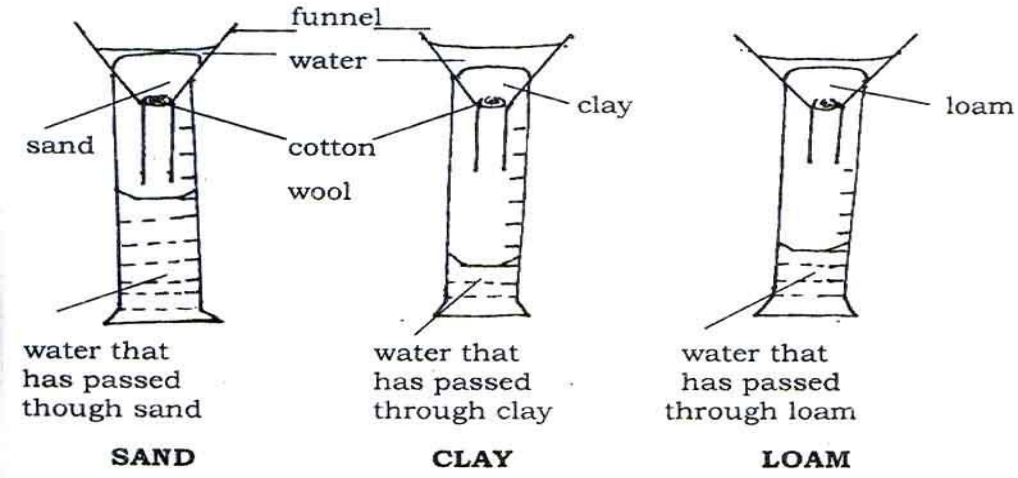
The volume of water falls because air has been displaced by water. In sandy soil, the volume of air is greater than in clay soil. This is because clay soil has smaller particles which are more closely packed together. Loam soil has intermediate air content. When equal volumes of soil and water are used to determine the amount of air in the three types of soil using measuring cylinders, it will be found that the volume of water falls greatly in sandy soil followed by loam and least in clay. This shows that air has been displaced greatly by water in sandy soil, followed by loam and least in clay. The percentage of air can be calculated as below:

$$\text{The \% age of air in the soil} = \frac{\text{Volume of air that has\_esgarjed}}{\text{Volume of the soil}}$$

Note: The change in water level in the measuring cylinder - to the volume of air that escaped.

a. Experiment to investigate the amount of water retained by soil

(i) Set up of apparatus:



Procedure

(i) Take three filter funnels, put cotton wool on each and put in the known equal volume of dry clay, loam and sandy soil,

(ii) Stand the filter funnels in the neck of the measuring cylinders (see picture above).

(iii) Add equal volume of water in the soil samples in each funnel,

(iv) Leave the experiment for sometime until the dripping has stopped in the three apparatus,

(i) Read the volume of water in the measuring cylinder and compare the readings.

Observation

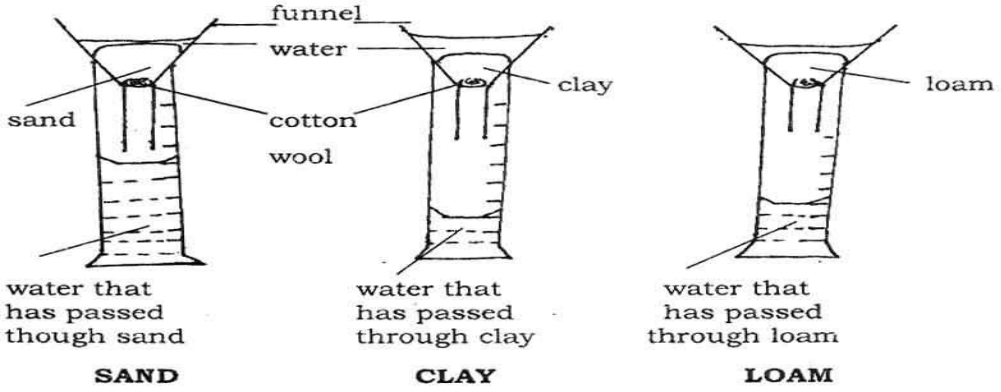
The readings indicate that the volume of water in the measuring cylinder containing sandy soil is greater, followed by that of loam and least in that of clay. This shows that least water is retained by sandy soil, followed by loam and greatest in clay soil.

Explanation

Much water is retained by clay than loam and sand. This is due to partly absorption of water by colloidal clay particles and partly to the large total surface area of the particles to which the water can cling as a film.

b. Experiment to investigate the rate of drainage of the soil

Set up of apparatus:



Procedure

(i) Take three filter funnels and in each place cotton wool.
(ii) Put equal volume of sand, loam, and clay soil in each funnel.
(iii} Stand the funnels in the necks of the measuring cylinders.
(iv) Pour into the funnels equal volume of water and note the time immediately
(v) Note the time for water to filter through.

