CHAPTER ONE

1.0 FOOD TESTS

These are tests that can be used to determine whether specific food substances are present or absent in a given food samples either in solution or in solid state.

The major foods eaten by animals are of two forms. These include: - organic compounds and inorganic compounds.

The main organic compounds are: - **carbohydrates, proteins, lipids and vitamins**.
The carbohydrates are divided into the following

(i) Monosaccharides for example glucose, fructose and galactose.
(ii) Disaccharides for example lactose, maltose and sucrose.
(iii) Polysaccharides for example starch, cellulose in plants and glycogen in animals, chitin in exoskeleton of arthropods.

All monosaccharides (simple sugars) and disaccharides (complex sugars) except sucrose are called reducing sugars because they have got an active reducing group. Sucrose is called non-reducing sugar.

The food substance tested during food tests include

(i) Starch
(ii) Reducing sugars
(iii) Non-reducing sugars
(iv) Proteins
(v) Lipid (fats and oils)
(vi) Vitamin C (Ascorbic acid)

When carrying out food test on any food substance it is very important to note the following:-

- The test reagent (i.e. type of food substance it tests, its nature and colour).
- The test procedure (i.e. proportionality, order of addition and conditions like heating, cooling and shaking).
- The colour change expected
- The colour of the original/test solution before adding the reagent i.e. turbid, colourless, milky, cloudy e.t.c.
- The nature of the test and resultant substance i.e. solution or precipitate.

1.1 THE TABLE BELOW SHOWS THE TEST REAGENTS AND THEIR COLOUR

REAGENT	ORIGINAL COLOUR
Iodine solution	Brown
Benedict's/Fehling's solution	Blue
Millon's reagent	Colourless
Copper (II) sulphate solution	Blue
Dilute Hydrochloric acid	Colourless
Sodium hydroxide solution	Colourless
Ethanol	Colourless
Distilled water	Colourless
DCPIP solution	Blue

1.2 THE TABLE BELOW SHOWS THE FOOD TYPE AND THE TEST REAGENT USED

FOOD TYPE	TEST REAGENT
Starch	Iodine solution
Reducing sugar	Benedict's solution/Fehling's solution
Non-reducing sugar	Benedict's solution/Fehling's solution, Dilute hydrochloric acid and sodium hydroxide solution
Proteins	Millon's reagent
	Copper II sulphate solution and sodium hydroxide solution (Biuret's test)
Lipids	Ethanol and water
Vitamin C	DCPIP (Dichlorophenolindophenol) solution

1.3 REDUCING SUGARS (Benedict's test/ Fehling's Test)

Test	Observation	Deduction
To 1cm^3 of the test solution, add 1cm^3 of Benedict's solution and boil.	A colourless solution changes to blue solution, then to green solution, yellow precipitate, orange precipitate and finally brown precipitate on boiling.	Reducing sugar present.
	Colourless solution turns blue solution which persists/ remains on boiling.	Reducing sugar absent.

Note: During the above test, the final colour indicates the quantity of reducing sugars present in a given food sample or solution i.e.

- Blue shows that no reducing sugars are present.
- Green shows that little reducing sugars are present.
- Yellow shows that moderate reducing sugars are present.
- Orange and brown/red shows that much reducing sugars are present.

1.4 NON REDUCING SUGARS

Test	Observation	Deduction
To 1cm^3 of the test solution, add 1cm^3 of dilute hydrochloric acid and boil for 1 minute. Cool under tap water and then add 1cm^3 of sodium hydroxide solution followed by 1cm^3 of Benedict's solution and boil again.	A colourless solution changes to blue solution, then to green solution, yellow precipitate, orange precipitate and finally brown precipitate on boiling.	Non-reducing sugar present.
	Colourless solution turns blue solution which persists/ remains on boiling.	Non-reducing sugar absent.

Note:

In testing for non-reducing sugars;

- Dilute hydrochloric acid is added to hydrolyse the non-reducing sugars to reducing sugars.
- The mixture is boiled to increase the rate of hydrolysis reaction and is cooled to stop the hydrolysis reaction.
- Sodium hydroxide or sodium hydrogen carbonate solution is added to neutralize the excess acid added because Benedict's / Fehling's solution does not work in acidic conditions.

1.5 STARCH (Iodine test)

Test	Observation	Deduction
To 1cm^3 of test solution in a test tube add 2-3 drops of iodine solution.	Milky/ cloudy solution turns to blue-black/black/blue solution.	Starch present.
	Milky/cloudy solution turns to brown solution.	Starch absent.

1.6 LIPIDS

(i) TRANSLUCENT MARK TEST

Test	Observation	Deduction
Rub the substance on a piece of paper (if provided as solid) or add 2 drops of test solution on a piece of paper. Allow to dry, hold the paper against light and observe.	Translucent spot or patch or mark is left on the paper.	Lipids present.
	No translucent mark is observed.	Lipids absent

(ii) SUDAN III TEST

Test	Observation	Deduction
To 1cm^3 of test solution add 2cm^3 of distilled water followed by 2-3 drops of Sudan III and shake.	Red droplets are seen in the mixture.	Lipids present.
	Solution remains with the original colour.	Lipids absent

(iii) EMULSION/ETHANOL TEST

Test	Observation	Deduction
To 1cm^3 of the test solution add 5cm^3 of ethanol and shake vigorously followed by 2cm^3 of distilled water.	Cloudy/ creamy/ milky emulsion/suspension is formed.	Lipids present.
	Mixture remains colourles	Lipids absent

1.7 PROTEINS

(i) MILLON'S TEST

Test	Observation	Deduction
To 1cm^3 of test solution add 4 drops of Millon's reagent and boil for 2 minutes.	A pink or red coagulated mass forms.	Proteins present.
	Colourless solution remains colourless solution	Proteins absent

(ii) BIURET'S TEST

Test	Observation	Deduction
To 1cm^3 of the test solution add 1cm^3 of Sodium hydroxide solution followed 2 drops of copper II sulphate solution and shake slightly.	Turbid/milky solution turns to purple solution.	Proteins present.
	Turbid/milky solution turns into colourless solution turns then to blue precipitate.	Proteins absent.

1.8 VITAMIN C

Test	Observation	Deduction
To 1cm^3 of DCPIP solution in a test tube add the test solution drop wise until in excess.	The blue colour DCPIP solution is decolourised/ discharged i.e. The blue solution turns to colourless solution.	Vitamin C present
	The blue colour of DCPIP solution remains/persists	Vitamin C absent

1.9 ENZYME ACTION

Enzymes are biological catalysts, proteins in nature that speeds up rate of chemical reactions. Enzymes act on substances known substrates.

1.9.1 Characteristics of enzymes:

- They work on specific substrates.
- They work at specific pH i.e. they are affected by pH changes.

- They work best at an optimum temperature (35°C-40°C).
- They are denatured by excess heat.

1.9.2 The Water Bath

The water bath is an alternative method of heating in food tests or food related experiments like those involving the investigation of the action of enzymes on food substances. It should be noted that in all enzyme controlled reactions, the temperature of water bath should be kept at least between 35-40^{0}C for the whole length of the experiment.

1.9.3 The following are the factors that affect the rate of enzyme action

(i) ***Temperature.***

Enzyme action increases with temperature up the optimum, beyond which enzymes are denatured.

(ii) ***pH.***

Enzymes have specific optimum pH. Any change in pH will affect enzyme action. pH can be acidic, alkaline or neutral.

(iii) ***Concentration of substrate.***

Enzyme activity increases with increase in substrate concentration.

(iv) Concentration of enzymes.

Enzyme activity increases with increase in its concentration.

(v) Co-factor/ co-enzyme

(vi) Inhibitors

These reduce enzyme activity.

1.9.4 HYDROLYSIS OF STARCH USING SALIVARY AMYLASE:

Starch is hydrolyzed by salivary amylase to maltose (reducing sugar) in a suitable pH medium i.e neutral or alkaline medium. In acidic medium starch is not hydrolyzed.

Test	**Observation**	**Deduction**
To 1cm^3 of starch solution, in a test tube, add 1cm^3 of diluted saliva. Warm in a water bath at 30-35^{0}C for 10 minutes. Add a few drops of iodine solution.	The brown colour of iodine solution persists/remains	Starch was hydrolyzed to reducing sugars
To 1cm^3 of starch solution, in a test tube, add 1cm^3 of diluted saliva followed by 10 drops of dilute HCl. Warm in a water bath at 30-35^{0}C for 10 minutes. Add a few drops of iodine solution.	the milky/cloudy turns to blue-black solution	Starch was not hydrolyzed to reducing sugars
To 1cm^3 of starch solution, in a test tube, add 1cm^3 of diluted saliva followed by 10 drops of sodium hydroxide solution. Warm in a water bath at 30-35^{0}C for 10 minutes. Add a few drops of iodine solution.	The brown colour of iodine solution persists/remains	Starch was hydrolyzed to reducing sugars

1.9.4 HYDROLYSIS OF STARCH BY OTHER ENZYMES (not salivary amylase):

These enzymes can be amylase in maize, diastase in barley. These enzymes are extracted from seeds by soaking different sets of seeds for example maize, for different times that is to say two days, seven days and ten days. They are then ground and water is added into them, to get fine extracts.

A control is set up by using an extract prepared from un soaked seeds.

These are then tested with Benedict's solution for reducing sugars.

In each of the extracts a sample is tested for reducing sugar using benedict's solution. The test will be positive soaked in water for a longer time and were germinating. This is because germination involves mobilizing the food reserves by the enzyme activity to soluble usable forms i.e. breaking down starch to maltose.

In unsoaked seeds, the Benedict's test will be negative i.e. starch is not broken down.

1.9.5 HYDROLYSIS OF SUCROSE BY INVERTASE

Invertase is the enzyme found in yeast and it brings about the conversion of sucrose to glucose and fructose which are reducing sugars.

Test	Observation	Deduction
To $1cm^3$ of sucrose solution add $1cm^3$ of yeast suspension and incubate the mixture in a water bath maintained at temperature of 35^oC to 40^0C for 15-20 minutes and then add $1cm^3$ Benedict's solution and boil.	A colourless solution changes to blue solution, then to green solution, yellow precipitate, orange precipitate and finally brown precipitate on boiling.	Non-reducing sugars (sucrose) was hydrolysed to reducing sugars

1.9.6 ALCOHOLIC FERMENTATION USING ENZYMES IN YEAST

Procedure

Mix glucose and yeast in a test tube and pour a layer of oil over it, this ensures anaerobic conditions. Fit it with a delivery tube fitted to another test tube containing lime water or indicator solution to test carbon dioxide evolved.

For positive results (in presence of carbon dioxide) if lime water is used

Observation

Solutions changes milky or cloudy

If indicators are used like bromethymol blue- changes colour from blue to yellow

Cresol red -changes colour from red to yellow

1.9.7 HYDROLYSIS OF PROTEINS BY THE ENZYME PEPSIN

Proteins are hydrolyzed to amino acids by pepsin in acidic solution. However, they can also be hydrolyzed by Trypsin but an alkaline medium.

Test	Observation	Deduction
To $1cm^3$ of protein solution add $1cm^3$ of pepsin solution followed by 2-3 drops of dilute HCl and incubate the mixture in a water bath maintained at temperature of 35^oC to 40^0C for 15-20 minutes.	The turbid/milky/cloudy solution turns to colourless solution i.e. the turbidity/ milkness/cloudness disappears.	Proteins were hydrolysed.

1.9.8 HYDROLYSIS OF HYDROGEN PEROXIDE BY THE ENZYME CATALASE

H_2O_2 is a toxic (poisonous) substance produced as a result of metabolic activity in the cells of both plant and animal tissues. These tissues contain an enzyme catalase which is capable of decomposing hydrogen peroxide (H_2O_2) into water and oxygen which are non-toxic.

$$2H_2O_2 \longrightarrow 2H_2O + O_2$$

Highly active tissues like liver cells show a very fast reaction compared to low active ones, and generally animal tissues show greater activity than plant tissues.

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 will relight a glowing splint indicating that it is oxygen.

This reaction does not occur in dead tissues e.g. boiled tissues. If boiled potato tuber or liver tissue instead of unboiled, no gas bubbles is given out. This is because boiling denatures enzymes in the potato or liver tissue.

If the potato tuber or liver tissue is cut into small pieces or crushed and dropped in the hydrogen peroxide solution, the reaction will be much faster as shown with faster evolution of gas bubbles. This is because crushed or small pieces of potato tuber or liver tissues have large surface area for enzyme reaction.

The reaction is fastest when pH is neutral, is moderate in alkaline, and very slow or stops in acidic medium.

1.10 WORKED EXAMPLES:

Example 1.

(a) You are provided with solution **N**. Carry out the following tests to identify the food substance in the solution. Record your observation and deductions, in the table below.

TEST	OBSERVATION	DEDUCTION
(i) To 1cm^3 of solution **N** in a test tube add 2-3 drops of iodine solution	Milky solution turned to blue-black solution	Starch present
(ii) To 1cm^3 of solution **N** in a test tube add 1cm^3 of Benedict's solution and boil	Milky solution turned to blue solution and remained blue solution on boiling.	Reducing sugar absent
(iii)To 1cm^3 of solution **N** add 3-4 drops of dilute hydrochloric acid and boil for one minute cool under tap water and add 3-4 drops of sodium hydroxide. Then add Benedict's solution and boil.	Milky solution turned to blue solution and remained blue solution on boiling.	Non reducing sugar absent
(iv)To 1cm^3 of solution **N** in a test tube add dilute sodium hydroxide followed by 4 drops of copper sulphate.	Milky solution turned into colourless solution, then to purple solution	Proteins present
(v) To 1cm^3 **DCPIP** in a test tube add solution **N** drop by drop	Blue solution remained blue solution	Vitamin C absent

(b) Identify the food substances in solution **N**

Starch and Proteins

(c) Name two sources from which the above foods can be obtained.

Sources of starch include cassava, maize, wheat e.t.c

Sources of protein include meat, beans, chicken, eggs, e.t.c

EXAMPLE 2

a. You are provided with an albumin solution (R), pepsin, dilute hydrochloric acid, sodium hydroxide solution and 4 test tubes. Carry out the tests below

Tests	**Observations**	**Deductions**
(i) To $2cm^3$ of **R** in a test tube 1, add $1cm^3$ of pepsin solution.	The turbid solution remains turbid	Proteins were not hydrolysed by pepsin
(ii) To $2cm^3$ of **R** in a test tube 2, add $1cm^3$ of pepsin solution followed by 2 drops of dilute hydrochloric acid.	The turbid solution becomes clear/colourless solution	Proteins were hydrolysed by pepsin.
(iii)To $2cm^3$ of **R** in a test tube 3, add $1cm^3$ of pepsin solution followed by 2 drops of sodium hydroxide solution	The turbid solution remains turbid	Proteins were not hydrolysed by pepsin
(iv)To $2cm^3$ of **R** in a test tube 4, add $1cm^3$ of boiled pepsin solution followed by 2 drops of dilute hydrochloric acid.	The turbid solution remains turbid	Proteins were not hydrolysed by pepsin

Place all the test tubes in a water bath maintained at a temperature between 35oC-40oC for 20 minutes and then record your observatons.

b. Explain your results in (a) above.

i. Test tube 1

There was no hydrolysis of proteins by pepsin because pepsin does not work in a neutral pH medium.

ii. Test tube 2

Proteins were hydrolysed because the hydrochloric acid provided the optimum pH medium for pepsin enzyme. I.e. pepsin works best in acidic medium.

iii. Test tube 3

There was no hydrolysis of proteins by pepsin because pepsin does not work in alkaline pH medium

iv. Test tube 4

There was no hydrolysis of proteins by pepsin because pepsin/enzyme had been denatured by excessive heat during boiling.

EXAMPLE 3

You are provided with solution **H.** Carry out the following tests to identify the food substances in solution **H** and investigate the effect of Saliva on the food substances in **H.** Record your observations and deductions in the table below**:**

Tests	Observations	Deductions
(i)To 1cm^3 of **H** in a test tube add 2-3 drops of iodine solution.	Milky solution turned to blue-black solution	Starch present
(ii)To 1cm^3 of **H** in a test tube add 1cm^3 of Benedict's solution and boil for 1 minute.	Milky solution turned to blue solution and remained blue solution on boiling.	Reducing sugar absent

(a) Rinse your mouth with water. Spit 3cm^3 of saliva in a test tube; dilute it with an equal volume of water. Label the solution **X.**

Label 3 test tubes **A, B** and **C**. Add 1cm^3 of **H** to each test tube and treat them as follows:

(i) To test tube **A** add 2cm^3 of solution **X** followed by 2cm^3 of dilute Hydrochloric acid.

(ii) To test tube **B** add 2cm^3 of solution **X** followed by 2cm^3 of dilute Sodium Hydroxide solution.

(iii) To test tube **C** add 2cm^3 of solution **X** and boil the mixture for 1 minute.

Incubate all the 3 test tubes in a warm water bath maintained at temperature between 35^o-40^{o}C for 20 minutes. (*You may continue with other work in the meantime*.) After 20 minutes carry out the following Benedict's tests and record your observations and deductions in the table below.

Test tubes	Observations	Deductions
A	Milky solution turned to blue solution and remained blue solution on boiling.	Reducing sugar absent
B	Milky solution turned to blue solution, then green precipitate and yellow precipitate on boiling.	Reducing sugar present
C	Milky solution turned to blue solution and remained blue solution on boiling.	Reducing sugar absent

(b) Explain your observations and deductions in the table above

(i) Test tube **A**

Solution H was not hydrolysed to reducing sugars by the active substance in solution X because the active substance in X does not work in acidic pH medium

(ii) Test tube **B**

Solution H was hydrolysed to reducing sugars by the active substance in solution X because the active substance in X does works best in alkaline pH medium

(iii) Test tube **C**

Solution H was not hydrolysed to reducing sugars by the active substance in solution X because the active substance in X was denatured by excessive heat during boiling.

(c) From your observations state the nature of the active substance in Solution **X**

It is an enzyme

(d) State 3 properties of the active substance

It is denatured by excessive heat.

It is affected by pH changes.

It is specific in nature

EXAMPLE 4

You are provided with the following: Hydrogen peroxide solution, Solution X, Solution Z and pieces of liver tissue, litmus papers and test tubes.

a) Carry out the following tests and record your observations and deductions in the table below. Label four test tubes 1, 2, 3 and 4 and place 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 1cm3 of hydrogen peroxide.	Few bubbles of gas evolved/ Little efferverscence occurs	Slow decomposition of hydrogen peroxide
	ii)	Test the mixture with red and blue litmus paper.	Red litmus turned blue while blue litmus remained blue	The mixture is alkaline
2	i)	Add solution **Z** to completely cover the liver tissue and add 1cm3 of hydrogen peroxide	Few bubbles of gas evolved/ Little efferverscence occurs	Slow decomposition of hydrogen peroxide
	ii)	Test the mixture with red and blue litmus paper.	Blue litmus turned red while red litmus remained red	The mixture is acidic
3	i)	Add distilled water to cover the liver tissue and 1cm3 of hydrogen peroxide.	Bubbles of gas are liberated vigorously/ fast efferverscence occurs	Very fast decomposition of hydrogen peroxide

	ii)	Test the mixture with red and blue litmus paper.	Red litmus remained red and blue litmus remained blue	The mixture is neutral
4	i)	Add distilled water to cover the liver tissue, boil and 1cm3 of hydrogen peroxide.	No bubbles are given off/ No effervescence occurs	No decomposition of hydrogen peroxide
	ii)	Test the mixture with red and blue litmus paper.	Red litmus remained red and blue litmus remained blue	The solution is neutral

b) In which test tube was the reaction most vigorus?

In test tube 3

c) What is the nature of;

(i) Solution **X**?

Solution X is alkaline

(ii) Solution **Z**?

Solution Z is acidic

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

The active substance in the liver tissue is most active in a neutral medium

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

Heat denatures the active substance in the liver, since there is no reaction as in test tube 4

f) Identify the active substance in the liver tissue; give a reason for your answer.

The active substance in the liver tissue is an enzyme called catalase

Reason: -It breaks down hydrogen peroxide to water and oxygen gas is liberated

-It is denatured by heat.

g) Which factors are being investigated in this experiment?

Effect of heat/temperature on the rate of enzyme activity

Effect of pH on enzyme activity

EXPERIMENTS:

EXPERIMENT 1

(a) You are provided with solution **P**. Carry out the following tests to identify the food substance in the solution. Record your observation and deductions, in the table below.

TEST	OBSERVATION	DEDUCTION
(vi) To $1cm^3$ of solution **P** in a test tube add 2-3 drops of iodine solution		
(vii) To $1cm^3$ of solution **P** in a test tube add $1cm^3$ of Benedict's solution and boil		
(viii) To $1cm^3$ of solution **P** add 3-4 drops of dilute hydrochloric acid and boil for one minute cool under tap water and add 3-4 drops of sodium hydroxide. Then add Benedict's solution and boil.		
(ix) To $1cm^3$ of solution **P** in a test tube add dilute sodium hydroxide followed by 4 drops of copper sulphate.		
(x) To $1cm^3$ **DCPIP** in a test tube add solution **P** drop by drop		

(b) Identify the food substance in solution **P**

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(c) Name two sources from which the above food can be obtained.

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EXPERIMENT 2

You are provided with solution **A**. Carry out the following tests to identify the food substances in this solution. Use the reagents provided. Record your observations and deductions in the table below.

Tests	Observations	Deductions
(i) To $1cm^3$ of **A** in a test tube, add 2-3 drops of iodine solution.		
(ii) To $1cm^3$ of **A** in a test tube, add $1cm^3$ of Benedict's solution and boil for 1 minute.		
(iii) To $1cm^3$ of **A** in a test tube add $1cm^3$ of dilute Sodium hydroxide solution followed by 4 drops of Copper (ii) Sulphate Solution**.**		
(iv) To $1cm^3$ of solution **A** in a test tube, add $1cm^3$ of 0.1M Hydrochloric acid, boil for 2 minutes and cool. Then add $1cm^3$ of dilute sodium hydroxide solution followed by $1cm^3$ of Benedict's solution and boil for 2 minutes.		
(v) To $1cm^3$ of **A** in a test tube, add $1cm^3$ of ethanol and shake thoroughly. Leave to settle then Pour off $1cm^3$ of the mixture into a test tube containing $1cm^3$ of water.		
(vi) To $1cm^3$ of DCPIP in a test tube add **A** drop by drop up to 10 drops.		

(a) Identify the food substances present in **A**

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(b) What is the purpose of,

(i) Adding 0.1 M Hydrochloric acid

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(ii) Cooling

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(iii) Adding dilute Sodium hydroxide solution

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(iv) Boiling

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EXPERIMENT 3

You are provided with suspension **S** and solution **P**. Carry out the following tests to identify the food substances in suspension S and identify the nature of the solution **P**. Record your observations and deductions in the table below:

Tests	**Observations**	**Deductions**
(i)To 1cm^3 of **S** in a test tube, add 3 drops of iodine solution.		
(ii)To 1cm^3 of **S** in a test tube, add 5 drops of Benedict's Solution and boil for 1 minute.		
(iii)To 1cm^3 of **S** in a test tube, add 1cm^3 of dilute Sodium hydroxide solution followed by 4 drops of copper (ii) Sulphate solution.		
(iv)To 1cm^3 of **S** in a test tube, add 1cm^3 of ethanol and shake thoroughly. Leave to settle then pour off 1cm^3 of the mixture into a test tube containing 1cm^3 of water.		
(v)To 1cm^3 of DCPIP in a test tube add **S** drop by drop up to 10 drops.		

(a) Put 2cm^3 of **S** in a test tube and add an equal amount of **P.**

Incubate the mixture in a water bath maintained at 40^{o}C for 20 minutes.

(*You may continue with other work in the meantime*.) After the 20 minutes, carry out the following tests and record your observations and deductions in the table below.

Tests	Observations	Deductions
(i)To 1cm^3 of the mixture add 3 drops of iodine solution.		
(ii)To 1cm^3 of the mixture, add 1cm^3 of dilute Sodium hydroxide solution followed by 4 drops of copper sulphate (ii) solution.		

(b) From your results in **(a)** and **(b)**,

(i) Suggest with a reason, the identity of solution **P.**

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(ii) State with a reason, one property of solution **P**.

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EXPERIMENT 4

You are provided with solutions **A, B, C** and **D**. Solution **A** contains food nutrients. You are required to determine the food nutrients in specimen **A** and investigate the action of solutions **B, C** and **D** on **A**

(a) Carry out the following tests and record your observations and deductions in the table.

Tests	Observations	Deductions
(i) To 1 cm^3 of solution **A** add 2 drops of iodine solution.		
(ii)To 1 cm^3 of solution **A** add 1cm^3 of Benedict's solution and boil		
(iii)To 1 cm of solution **A,** add 1cm^3 dilute sodium hydroxide solution followed by 3 drops of copper sulphate solution		

(b) Label three test tubes as **1, 2** and **3** and add contents into each test tube as indicated in the following table

Test tube	Contents
1	1 cm^3 of **B** + 1 cm^3 distilled water, shake to mix them add 1 cm^3 of **A**
2	1 cm^3 of **B** + 1 cm^3 of C shake to mix then add 1 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 test tube rack and leave for 15 minutes. After 15 minutes carry out a Benedict's test on the contents of each test tube and record your observations and deductions in the following table

Test tube	Observations	Deductions
1		
2		
3		

(c) Explain your results in (b) for each test tube.

Test tube **1**

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Test tube **2**

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Test tube **3**

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

(i) The active ingredient in solution **B**

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(ii)Solution **C**

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(iii)Solution **D**

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EXPERIMENT 5

You are provided with specimens **A** and **B**.

(a) (i) State the identity of each specimen

A

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B

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

Specimen A	**Specimen B**

(b)Make an accurately labeled diagram of specimen **A**

(c)Using a knife or scapel, slice each specimen half way.

(i) Add three drops of iodine solution to the cut surface of one half of each specimen and spread the drops. Record your observation and deductions in the table below.

Specimen	Observation	Deduction
A		
B		

(ii) Cut half way of the remaining portion of specimen A into small chips and grind it in a mortar to make a paste. Add 10cm^3 of water to the paste and stir. Decant to obtain an extract and label it solution **A**. Perform the following tests on solution A and record your results and deductions in the table below.

Test	Observation	Deduction
To 1cm^3 of solution **A**, in a test tube, add 1cm^3 of Benedict's solution and boil.		
To 1cm^3 of solution **A**, in a test tube, add 1cm^3 of Millon's reagent and boil.		
To 2cm^3 of DCPIP solution in a test tube, add solution **A** drop by drop.		

(a) Suggest two roles of specimen **A**, giving a reason in each case.

Role	Reason
(i)	
(ii)	

EXPERIMENT 6

You are provided with solutions; **C, D** and **E**.

(a) Carry out the following tests to identify the food substances in solutions **C** and **D** and identify the nature of solution **E**. Record your observations and deductions in the table provided.