Results

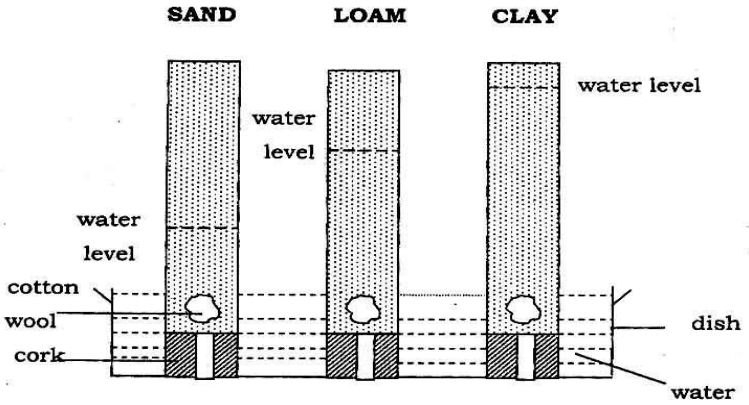
It will be found that the water drains through fastest in sandy soil followed by loam and least in clay.

Explanation

The large air spaces enable the water to drain more rapidly in sandy soil followed by loam and least in clay.

c. Experiment to show the rise of water in soil by capillarity

Set up of apparatus:



Procedure

(i) Set up apparatus as shown in the figure above.
(ii) Note the time you have set up your apparatus.
(iii) Note the rise of water up through the hourly intervals and measure the level above the free water surface.
(iv) Note the time and write your results below.

Observations

Water rises greatest at the early stages of the experiment in sandy soil and highest at the end of the experiment in clay soil.

Explanation

The larger air spaces in the sandy soil enable the water to rise more rapidly in the first hours of the experiment than in loam soil and clay meanwhile the smaller air spaces in clay although slower at the early stage of the experiment, enable the water finally to rise higher than in the sand and loam.

d. Experiment to separate the soil component:

Procedure

(i) Take a measuring cylinder and in it place loam soil to cover about 'A of the total volume.

,(ii} Add water to the soil until the cylinder is almost full,

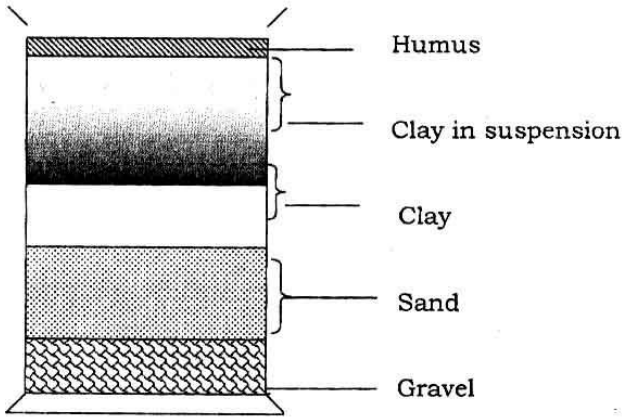
(iii) Shake the cylinder vigorously for thorough mixing of the soil.

(ii) Put the cylinder on a flat surface to allow it to settle.

(iii) Make your observation carefully and note the order and rate of settling down of different soil particles.

(vi) Draw and label the apparatus after all the particles have settled.

separation of different kinds of soil component



Activity 83

You are provided with soil samples Q_1, Q_2, Q_3. (Q_1 is loam soil, Q_2 is sand soil, Q_3 is sandy soil)

Procedure

Measure 20 cm^3 of sample Q_1 and put into a funnel lined with filter paper.

Place the funnel into the measuring cylinder.

Measure 20cm^3 of water and pour into soil in the funnel.

(a) Read the volume of water collected after 30 seconds for 2 minutes and record the results in the .table below. Repeat the procedure with soil samples Q_2 and Q_3.

Sample	Volume of water (cm^3) every 30 seconds			
	30 seconds	60 seconds	90 seconds	120 seconds
Q_1				
Q_2				
Q_3				

(b) In the space below, sketch a graph of volume of water collected against time for each soil sample.

(c) Explain the differences in the shapes of the curves.

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(d) Basing on your results, suggest how suitable each sample is for crop growth.

Q1……

Q2……

Q3……

Activity 84

You are provided with soil samples **U** and **M**. (U is loam soil and M is clay soil).

Procedure

Label the two measuring cylinders provided **U** and **M**.

Place a small piece of cotton wool at the bottom of each of the funnels provided and place the funnels on the labelled measuring cylinders.

Measure 40cm^3 of soil sample **U** (loam soil) and pour it into the funnel placed on measuring cylinder U. Repeat the procedure with soil sample M (clay soil). Add 100cm^3 of water, pour at once to each soil sample in the funnels.

(a)Record the volume of water that goes through each soil sample after 5 minutes, in the table below. Complete the table by calculating the volume of water retained by each soil sample.

Soil Sample	**Volume of Water added (cm^3)**	**Volume of Water that goes through the soil (cm^3)**	**Volume of Water retained by soil (cm^3)**
U			
M			

Note

(i) That the volume of water that goes through the soil sample U should be greater than the volume of water that goes through the soil sample M; and the reverse is true for the volume of water retained by soil.

(ii) The volume of water retained by soil (in cm3), is calculated by Subtracting the volume of water that goes through the soil from the volume of water added (100cm3).

(b) State the soil properties being investigated in this experiment.

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c) From the results of your experiment, state with reasons, which of the two soil samples is more suitable for crop production?

Soil sample……

Reasons

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……

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d) How would you improve on the soil you consider less suitable for crop growth?

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