Tests	Observations	Deductions
i. To $1cm^3$ of solution **C** in a test tube, add 3 drops of iodine solution.		
ii. Repeat test i) using solution **D**.		
iii. To $1cm^3$ of solution **C** in a test tube add $1cm^3$ of Benedict's solution and boil.		
iv. Repeat test (iii) using solution **D**.		
v. To $1cm^3$ of solution **C** in a test tube, add $1cm^3$ of dilute sodium hydroxide, followed by 4 drops of copper II sulphate solution.		
vi. Repeat test (v) using solution D.		
vii. To $1cm^3$ of solution **C** in a test tube, add $1cm^3$ of solution **E**. Boil the mixture for 2 minutes and cool. Then add $1cm^3$ of dilute sodium hydroxide solution followed by $1cm^3$ of Benedict's solution and boil.		

(b)Explain the results in test (vii).

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(c) From the results, suggest what solution E could be.

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EXPERIMENT 7

You are provided with suspension **S** and solution **P.**

(a) Carry out the following tests to identify the food substances in suspension **S** and identify the nature of solution **P**. Record your observations and deductions in the table below

Tests	Observations	Deductions
i) To 1cm^3 of **S** in a test tube, add drops of iodine solution		
ii) To 1cm^3 of **S** in a test tube, add 5 drops of Benedict's solution and boil.		
iii) To 1cm^3 of **S** in a test tube, add 1cm^3 of dilute sodium hydroxide solution followed by 4 drops of copper II sulphate solution.		
iv) To 1cm^3 of **S** in a test tube, add 1cm^3 of ethanol and shake thoroughly. Leave to settle then pour off 1cm^3 of the mixture into a test tube containing 1cm^3 of water.		
v) To 1cm^3 of DCPIP in a test tube add **S** drop by drop up to 10 drops.		

(b) Put 2cm^3 of S in a test tube and add an equal amount of **P**. Incubate the mixture in a water bath maintained at 40^{o}C for 20 minutes. ***(You may continue with other work in the***

meantime.) After 20 minutes, carry out the following tests and record your observations and deductions in the table below.

Tests	Observations	Deductions
i) To 1cm^3 of the mixture, add 3 drops of iodine.		
ii) To 1cm^3 of the mixture, add 1cm^3 of dilute sodium hydroxide solution followed by 4 drops of copper sulphate solution.		

(c) From your results in (a) and (b).

i) Suggest with a reason, the identity of solution **P.**

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……

ii) State with a reason, one property of solution **P.**

……

……

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EXPERIMENT 8

You are provided with specimens, **A_1** and **B_1** which are storage organs.

(a) What type of storage organ is each specimen? Give two reasons for your answer in each case.

i) **A_1**

……

Reasons

……

……

……

ii) **B_1**

.....

Reasons

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.....

(b) What is the importance of storage organs to plants?

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.....

(c) Solutions $\mathbf{A_2}$ is an extract from specimen $\mathbf{A_1}$ and solution $\mathbf{B_2}$ is an extract from specimen $\mathbf{B_1}$.

Carry out the following tests to determine the food substances contained in each specimen.

Record your observations and deductions in the Table 1.

Table 1

Tests	**Observations**	**Deductions**
(i)To 1cm^3 of $\mathbf{A_2}$ in a test tube, add 3 drops of iodine solution.		
(ii)Repeat test (i) using solution $\mathbf{B_2}$ instead of $\mathbf{A_2}$.		
(iii)To 1cm^3 of $\mathbf{A_2}$ in a test tube, add 5 drops of dilute sodium hydroxide solution followed by a solution of copper sulphate drop by drop.		

(iv)Repeat test (iii) using solution **B_2** instead of **A_2**.		
(v)To 1cm^3 of **A_2** in a test tube, add 1cm^3 of Benedict's solution and boil.		
(vi)Repeat test (v) using solution **B_2** instead of **A_2**		

(i) Giving a reason, suggest which of specimens **A_1** and **B_1** would sprout first if favourable conditions for growth were provided.

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……..……

EXPERIMENT 9

You are provided with specimen **A**.

(a) You are required to find the food components in specimen **A** using the reagents provided.

Procedure:

Put specimen **A** into a mortar. Using a pestle carefully grind to form a paste. Keep a small portion of the paste.

To the remaining portion of the paste add 10cm^3 of distilled water and stir thoroughly using a glass rod for at least 5 minutes to get a suspension. Allow the suspension to settle and decant to get a clear solution. Put the prepared solution in a clean boiling tube and label it solution **A**.

(b) Using solution **A**, carry out food tests using the reagents provided.
State clearly the procedure, observation and conclusion in the space below.

	Test	Observation	Deduction
Proteins			
Starch			

Reducing Sugars			

(c) To the remaining paste in (a) above rub it gently on a clean sheet of white paper. What is your

i) Observation:

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……

……

ii) Conclusion:

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(d) i) From the results of the tests carried out above, name the food components in specimen **A.**

……

……

(ii) What is the importance of each food component to animals?

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EXPERIMENT 10

You are provided with solution X

(a) Carry out tests below and record your observations and conclusion.

Test.	**Observation.**	**Conclusion.**
(i) To 1cm^3 of solution X in a test tube, add 3 drops of iodine solution.		
(ii) To 1cm^3 of solution X in a test tube add 1cm^3 of Benedict's solution and boil.		
(iii) To 1cm^3 of solution X in a test tube add 1cm^3 of sodium hydroxide followed by copper (II) sulphate solution drop by drop.		
(iv) To 1cm^3 of DCPIP solution add solution X drop by drop.		

(b) (i) Which food substance is present in solution X?

……

(ii) What is the function of this food nutrient in man?

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……

(c). Rinse your mouth with water, collect 5cm^3 of your saliva in a clean test tube, put 1cm^3 of solution X in a test tube and add 1cm^3 of saliva. Place the mixture in a water bath maintained at 35^{0}C-40^{0}C for 15 minutes.

(i) Add 1cm^3 of Benedict's solution to the above mixture and boil.

Observation:

……

……

Conclusion:

……

……

(ii) Boil 1cm^3 of saliva in a clean test tube cool. To the cooled saliva add 1cm^3 of solution X Place the mixture in a water bath at 35^0-40^{0}C for 15 minutes, then add 1cm^3 of Benedict's solution and boil.

Observation:

……

……

Conclusion:

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……

(d) (i) Why was the mixture kept in a water bath at 35^0-40^{0}C?

……

……

(ii) Why was the mixture left to stand for 15 minutes?

……

……

(e) Explain the results obtained in experiments above;
Experiment (c) (i)

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Experiment (c) (i)

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(f) What physiological process is experiment (c) demonstrating?

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EXPERIMENT 11

You are provided with specimen **Q.** Study it carefully and answer questions that follow.

(a) (i) Identify the specimen

……..…

(iii) Identify the plant organ

……...……..

(iv) Give the functions of the specimen

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……..……

……..……

(v) Give the reasons to defend your answers in (a) (iii) above

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……..……..

b. Peel specimen **Q** using a knife and cut out four equal cubes from it, each measuring 2cm x 2cm x 2cm. Label four test tubes; **1, 2, 3**, and **4.** Pour $2cm^3$ of hydrogen peroxide into each of the test tubes **1, 2** and **3** plus $2cm^3$ of water into test tube **4**.

(i) Put one cube of specimen **Q** into test tube **1** and record your observations and deductions in the table.

(ii) Grind the second cube of **Q** in a mortar and transfer all the ground material at once into a test tube **2,** and record your observations and deductions in the table.

(iii) Boil the third cube of **Q** in a test tube for 5 minutes, remove the boiled cube from the water and allow it to cool. Transfer the boiled cube into test tube **3** and record your observations and deductions in the table.

(iv) Put the fourth cube of **Q** into a test tube **4** and record your results in the table of results.

Table of results

Test tube and contents	Observations	Deductions
(1) Whole cube + hydrogen peroxide		
(2) Ground material + hydrogen peroxide		
(3) Boiled cube + hydrogen peroxide		
(4) Whole cube + water		

(c)With reference to your observations in (b) above, explain your results in

(i) Test tube **1**

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(ii) Test tube **2**

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(iii) Test tube **3**

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(iv) Test tube **4**

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(d) (i) Identify the substance that caused the reactions in the table above

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(ii) Give three properties of the substance identified in (c) (i) above

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(iii) What is the importance of the reaction?

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(iv) What term is given to the set up and observations plus deductions in test tube **4**

……..……

EXPERIMENT 12

You are provided with specimens **E** and **F**. Carry out the following tests using the specimens and record your observations in the table provided.

(a) Peel specimen **E** using a knife and cut four equal cubes from it, each measuring 2cm x 2cm x 2cm. Label four test tubes; **1, 2, 3** and **4**.

Pour $2cm^3$ of hydrogen peroxide into each of test tubes **1, 2** and **3** and $2cm^3$ of water into test tube **4**.

i) Put one cube of specimen E into test tube 1 and record your observations in the table.

ii) Grind the second cube of **E** in a mortar and transfer all the ground material at once into test tube **2**, record your observations in the table.

iii) Boil the third cube of **E** in a test tube for 5 minutes, remove the boiled cube from the water and allow it to cool. Transfer the boiled cube into test tube **3** and record your observations in the table.

iv) Put the fourth cube of **E** into test tube **4** and record your results in the table of results.

(b) Repeat the procedure in (a) using specimen F and record your observations in the table of results.

Table of results

Test tube and contents	Observations using specimen E.	Observations using specimen F.
1) Whole cube + hydrogen peroxide		
2) Ground material + hydrogen peroxide		
3) Boiled cube + hydrogen peroxide		
4) Whole cube + water		

(c) With reference of your observations in (a) or (b), explain your results in

i) Test tube **1**

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ii) Test tube **2**

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iii) Test tube **3**

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iv) Test tube **4**

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(d) i) How do your observations in (a), that is, when using specimen **E** compare with those in (b) that is, when using specimen **F**?

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ii) From your answer in (d) (i), what conclusion do you make ?

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EXPERIMENT 13

a) You are provided with solution A which contains food nutrients, B_1, B_2 and B_3 which contains different concentrations of the same active substance. Perform the experiment below on solution A and record your test procedure, observation and conclusions in the table 1 below.

Table 1

Test	**Observation**	**Deductions**
IODINE TEST		
BENEDICT'S TEST		

BUIRET TEST		
DCPIP TEST		

b) Label three clean test tubes B_1, B_2, B_3 and place $1cm^3$ of solution A in each test tube followed by $1cm^3$ correspondingly labelled solutions B_1, B_2 and B_3
Place all the test tubes containing the mixtures in a test tube rack for 10-15 minutes.
Repeat Benedict's test on each test tube and record your observation and deductions in the table 2 below.

Table 2

Test tube	**Observations**	**Deductions**
B_1		
B_2		
B_3		

c) Explain the results in the table 2
B_1
……
……
……
……

B_2

……

……

……

B_3

……

……

……

d) i) With a reason suggest the name of the active substance in solution B

……

……

ii) Arrange the solution B_1, B_2 and B_3 in increasing order of concentration of the active substance/enzyme

……

iii) Suggest the part of human alimentary canal where the active substance in solution B can be found.

……

iv) Suggest the fluid of the alimentary canal where the active substance in solution B can be found.

……

e) What physiological process is the experiment investigating?

……

f) What factor of the active substance is being investigated in the experiment?

……

g) Name any other three factors that may affect the rate of reaction in the experiment above.

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EXPERIMENT 14

You are provided with solution Q and R.

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

Test	Observations	Deductions
i. To 1cm^3 of solution Q in a test tube, add 3 drops of iodine solution		
ii. To 1cm^3 of solution Q add 1cm3 of Benedict's solution and boil		
ii. To 1cm^3 of solution Q in a test tube, add 5 drops of dilute sodium hydroxide solution followed by 3-4 drops of copper II sulphate solution		

(b) i) Mix 1cm^3 of Q with 1cm3 of R and add 3 drops of dilute hydrochloric acid. Observe and record the appearance of the mixture.

……

ii) Put the test tube of the mixture in b(i) above in warm water maintained at about 35 to 40^{o}C and leave for 15 minutes, observe and record the appearance of the resulting mixture.

……

(c) What was the purpose of maintaining the mixture Q and R at 35-40^{o}C?

……...

(d) What conclusion can you draw about the effect of solution R n solution Q?

……

(e) Giving two reasons, suggest the name of solution R.

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EXPERIMENT 15

You are provided with specimens P, Q and solution M which is hydrogen peroxide. Carryout the following tests and record your observations in and deductions in table 1 below.

Table 1

Test	Observations	Deductions
i. To $1cm^3$ of solution M in a test tube, add 1 piece of P		
ii. To $1cm^3$ of solution M add 1 piece of Q		
iii. To $1cm^3$ of solution M in a test tube, add 1 piece of R		
iv. Boil 1 piece of P in water in a test tube for 2 minutes and leave it to cool To $1cm^3$ of M in a test tube, add boiled piece of P		
v. Boil 1 piece of Q in water in a test tube for 2 minutes and leave it to cool To $1cm^3$ of M in a test tube, add boiled piece of Q		
vi. Crush 1 piece of P in a motor. To $1cm^3$ of M in a test tube, add crushed piece of P		
vii. Repeat the procedure in (vi) but use Q		

(b) Explain your observations and deductions in,

(i) Tests (i), (ii), and (iii)

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(ii) Tests (iv) and (v)

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(iii) Tests (vi) and (vii)

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(c) You are also provided with solutions P1 and Q1 which are extracts from specimens P and Q respectively.

(i) Measure 2cm^3 of M into a test tube followed by 1cm^3 of P1 and immediately insert the bulb of the thermometer and read and record in table 2 the highest temperature of the reaction.

Repeat the instruction above using Q1 instead of P1.

Table 2

	Temperature (°C)	**Deduction**
P1		
Q1		

(ii) Suggest the significance of reaction of P1 to the survival of a mammal.

……

……

……

……

EXPERIMENT 16

You are provided with solutions A, B, C, X, and Y. You are to carry out tests using the solutions and answer the questions that follow.

(a) Carry out an iodine test on solution X and record your test, observations and deductions in table 1.

Table 1

Test	**Observations**	**Deductions**
Iodine test		

(b) Label 3 test tubes as 1, 2, and 3 and add contents to each test tube as shown in the table 2 below.

Table 2

Test tube	**Contents**
1	Add $2cm^3$ of X followed by 3 drops A, shake to mix. Then add $2cm^3$ of Y
2	Add $2cm^3$ of X followed by 3 drops B, shake to mix. Then add $2cm^3$ of Y
3	Add $2cm^3$ of X followed by 3 drops C, shake to mix. Then add $2cm^3$ of Y

(i) Test the contents of each test tube using a blue and red litmus papers and record your results in table 3.

Table 3

Test tube	**Observation**	**Deduction**
1		
2		
3		

(ii) Incubate the 3 test tubes with their contents in a water bath maintained at 37-40°C for 15 minutes.
After 15 minutes, take off $2cm^3$ from each test tube one at a time, add $2cm^3$ of Benedict's solution and boil. Record your observations in table 4. After 20 minutes, repeat the Benedict's test on the remaining mixture in each test tube and record your observations in table 4.

Table 4

Time	Observations		
	Test tube 1	**Test tube 2**	**Test tube 3**
15 minutes			
20 minutes			

(c) Explain your results in table 4 for each test tube.

Test tube 1

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……

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Test tube 2

……

……

……

……

Test tube 3

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……

……

……

EXPERIMENT 17

You are provided with specimen P and Q. Use them to answer the questions that follow.

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

……

……

……

(b) Cut both specimens longitudinally and state the type of fruit each specimen is, giving a reason in each case.

Specimen P

……..

Reason.

……..

Specimen Q

……..

Reason.

……..

(c) Label test tubes 1, 2, 3, 4, and 5. Open up specimen P to obtain four different seeds and label them P1, P2, P3 and P4 respectively and label specimen Q as Q1.

Treat them as follows.

P1-Leave as it is and put it in test tube 1
P2-Crush with a motor and pestle and put it in test tube 2
P3-Boil in $2cm^3$ of water for 5 minutes, pour of the water, cool and put it in test tube 3
P4-Leave as it is and put it in test tube 4
Q1-Leave as it is and put it in test tube 5.

Carryout the following tests with hydrogen peroxide and write your observations and deductions.

Test	**Observations**	**Deductions**
(i) To test tube 1, add $2cm^3$ of hydrogen peroxide.		
(ii) To test tube 2, add $2cm^3$ of hydrogen peroxide.		

(iii) To test tube 3, add $2cm^3$ of hydrogen peroxide.		
(iv) To test tube 4, add $2cm^3$ of water.		
(v) To test tube 5, add $2cm^3$ of hydrogen peroxide.		

(d) From your observations in the table above, state the factors being investigated.

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(e) Explain your observations in

(i) Test tube 1

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(ii) Test tube 2

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(iii) Test tube 3

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(iv) Test tube 4

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(v) Test tube 5

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CHAPTER TWO

2.0 DIFFUSION AND OSMOSIS

Diffusion is the movement of molecules from a region high concentration to a region of low concentration.

Osmosis is the movement of solvent (water) molecules from a solution of low solute concentration to the solution of high solute concentration across a semi-permeable membrane.

A student in this case will be provided with solutions of different concentrations and a specimen (majorly plant material/tissue). Experiments here may involve placing cut plant tissues e.g. stems, potato cylinders, pawpaw strips, and etc in solutions of different concentrations and measurements taken may be curvature of plant tissues, change in length of plant tissues.

2.1 CURVATURE OF PLANT TISSUE

Cut a plant stem for example *Commelina* or flower stalk of *Cana* lily, into 4 equal strips and place one in each solutions of different concentrations of sucrose, and leave to stand for some time. After this time, a student may be asked to observe the cut strips and feel them using his or her fingers.

In such an experiment, the stems curve and the degree of curvature is used to determine the extent of osmosis.

- Solutions whose concentration is near similar to that of the cell sap (**isotonic solutions**) have pieces of stem in them remaining strong and straight.
- Solutions whose concentrations are higher than those of the cell sap (**hypertonic solutions**) have strips in them curving inwards i.e. with epidermis outermost. They are also weak or softer due to flaccidity of their cells resulting from the movement of water from them by osmosis.
- Solutions whose concentrations are lower than those of the cell sap (**hypotonic solutions**) have strips in them curving outwards i.e. with epidermis inner most. Such strips are also found to be strong due to uptake of water by osmosis, which has cause the cell in them to be turgid.

2.2 CHANGE IN LENGTH METHOD

Plant tissues e.g. potato cylinders of the same length and diameter (same volume) are placed in solutions of different concentrations e.g. sucrose and allowed to stand for sometime like 1 hour.
Then their lengths are measured and their nature recorded.
Results can be recorded as change in length (final length-initial length**)**

Or

Recorded as percentage (%) change in length

$$\text{Percentage (\%) change in length} = \frac{\text{New length} - \text{original length}}{\text{Original length}} \times 100\%$$

Results can be also be recorded in terms of ratios as initial length**:** final length.

The student may be asked to plot a graph of sucrose concentration against changes in length or percentage change in length.

2.3 EFFECT OF DILUTE SOLUTIONS (HYPOTONIC SOLUTIONS) ON PLANT TISSUES (CYLINDERS)

Observation

(i) Texture: plant tissues are hard and brittle

(ii) Size: plant tissues are longer than their original length

Explanation

Plant tissues (cylinders) placed in solutions more dilute than their sap take in water by osmosis and their cells become turgid.

2.4 EFFECT OF MORE CONCENTRATED SOLUTIONS (HYPERTONIC SOLUTIONS) ON PLANT TISSUES (CYLINDERS)

Observation

(i) Texture: tissues appear soft and flabby

(ii) Size: they are shorter than their length.

Explanation

Plant tissues place in stronger (more concentrated) solutions than their cell sap loses water by osmosis and their cells become flaccid.

2.5 EFFECT OF ISOTONIC SOLUTIONS ON PLANT TISSUES (CYLINDERS)

Observation

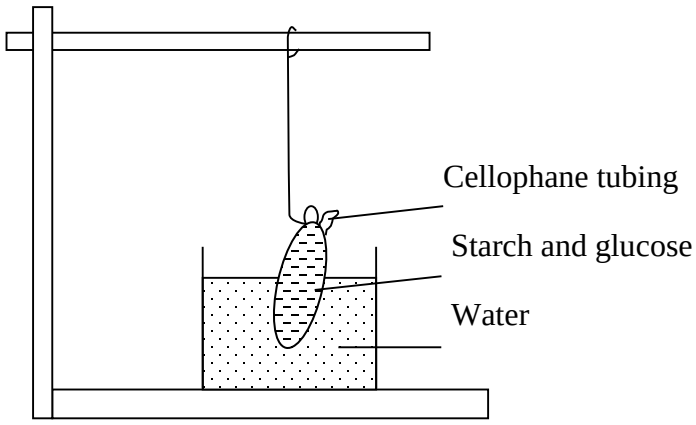
There is no change in length

Explanation

Plants tissues placed in solutions with the same concentration as that of their cell sap there is no net gain or loss of water by osmosis.

2.6 OSMOSIS VIA A SEMI-PERMEABLE MEMBRANE

Arrangement of apparatus



A mixture of starch and glucose is placed inside a cellophane tubing/bag and tied very tightly. Then lowered into a beaker of distilled water and the experiment is allowed to stand for some time.

After this time water is tested for the presence of a reducing sugar using Benedict's solution, and for starch using iodine solution.

It is found that only glucose has diffused through (because it is made up of smaller molecules than starch) and the cellophane tubing acts as a semi permeable membrane.

Possible questions to be asked from such an experiment

a) What is the nature/structure of the cellophane bag/tubing

It is a semi permeable/ selectively permeable membrane

b) Which physiological or biological process is involved?

It is osmosis

c) What is the function of this process?

- It is for absorption and movement of water across the root
- For maintenance of turgidity and hence the support of stems of herbaceous plants
- It helps in the opening and closure of stomata and flowers.

2.7 EXPERIMENTS

EXPERIMENT 18

You are provided with specimen **F** and seven sucrose solutions of 0.0M, 0.1M, 0.3M, 0.4M, 0.5M, and 0.6M.

Place 12cm^3 of each solution into separate test tubes and label them accordingly.

Using a sharp Knife/scalpel cut slices about 5mm thick. From the largest slices cut out a total of seven potato strips each about 5mm wide.
Trim all of them to a length of 50mm wide.
Immerse one potato strip in each solution and leave for at least 45 min. At the end of this period remeasure their lengths to the nearest millimeter.

(a) (i) Calculate the change in length and from this work out the percentage change in length. Record your results in a suitable table.

Sucrose concentration/M	Initial length/mm	Final Length/mm	Change in length/mm	Percentage change in length
0.0				
0.1				
0.2				
0.3				
0.4				
0.5				
0.6				

(ii) Plot a graph of percentage change in length against sucrose concentration

EXPERIMENT 19

You are provided with plant materials labeled P_1 and P_2, sucrose solutions A – F of concentrations 0.0M, 0.1M, 0.2M, 0.3M, 0.4M, and 0.5M respectively.

(a) Carry out the procedure below:-

i) Measure and cut pieces of 5.0cm length of the specimen P_1. Then from each piece obtain four equal sized strips by slicing P_1 longitudinally using a sharp razorblade. Repeat this procedure using specimen P_2. Observe the strips from P_1 and P_2. Record and account for the appearance and physical nature of the strips from the specimens.

Strip from P_1.

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……

……

……

……

Strip from P_2

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……

……

……

……

ii) Transfer 30ml of sucrose solution into petri dishes labeled A – F.

iii) Choose the best strips and immerse one strip from P_1 into each solution plus one strip from P_2 into solution A only.
Leave the set up to stay for 20 minutes before examining the strips. Record and account for the appearance and physical nature of the strips placed in solution A after 20 minutes.
Strip from P_1.

……

……

……

……

Strip from P_2

……

……

……

……

……

(b) Explain the curvature of the strips P_1 placed in the following sucrose solutions.
A

……

……

……

……

D

……

……

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……

……

F

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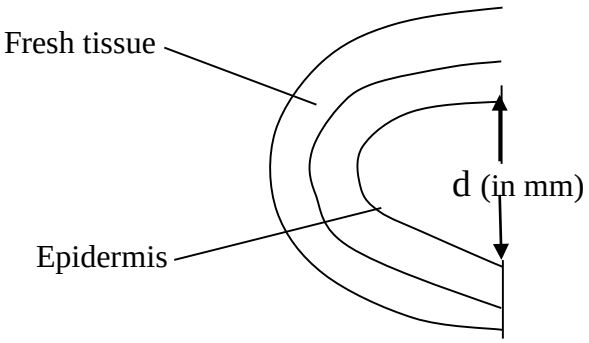
……

……

(c) Establish the extent of curvature of strip from P1 by measuring the difference between the ends of the strip as illustrated below.



(i) Tabulate your results below.

Sucrose concentration/m	Initial length/mm	Final Length/mm	(Change in length/mm)
0.0			
0.1			
0.2			
0.3			
0.4			
0.5			

(ii) Plot a graph to show the relationship between – d – and sucrose concentration.

(iii) On your graph, show the sucrose concentration that is isotonic to the potato tissue

……

(b) Compare the physical condition of the strip from the sucrose concentration of 0.0M with that from 0.6M. Record your observation.

0.0M

……

……

……

……

0.6M

……

……

……

……

(c)Explain the changes that took place in those potato strips that:

(i) Increase in length

……

……

……

……

……

(ii) Decreased in length

……

……

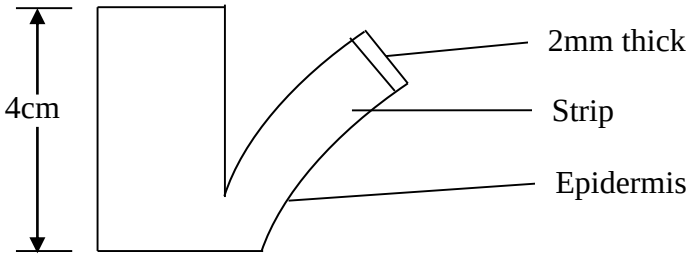
……

……

EXPERIMENT 20

You are provided with solutions A, B, C and a piece of a plant stem, T. You are to carry out tests on T, using the solutions, by following the instructions below.

Label three petri dishes A, B and C and fill each of them with the corresponding solution. Measure and cut off a piece 4cm long from T. Using a razor blade, evenly peel off 3 strips, each about 2mm thick, along the whole length of the cut piece (see figure 1). Ensure that each has the epidermis.



Put one in each of solutions in the petri dishes and leave for 20 minutes *(you may proceed with other work*)

(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 in the table. Label the epidermis.

Table 1

	Strips after 20 minutes in solution		
	A	**B**	**C**
Distance between ends (cm)			
Drawing			

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

(i) Solution A

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……

……

……

(ii) Solution B

……

……

……

……

(iii) Solution C

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……

……

(c) (i) Which one of the solutions A, B and C has a concentration which is almost the same as that of the cell sap of the plant strip?

……

(ii) Explain your answer

……

……

……

……

(d) (i) Name the process which has been demonstrated in the experiment.

……

(ii) Outline the importance of the process to flowering plants

……

……

……

EXPERIMENT 21

You are provided with specimens E and F which are plant organs.

(a) Using cork borer (size 4), obtain two cylinders from specimen E and cut each to make 4cm long. Label them 1 and 2.
Put solution A in a petri dish and place cylinder 1 in it ensuring that it its completely immersed in the solution.
Put solution B in another petri dish and immerse cylinder 2 in it.
Leave the set up to stand for 25 minutes. Then remove each cylinder and measure the length.
Record your result in the table below.

Cylinder	Initial length	Final length	Change in length
1			
2			

(b) State and explain the changes in length you obtained for cylinder 1 and 2.

Change in length for cylinder 1. ……..……..

Explanation

……

……

……

Change in length for cylinder 2. ……..……..

Explanation

……

……

……

(c) i) Using the tip of your fingers, feel the two cylinders and state what you noticed.

Cylinder 1

……

……

Cylinder 2

……

……

ii) From your results obtained in c (i) above state the nature of;

Solution A ……..…….

Solution B ……...

(d) Cut a long internode of from specimen F 4cm long.

Slice the internode longitudinally using a razor blade or scalpel to make four equal strips.

Select two strips of equal size and length and label one A, and another B.

Place one strip in solution A in a petri dish and the second strip in solution B. let the setup stand for 15 minutes.

(i) Draw each of the strips after 15 minutes in the space below. Shade on your drawing the epidermal layer.

Strip A

Strip B

(ii) Explain the differences you obtained in the appearance of the strips above.

Strip A

……

……

……

Strip B

……

……

……

CHAPTER THREE

3.0 ANATOMY OF PLANTS AND ANIMALS

Anatomy is the bodily structure of organisms. A number from this section may be on topics such as insects, modified roots, stems, leaves, fruits, seeds and germination, flowers and inflorescence, birds, fish, feathers (birds) and bones (teeth).

A number of specimens may be provided and a student asked questions to identify each, classify, give similarities and differences, their habitats or habits, adaptations, draw the structure asked for, label it, stating the magnification and even describing it.

All answers to such questions should be based on use of external and observable features on these specimens whose details can be viewed using a hand lens.

3.1 DRAWING AND LABELING

- Always use a sharp HB pencil or clutch pencil or sketch pencil
- Draw what you see but not what you imagine.
- Draw large diagrams
- Don't shade or colour your diagram
- All drawings must be proportional to the whole diagram
- Always make sure that you include the magnification, preferably at the bottom right corner. The magnification of a drawing is the ratio of the size of the drawing to the size of the specimen.

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

  It can be written as X2 or X3 or X4 or X0.5 e.t.c

  Parameters of size can be obtained using measurements of length or width of the specimen and drawing respectively.
- Each drawing must be given a title.
- All drawings should preferably be in an upright posture and labeled (Unless when not requested to do so).
- Label lines must touch actual part of the diagram being labeled. Straight label lines must be used, preferably horizontal lines on the right and left sides of the drawing. Do not use arrow heads or dotted lines.
- Label lines must not cross each other.
- Diagrams drawn must be drawn in the central area of the space provided and space for labeling should be put into special consideration.
- Avoid labeling in plural when labeling a single point or when only one line is used.
- Do not leave any gaps between the diagram and its individual component parts/ lines.
- Take special note of spellings when labelling. Some words have similar pronunciation but have different meanings such as a bud and bad, west and waste, axillary and auxiliary.

3.1.1 VIEW AND SECTIONS:

A table showing drawing of views and sections

View/section	Description
T.S = transverse section(horizontal section or cross section)	This is cut in the plane at right angles to the longitudinal section i.e. across the fruit between the two scars
L.S =longitudinal section	Involves cutting across the specimen's best line of symmetry for example in fruits it is cut from the point of attachment of stalk to the scars.
Dorsal view	(Back) side as seen from the back of the organism
Lateral view	drawing the side view i.e left side and right side of the specimen
Anterior view	Side as seen from the front of the organism i.e it's upper parts
Posterior view	(Hind) side as seen from the rear or hind part. Posterior part is the rear part.
Interior part	Inner part
Exterior part	Outer part
Trunk	Part of the body of an organism, without appendages, such as limbs, the tail and the head on an animal, branches and roots on a tree
Caudal	Part of the tail (tail region)
Proximal end	Upper or top of a drawing or specimen
Distal end	lower end or bottom part of a drawing or specimen
Ventral	Abdominal side

3.2 CLASSIFICATION:

Classification is the grouping of organisms according to their similar characteristics. Organisms with similar characteristics are placed in the same group while those with different characteristics are placed in another group. Similarly a group of organisms which are found in the same group, can be separated and placed in respective groups, depending on their different characteristics.

3.2.1 Dichotomous key:

Organisms can be identified using their characteristics by using a **dichotomous key** or **an identification key. Dichotomous key** is therefore a tool for identifying organisms basing on their characteristics.

3.2.2 The characters used in the dichotomous key:

- Characters should be permanent i.e. should not change with the environment.
- Characters should be visible and tangible.
- Avoid using characters involving size, age or colour because these characters may change with time.
- Use descriptive features but not groupings. E.g. if it is an insect, use features found in an insect like three main body parts, pair of wings e.t.c. instead of saying it is an insect.

- Don't use action words but use features enabling that action to take place e.g. possesses sucking mouth parts instead write possess proboscis.
- Don't use one character more than once.

3.2.2 How to construct a simple dichotomous key?

A dichotomous key can be constructed using a collection of specimens.

- First take a clear observation of each specimen and note the features on them that will allow you to separate them.
- Divide the specimen into two groups depending on contrasting features and continue dividing each group into two at each level until you remain with one spacemen.
- The members of each group may not necessarily be equal, one group can even have member.
- The easiest way of constructing a dichotomous key is by using a comparison table. This allows you to look at a given character throughout all the specimen and then see how they differ.
- After obtaining the contrasting characters in the table, then you may use a comparison tree or flow chart or spider key.

Note: A comparison tree is your rough work which must never appear in the space meant for the dichotomous key, the same applies to the table unless it has been asked.

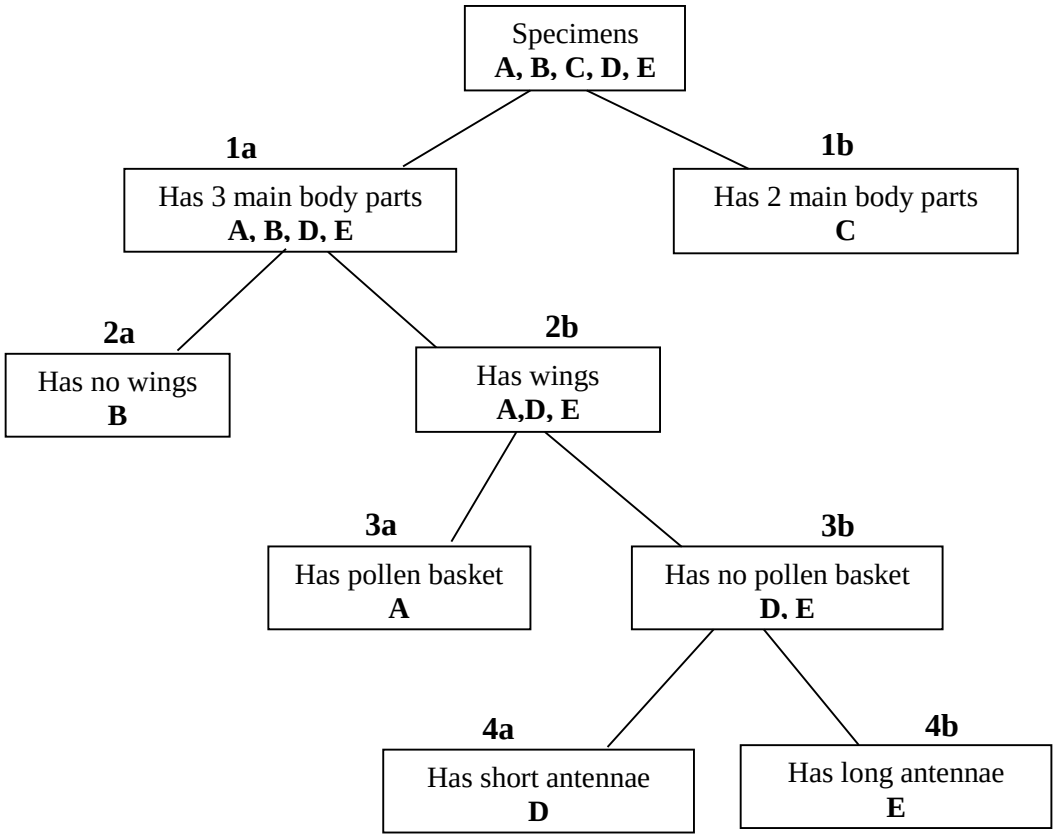
Example 1:

You are provided with the following specimens A (worker bee), B (soldier termite), C (tick), D (housefly) and E (cockroach). Study them and construct a dichotomous key.

Comparison table

Character	**A**	**B**	**C**	**D**	**E**
Main Body parts	3 body parts	3 body parts	2 body parts	3 body parts	3 body parts
Pairs of legs	3 pairs	3 pairs	4 pairs	3 pairs	3 pairs
Wings	Present	Absent	Absent	Present	Present
Pollen basket	Present	Absent	Absent	Absent	Absent
Antennae	Short antennae	Short antennae	No antennae	Short antennae	Long antennae

Flow chart/comparison tree



From the above flow chart the dichotomous can be constructed.

1 a) Has three main body parts……A, B, D, E (go to 2)
b) Has four main body parts……..C

2 a) Has no wings …… B
b) Ha wings ……..A, D, E (go to 3)

3 a) Has pollen basket ……A
b) Has no pollen basket ……D, E (go to 4)

4 a) Has short antennae ……...D
b) Has long antennae ……E

N.B The number of levels must be n-1 where n is the number of specimens. For example in the above dichotomous key, the number of specimen is 5. Therefore, the number of levels = 5-1 = 4

3.3 PLANT PARTS AND STRUCTURE

Plants are members of kingdom Plantae, which is divided into two divisions equivalent to phyla. These are spermatophyta and pteridophyta.

3.3.1 Flowering plants:

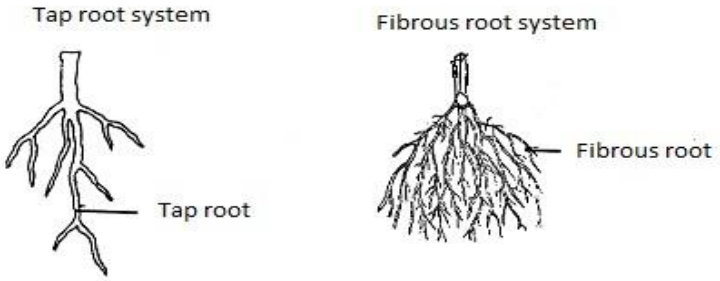
Flowering plants belong to division spermatophyte and class Angiospermae, which is divided into monocotyledonous and dicotyledonous plants.
Flowering plants are divided into two main systems/parts:

(a) Shoot system: This is the part found normally above the ground. It consists of the following parts; stems, leaves, and flowers/buds.

(b) Root system: This is the descending part of the axis of the plant. There are main types of root system

(i) Tap root system: The main root of this system is called tap root and grows downwards into the soil from which other roots (lateral roots) branch from. This a characteristic of dicotyledonous plants e.g. beans, peas, soya beans and ground nuts.

(ii) Fibrous root system: This is a root system without a main root and all roots arise from the same point at the base of the stem. This a characteristic of monocotyledonous plants e.g. millet, maize, sorghum, rice, wheat e.t.c.



3.3.2 Modified roots:

These subdivided into modified tap roots and modified adventitious roots.

(a) Modified tap roots:

(i) Storage roots: These are thick fleshy and succulent roots, also called root tubers. They for modified for storage of food. They include cassava roots and carrots.

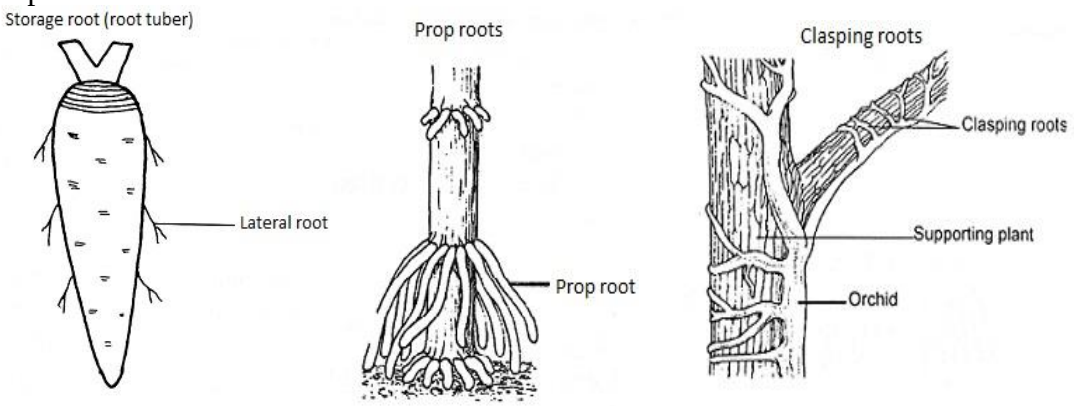
(b) Modified adventitious roots:

(i) Storage roots: These are modified adventitious that grow from the nodes of creeping plants. These roots are also known as root tubers. They are modified for food storage. Examples include; sweet potato roots.

(ii) Prop roots: These roots develop from nodes of a stem close to the soil surface. They provide extra support to the plant. They are found in maize, sugar cane, sorghum etc.

(iii) Clasping roots: These are roots growing from the nodes of climbing stems of some plants. They provide extra support to the plant.

(iv) Sucking roots: These are roots found growing on certain parasitic plants, for example, dodder plants. They absorb water, mineral salts and organic food compounds from the host plant.



3.3.3 STEMS

A stem is the ascending portion of the plant axis that develops from the plumule of an embryo. They bear leaves, buds and flowers. Points on the stem were leaves or buds arise are called nodes and the regions between successive nodes are called internodes.

Most stems are found above the ground, however there are some stems that are found under the ground and these are referred to as underground stems.

Stems generally conduct materials like water, mineral salts, manufactured food and some manufacture and store food.

3.3.4 Modified stems:

Stems that are considered normal, are located above the ground are grow upright above the ground. Stems that are different from the normal ones are called modified stems and most of them are found under the ground. Modified stems have additional functions.

Modified stems include;

a) Rhizome

This is a horizontal thick underground stem having adventitious roots growing from the lower side of the nodes.

It has terminal buds which develop into aerial shoots and it bears buds in axils of scale leaves.

They store food for the plant and also acts as organs for vegetative propagation or reproduction.

For example, ginger, couch grass, spear grass e.t.c

b) Stem tuber

This is a short fleshy underground stem swollen to enable food storage.

It has scale leaves and axillary buds which form the eyes. For example, Irish potatoes.

They store food for the plant and also acts as organs for vegetative propagation or reproduction.

c) Bulb

This is a short conical shaped underground stem comprising of thick fleshy leaves arranged in concentric circles. Fleshy leaves store food for the plant and are protected by scale leaves. Bulbs also contain buds used for vegetative propagation e.g Onions and garlic.

d) Corm

A corm is a swollen fleshy underground stem that grows in a vertical direction. It has a terminal bud lying at the top of the stem and has scale leaves arising from the nodes. E.g Cocoyam

They store food for the plant and also acts as organs for vegetative propagation or reproduction.

3.3.5 Other stems

a) Climbing stems

These are stems that grow clinging to a support by means of tendrils e.g in Passion fruits.

b) Twinner / Twining stems

These are stems that grow ascending spirally around the support e.g. in bean plant, yams (Balugu).

c) Stolons

These are horizontally growing stems that have roots at the nodes and develop buds that grow into new plants. E.g Straw belly

d) Runners

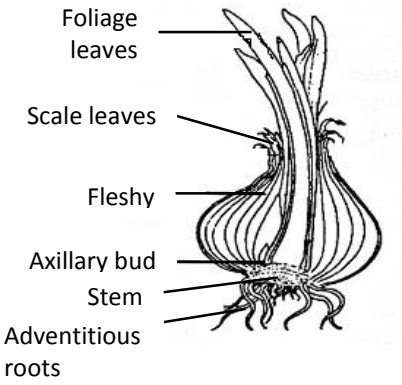
Runners are slender trailing stems lying flat on the ground with long internodes, and adventitious roots e.g Commelina sp (wondering jaw) and oxalis.

e) Suckers

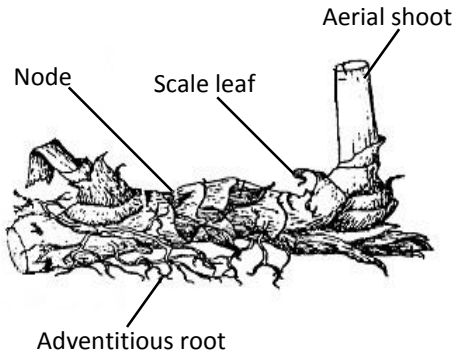
A sucker is a creeping stem that grows obliquely upwards, directly giving rise to a leafy shoot. E.g Banana, pineapple, sisal plant e.t.c.

N.B: Runners, stolons, suckers are collectively called creepers or creeping stems

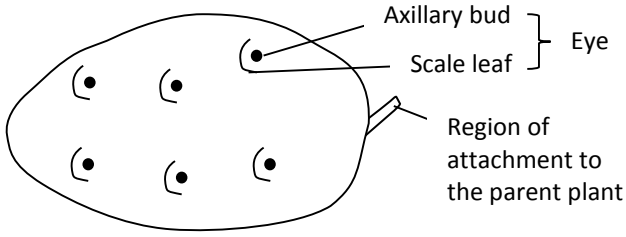
Bulb



Rhizome



Stem tuber



3.3.6 LEAVES

This is a thin flattened structure which grows laterally from the node of the stem. It is where photosynthesis takes place.

A typical leaf is made up of three main parts namely

(i) **Leaf base**: This is the part that attaches the leaf to the stem.

(ii) **Leaf stalk** (**petiole**): This connects the leaf base to the leaf blade.
(iii) **Leaf blade** (**lamina**): This is the expanded and flattened portion of leaf.

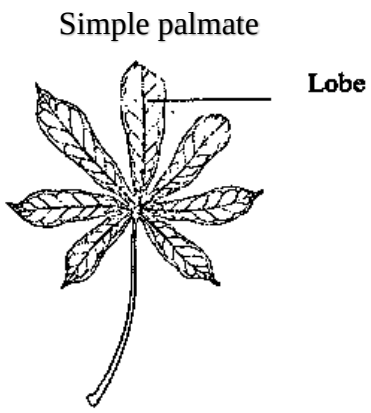
Leaf venation:
This is the arrangement of veins in the lamina of a leaf. There are two types of venation namely;

(i) **Reticulate venation**: Here the veins in the lamina branch while intersecting to form a net. These are found in dicotyledonous leaves.
(ii) **Parallel venation:** In this venation, the veins run side by side without branching. These are found in monocotyledonous leaves.

Leaf margin:
There are several types of leaf margins. These include;

(i) **Entire margin**: This is a margin without indentations of any kind e.g mango leaves, orange leave.
(ii) Serrated margin: This is a margin with indentations pointing toward the apex. E.g Hibiscus and lack jack leaves.
(iii) Crenate margin: This is a margin with round indentation. E.g Bryophylum.
(iv) Wavy margin: This is a margin with wavy blunt curves e.g *Solanum incanum*
(v) Lobed margin: This is a margin in which the lamina is deeply divided but do not separated completely. E.g cassava, sweet potato, passion pawpaw, e.t.c

Types of leaves:
There are two major types of leave. These include simple leaves and compound leaves.



A. Simple leaves:
Simple leaves are leaves with a single lamina which is not completely divided up into leaflets e.g. mango, Jack fruit, orange etc. Pawpaw and cassava have simple digitate/palmate leaves.

B. Compound leaves:
Compound leaves are leaves with a single lamina which is completely divided up into leaflets.

Types of compound leaves:

i) ***Compound pinnate:***
Here leaflets are arranged in two rows opposite one another along the midrib (rachis) e.g. cassia leaf.

ii) ***Compound bipinnate:***
Here leaflets are arranged opposite each other on the rachis and each leaflet further divides into smaller units called pinnules e.g. Jacaranda leaf.

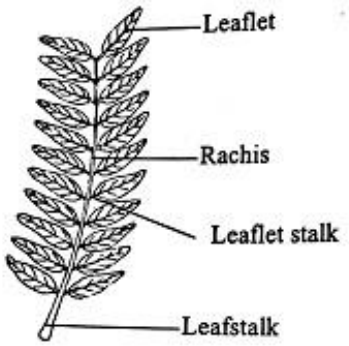
iii) ***Compound trifoliate:***

These are compound leaves with only three leaflets e.g. Soya bean, beans, oxalis, straw berry, peas etc.

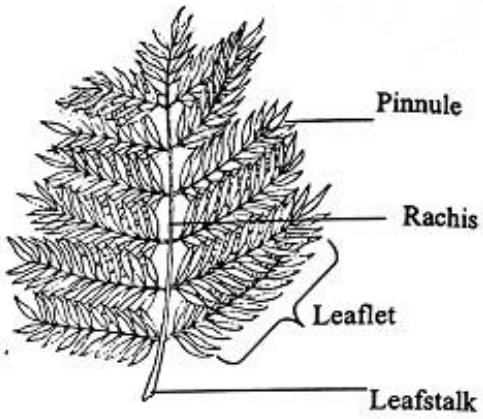
iv) ***Compound digitate or palmate:***

These are compound leaves with leaflets radiating out from the end of petiole like fingers of the hand e.g. Silk cotton and gynandropsis.

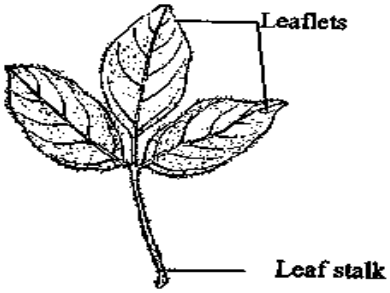
Compound pinnate



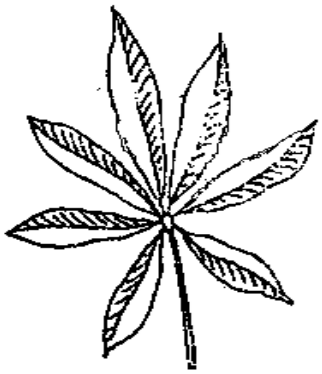
Compound bipinnate



Compound trifoliate



Compound palmate



Note:

Lamina may also have the following features;

- May have hairs to trap moisture hence reducing transpiration.
- May be thick and succulent to store mainly water and food which is an adaptation for plants leaving in dry areas e.g. Sisal, cactus, and bryophylum.
- It may be rough which provides protection.
- It may have spines for protection against herbivores.

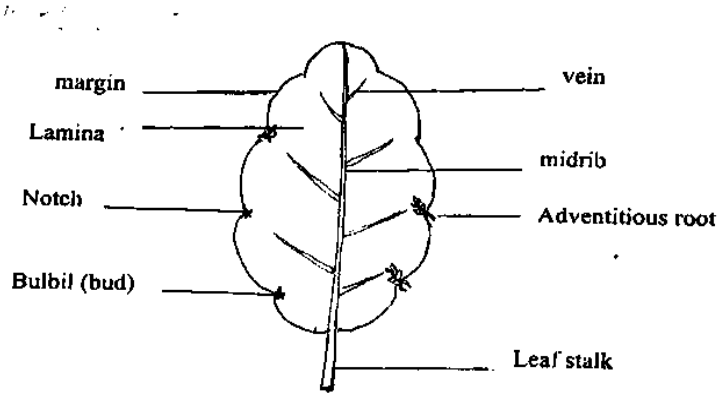
Leaf modifications:

Some leaves have been modified into specialized forms to perform other functions other than the usual photosynthesis, transpiration and gaseous exchange.

Functions of modified leaves include;

a) Some leaves store food and water for the plant. They are thick, succulent and swollen e.g. fleshy leaves of an onion, Bryophylum etc.
b) Some leaves are modified for vegetative propergation/reproduction. These have buds n the margin e.g. Bryophylum.
c) Some leaves are used for support and attachment on other objects. They have leaf tendrils at the apex or between the two leaflets e.g. peas.
d) Some leaves trap and digest insects e.g. *Nepenthes*. These leaves have leaf blades which arises as an outgrowth of leaf apex.
e) Some leaves provide protection e.g. pineapples, prickly pear, etc. These leaves have spines.

Bryophyllum leaf



3.3.7 FLOWERS

A flower is part of a shoot specialized for sexual reproduction. The flower consists of several parts arranged in rings known as whorls. These whorls from outermost to innermost are namely;

a) ***Calyx (sepals):***

This is the outermost whorl of a flower. It is made up of sepals that are normally green in colour. However, in some flowers the sepals maybe brightly coloured, hence referred to as *petaloids*.

Sepals maybe either free (polysepalous) or fused (gamosepalous).

Calyx protect the inner whorls of a flower during the bud stage.

b) ***Corolla (petals):***

This is the second whorl of a flower and it is made up of petals which are normally brightly coloured to attract pollinators. The petals can either be free (polypetalous) or fused (gamopetalous).

In monocots, petals are small and dull coloured combined with sepals to form a ***perianth***.

c) ***Androecium (stamens):***

This is the third whorl of a flower made up of stamens. Stamens form the male part of the flower and each consists of a filament which supports a head called anther.

d) ***Gynoecium (pistil/carpels):***

This is made up of female reproductive parts called carpels. Each carpel is made up of ovary, style and stigma. A flower with one carpel is referred to as ***monocarpous***, that with several fused carpels is referred to as ***syncarpous*** and that with several unfused carpels are referred to as ***apocarpous.***

Other terms used to describe flowers:

(i) ***Compete flower*****:** This is a flower having all the four floral whorls.

(ii) ***Incomplete flower*****:** This is a flower lacking one or more of the four floral whorls.

(iii) ***Bisexual flower*****:** This is a flower with both male and female parts i.e. it has pistil and stamens. These flowers are also called hermaphrodite flowers.

(iv) ***Unisexual flower*****:** This is a flower with either male sexual parts or female sexual parts.

(v) ***Pistillate flower*****:** This is a female flower i.e. a flower with carpels and no stamens.

(vi) ***Staminate flower*****:** This is a male flower i.e. a flower with stamens and no carpels.

(vii) ***Regular flower*****:** This is a flower which can be divided symmetrically along more than one plane.

(viii) ***Irregular flower*****:** This is a flower which can be divided in two similar halves along only one plane.

(ix) ***Superior ovary*****:** This is the ovary that arises above the rest of the floral parts.

(x) ***Inferior ovary*****:** This is the ovary that arises below the rest of the floral parts.

Pollination of flowers:

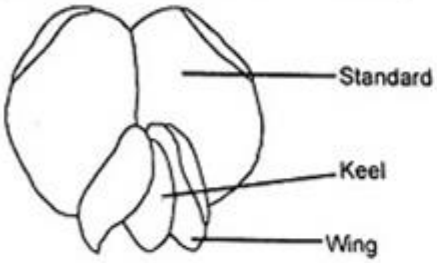
Flowers are generally pollinated by insects (insect pollinated flowers) and wind (wind pollinated flowers).

Characteristics of insect pollinated flowers.

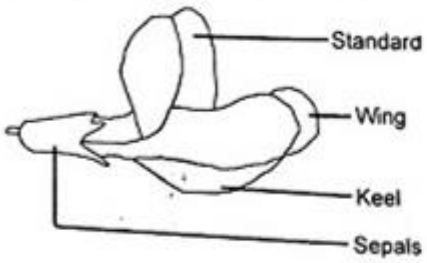
- They have large and conspicuous petals to provide large landing area and to be easily seen by insects.
- They have brightly coloured petals to attract insects.
- They are scented to attract insects.
- They have sticky stigma on which pollen grains can stick.
- They produce sticky pollen grains so as to stick on the body of insects.
- They produce nectar that attracts insects.

Examples of insect pollinated flowers include; crotalaria flower, hibiscus flower, morning glory, cassia flower e.t.c.

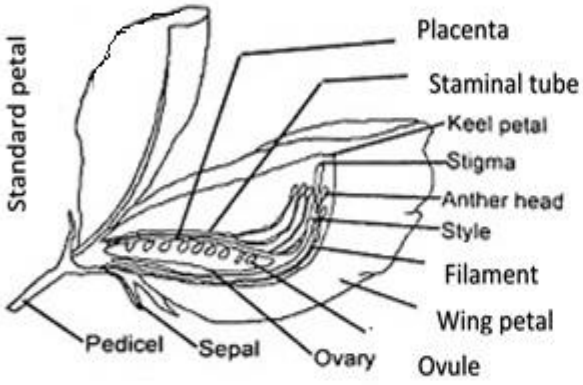
Anterior view of crotalaria flower



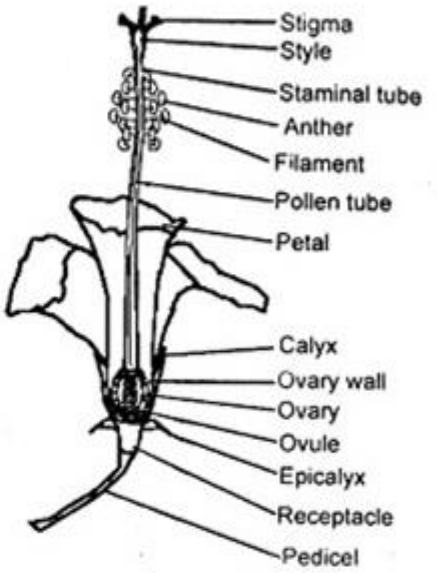
Lateral view of crotalaria flower



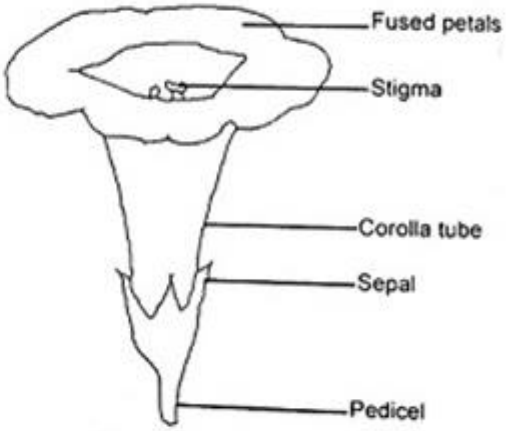
Longitudinal section of crotalaria flower



Longitudinal section of Hibiscus flower



External parts of morning glory flower

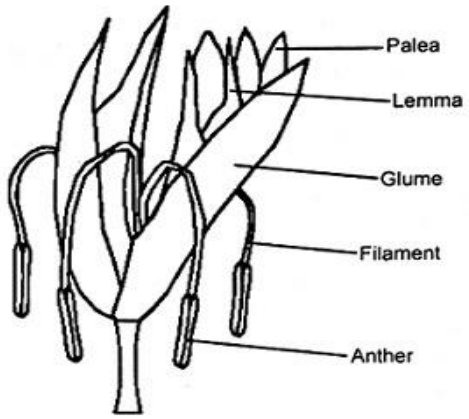


Characteristics of wind pollinated flowers.

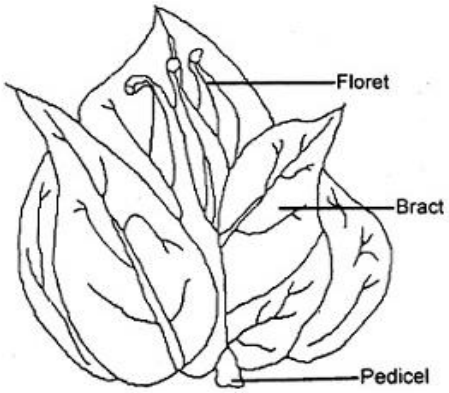
- They have feathery stigma which provide a large surface area for filtering pollen grains from the air.
- They have long styles for protruding the stigma outside.
- They have loosely attached anthers.
- They produce many dusty small pollen grains which are light in weight.
- They have long thin filaments for holding the anthers outside the flower.
- They have small dull coloured petals or perianth.

Examples of wind pollinated flowers include; grass flower and maize flower.

Drawing of a maize spikelet



External structure of Bougainvillea flower



3.3.8 FRUITS AND SEED:

A seed is a fertilized mature ovule. It has one scar (hilium) which is a spot where it was attached to the pod inside the fruit using the funicle.

A fruit is a mature fertilized ovary containing or more seeds. It has a fruit coat known as a pericarp. It has two scars, one where it was attached to the receptacle and the other of the remains of the style or stigma.

CLASSIFICATION OF FRUITS

Fruits are divided into three groups namely;

(i) Simple fruits:

These are fruits which are formed from one flower in which the pistil is either monocarpous or syncarpous.

(ii) Aggregate fruits:

These are fruits formed from one flower with gynoecium having several free carpels (apocarpous).

(iii) Multiple fruits:

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

SIMPLE FRUITS

These are the majority of fruits and are divided into dry fruits and succulent fruits.
Dry fruits are divided into dry dehiscent and dry indehiscent fruits.

a) Dry indehiscent fruits:

These are single seeded fruits with a pericarp which does not split to set free its seed. These fruits include achene, nut, caryopsis, cypsela and samara.

(i) Achene:

This is a small one seeded dry fruit with a tough leathery pericarp which does not split or dehisce. For example sun flower.

(ii) Nut:

This is a one seeded fruit with a very hard and tough pericarp e.g. cashew nut.

Note: Ground nuts and coconut fruits are **not** nuts.

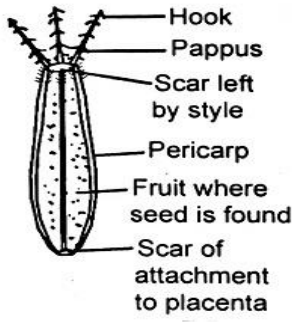
(iii) Caryopsis:

This is achene-like fruit in which the pericarp and testa have become fused together e.g. maize.

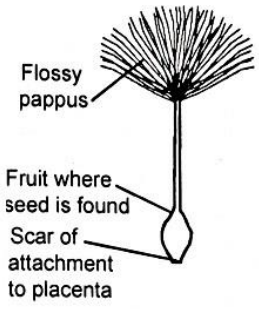
(iv) Cypsela:

This is a small hard one seeded fruit with a persisted calyx above the inferior ovary which forms a parachute of hairs known as ***pappus*** that facilitate wind dispersal by increasing the surface area that can be acted on by wind maximally. E.g tridax, black jack, Dandlion etc.

Bidens pilosa (Black jack)



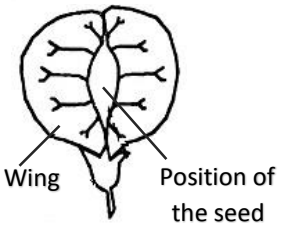
Dandilion:



(v) Samara:

This is an achene like fruit in which the pericarp grows flattened to form a wing which facilitates wind dispersal by increasing the surface area that can be acted on by wind maximally. E.g African rose wood.

Elm-Samara



b) Dry dehiscent fruits:

These are fruits where the pericarp on drying splits open (dehisces) to release seed. They split along lines of weakness referred as **sutures**.

These fruits are classified according to the number of splits (sutures) which occur in the pericarp. These include follicle, legume, capsule and schizocarp.

(i) Follicle:

This is a dry many seeded fruit that splits longitudinally along one line of weakness e.g Sodom apple.

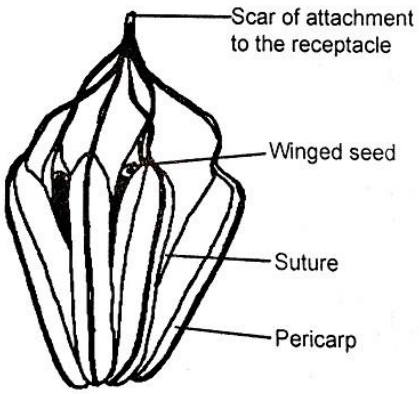
(ii) Legume:

This is a dry many seeded fruit that split longitudinally along two lines of weakness e.g. bean pod, pea pod, cassia pod etc.

(iii) Capsule:

This is a dry many seeded fruit that split longitudinally along more than two lines of weakness e.g Dutchman's pipe, castor oil, cotton, etc.

Diagram of dutchman's pipe-Capsule



(iv) Schizocarp:

This is many seeded fruit which on drying breaks up into several parts, each called a mericarp containing only one seed e.g. *desmodium.* They possess sticking hairs that attach to the body/fur of animals to facilitate animal dispersal.

SUCCULENT FRUITS:

These are fruits which become juicy as they ripen. Part of these fruits are fleshy and edible. The pericarp is divided into three layer i.e. epicarp, mesocarp and endocarp. Succulent fruits include drupe, berry and pome.

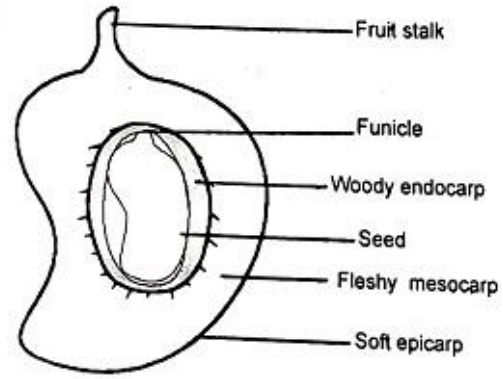
a) Drupe:

These are single seeded succulent fruits with a pericarp divided into three layers namely;

- ✓ ***Epicarp*** – an outer thin soft layer.
- ✓ ***Mesocarp –*** a middle fleshy edible layer.
- ✓ ***Enocarp –*** an inner hard and woody layer which forms the stone.

Example include avocado, mango fruit, coconut, etc.

Longitudinal section of a mango fruit:



Characteristics of drupes:

- Has one seed.
- Has fleshy mesocarp.
- The endocarp is hard and fibrious.
- Has only a single chamber (locule) where a seed is located.
- Seed is attached at the base of the fruit i.e. has basal placentation.

b) Berry:

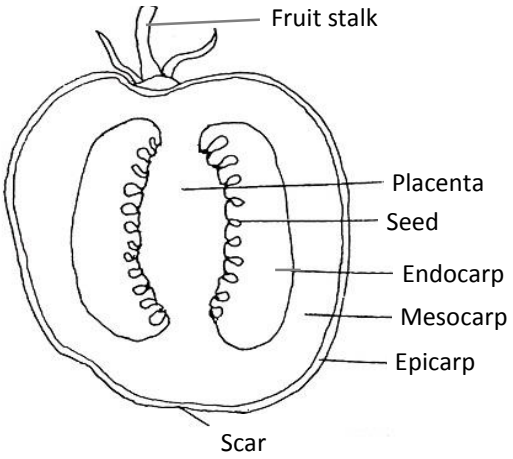
This is a juicy fruit with many seeds e.g. tomato, orange, etc. The whole of its pericarp is soft.

Characteristics of berries:

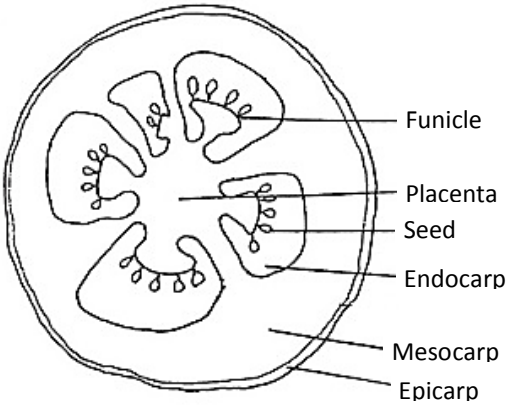
- Have many small seeds.

- Have a spongy mesocarp.
- Endocarp id juicy, with several juicy hairs or sac in some fruits.
- Have several chambers (loculi).
- Seeds are attached around the placenta centrally (axile placentation).

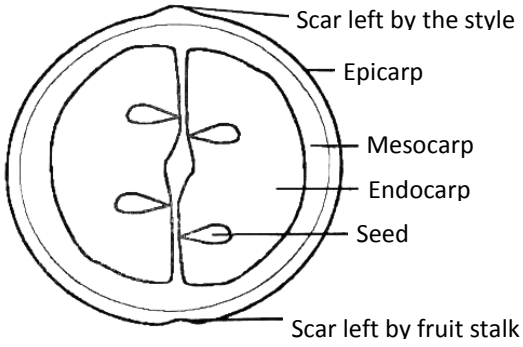
Longitudinal section of a tomato fruit:



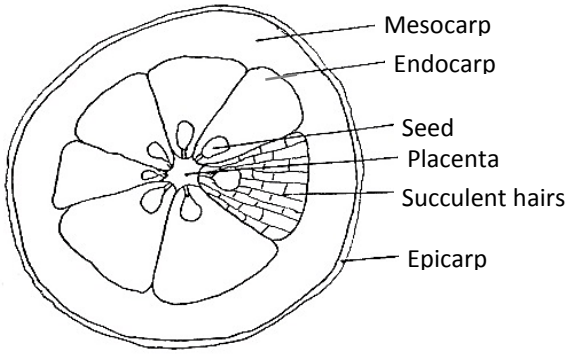
Cross section of a tomato fruit:



Longitudinal section of an orange fruit:



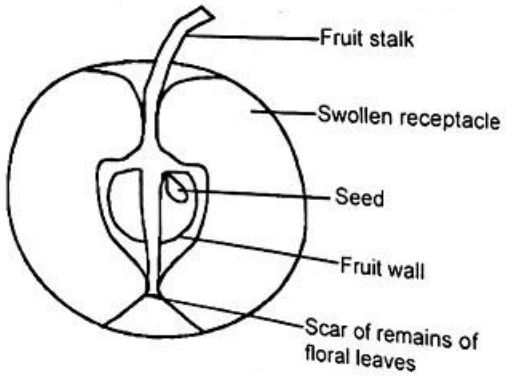
Cross section of an orange fruit:



c) Pome:

This consists of a fleshy pericarp whose receptacle forms part of the fruit e.g. apple.

Longitudinal section of an apple:



3.3.9 PLACENTATION:

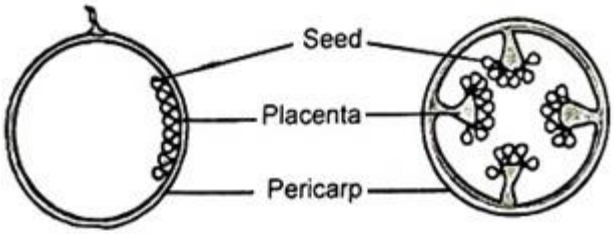
This is the arrangement of seeds and their attachment on the placenta.

There are several types of placentation and these include;

a) Axile placentation:

Seeds arrange themselves radially/centrally around the placenta which is centrally located e.g. oranges, tomatoes, lemon and banana.

Diagram of Pareital placentation of passion fruit:

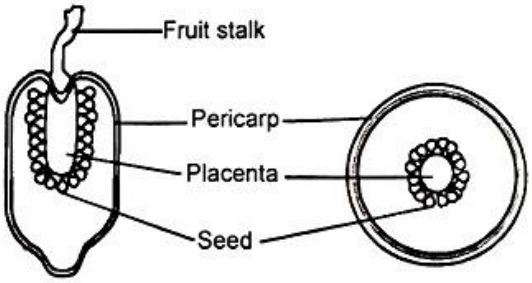


b) Marginal placentation:
Seeds are arranged along the placenta located on the margin of the pod of fruits like legumes e.g bean pod, pea pod, or follicles for example Sodom apple.

c) Basal placentation:
Here seeds are attached at the base of the pericarp e.g. mango, avocado, etc.

d) Parietal placentation:
There the seed are attached to the inner walls of the pericarp (endocarp) and appear as ridges e.g. pawpaw, passion fruit, cucumber, etc.

Diagram of free central placentation of green paper:



e) Free central placentation:
Here the placenta projects freely in the center of the locule (chamber) from where the seeds are attached all around the placenta e.g. green paper.

3.3.10 SEEDS AND FRUIT DISPERSAL:

This is the scattering of fruits and seeds from their parent plants.

Importance of seed and fruit dispersal:

- It reduces overcrowding among plants of the same species.
- It reduces competition for resources.
- It allows colonization of new areas.
- It minimizes the spread of diseases.
- It enhances chances of survival and continuity of plant species.

Types / modes of dispersal:
There are four types of dispersal namely; animal dispersal, self-dispersal (explosive dispersal), wind dispersal and water dispersal.

a) *Animal dispersal:*
Fruits dispersed by animals have the following characteristics;

- Some are large and brightly coloured to attract animals.
- Some fruits when are scented to lure animals.

- Some fruits possess hooks on their pericarps to attach on the fur, skin or cloth of animals e.g. Black jack and *desmodium*.
- Some fruits are succulent i.e. have edible parts.

b) Wind dispersal:

Seeds/fruits dispersed by wind have the following characteristic;

- They are light in weight.
- They have structures like hair or wings that allow the float in air.
- They are loosely attached to allow them be easily shaken off by wind.

c) Self-dispersal:

These fruits are mainly dry dehiscent, that split along lines of weakness ejecting/releasing the seeds e.g. legumes.

d) Water dispersal.

Seeds/fruits dispersed by water have the following characteristics;

- They are usually light and contain air spaces that allow them float on water so that they can be carried by running water.
- Some fruits have fibrous mesocarp to prevent water from penetrating them.
- They normally possess impermeable outer coat.

3.4 EXPERIMENTS

EXPERIMENT 22

You are provided with specimen **F, H, J, K, L** and **M** which are parts of a plant.

(a) Observe specimens **K, L** and **M** and record their characteristic features in reference to veins, surface and petiole.

Specimen	Characteristic feature
1) K	Veins: …… …… …… Surface: …… …… ……

	Petiole: …… …… ……
2) L	Veins: …… …… …… Surface: …… …… …… Petiole: …… …… ……

3) M	Veins: …… …… …… Surface: …… …… …… Petiole: …… …… ……

(b) Specimens are adapted for the habitats for the habitats in which they grow.

i) Adaptation of **F**.

……

……

……

……

ii) Adaptation of **K**.

……

……

(c) Observe specimens **F, H, J, K, L** and **M** and construct a dichotomous key to identify the specimens.

EXPERIMENT 23

You are provided with specimens **A, B, C** and **D** which are plant parts

(a) Observe them carefully and record their characteristic features with reference to veins, petiole and surface.

i) Specimen A:

Veins……

……

……

Surface……

……

Petiole……

……

……

……

ii) Specimen B:

Veins……

……

……

Surface……

……

……

Petiole……

……

……

iii) Specimen C:

Veins……

……

……

Surface……

……

Petiole……

……

……

(b) Observe specimen C and D for each specimen, state one way in which the specimens are adapted to the habitats in which they grow

i) Adaptation of C

……

……

……

ii) Adaptation of D

……

……

(c) Observe specimen **A, B, C** and **D** and construct a dichotomous key to identify the specimens

EXPERIMENT 24

You are provided with specimens **P, Q, R, S, T** and **U** which are plant materials, study the carefully and answer questions that follow.

(a) Giving reasons, identify the type of fruit each of the specimen is in the table provided below:

Specimen	**Type**	**Reason(s)**
P		
Q		
R		
S		
T		
U		

(b) (i) Cut transversely through specimens **Q** and **T.**
(ii)Make well labeled drawings of one half of each specimen.

(c) (i) State the possible food reserves stored in **Q** and **T**

Q……

T……

(ii) How does specimen **Q** differ from **T**?

……

……

……

(iii)State the similarities between Specimens **Q** and **T**

……

……

(d)(i) State the reasons how you would believe specimens **P** and **R** are dispersed

P……

……

R……

……

(ii) What is the biological nature of specimens **P, S** and **U?**

P……

S……

U……

(e) (i) Break specimen **P** open. Draw and label the longitudinal section of one opened half, state your magnification.

(ii) State 4 differences between **R** and **P**

……

……

……

……

(f) State the type of placenta (placentation) in each of the specimens **P, Q, R** and **T**

P……

Q……

R……

T……

(g) (i) Make a well labeled drawing of Specimen **S**, state your magnification.

(ii) List the differences and similarities between **Q** and **S**

Differences:

……

……

Similarities

……

……

(h) Make the following sections draw, label and state your magnification:

(i) Longitudinal section of U

(ii) Longitudinal section of **R**

(iii) Transverse section of **R**

(iv) Longitudinal Section of **T**

(i) Observe specimens **P, Q, R, S, T** and **U** and construct a dichotomous key to identify the specimens.

EXPERIMENT 25

You are provided with specimens **X, Y** and **Z** which are fruits. Cut across section of specimen **Z** and examine the specimens using a hand lens where necessary.

(a) Giving a reason in each case, state the type of fruit each one is.

(a) (i) Specimen **X**

……

Reason

……

……

(ii) Specimen **Y**

……

Reason

……

……

(iii) Specimen **Z**

……

Reason

……

……

(b) Using observable features describe how each specimen is dispersed.

(i) Specimen **X**

……

……

……

(ii) Specimen **Y**

……

……

……

(iii) Specimen **Z**

……

……

……

(c) Cut across section of specimen **Z** draw and label the section in the space below. State your magnification.

EXPERIMENT 26

You are provided with specimens **O, P, Q** and **R**

(a) State the identity of each specimen and give a reason in each case.

Specimen	**Identity**	**Reason**
i) O		
ii) P		
iii) Q		
iv) R		

(b) Suggest a method for dispersal of each specimen.

Specimen	**Mechanism**
i) O	
ii) P	
iii) Q	
iv) R	

(c) Make a transverse section of specimen **O**

i) State the type of placentation for specimen **O**

……

ii) Draw an accurately labeled diagram of one half of specimen **O.**

(d) Construct a dichotomous key of specimen **O, P, Q** and **R**. (Stick to the order **O,P, Q** and **R**)

EXPERIMENT 27

You are provided with specimen **T** which is a plant organ, study it carefully and answer questions that follow.

(a) Describe the external structure and appearance of the specimen

……

……

……

(b) Identify the plant organ

……

(c) Give the function of the specimen

……

(d) Cut through the specimen longitudinally into 2 halves, draw and label

(e) (i) State the method of pollination for the specimen and give three reasons for your answer.

Method

……

Reasons

……

……

(ii) State the advantage of the method of pollination of the specimen

……

……

(iii) What features increase the chances of cross pollination

……

……

(iv) Describe how pollination would occur in the specimen

……

……

……

……

EXPERIMENT 28

You are provided with specimens **K, L** and **M** which are plant parts.

(a) Giving two reasons in each case, identify which part of the plant each specimen **K** and **L** is,

K……

Reasons:

……

……..

L……

Reasons:

……

……

(b) All the specimens **K, L** and **M** are modified to perform other functions other than the usual functions. Using observable features, state what each specimen is modified to do. Record the observable features and the function each specimen is modified to perform in the table below.

Specimen	**Features on the specimen**	**Function**
K		
L		
M		

(c) Cut a small piece of Specimen K and squeeze the piece between your fingers. ***(Do not damage the specimen. It will be required in part (e))***. From your observations of specimen K, state all the functions performed by the specimen.

……

……

(d) Explain how the features on specimen:

i) **K** enables the specimen to live successfully in its habitat.

……

……

……

ii) **M** enables the plant from which the specimen was obtained to live successfully in its habitat.

……

……

……

(e) Draw and label specimen **K** in the space below.

EXPERIMENT 29

You are provided with specimen **K, L** and **M** which are flowers**.**

(a) From **two** observable features in each case, suggest the mode of pollination of each of specimens **L** and **M**.

i) Mode of pollination of **L**,

……

Features:

……

……

ii) Mode of pollination of **M**.

……

Features:

……

……

(b) Give **four** observable differences between the structure of specimen **K** and **L.**

K	**L**
(i)	
(ii)	
(iii)	
(iv)	

(c) Give **one** advantage of specimens **K** and **L** over specimen **M.**

……

……

(d) Remove the petals and sepals from specimen **L**. Draw and label the remaining part of the specimen. State the magnification of your drawing

EXPERIMENT 30

You are provided with specimen **P**. Cut it longitudinally.

(a) Draw and label one-half of the specimen in the space provided

(b) Describe the following parts of specimen **P**.

i) Sepals

……

……

……

……

ii) Petals

……

……

……

……

iii) Male parts of the flower

……

……

……

……

iv) Female parts of the flower

……

……

……

……

(c) i) State the type of pollination that occurs in specimen P.

……

ii) Describe how specimen P is adapted to the type of pollination stated in (c) (i) above.

……

……

……

……

EXPERIMENT 31

You are provided with specimen **X** which is part of a plant

(a) Describe the sepals and petals of the specimen

i) Petals

……

……

……

ii) Sepals

……

……

……

(b) Suggest with reasons the agent of pollination of specimen **X**

i) Agent

……

…

ii) Reasons

……

……

……

……..……

(c) Using a razorblade, cut specimen **X** longitudinally, draw and label one half of the specimen. State your magnification

EXPERIMENT 32

You are provided with specimens **P** and **Q** which are similar plant parts.

(a) Using two common features, state what plant parts they are.

……

……

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……

……

……

(b) From their structures, state two functions performed by each specimen.
(i) Functions of **P**

……

……

(ii) Functions of **Q**

……

……

(c) Give four structural differences between specimens **P** and **Q**

……

……

……

……

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

……

……

……

(e) Draw the structure of specimen **Q** including two nodes and one complete internode. Do not label. State your magnification

EXPERIMENT 33

You are provided with specimens Q1, Q2, Q3 and Q4 which are plant organs. Study them carefully and answer the questions that follow.

(a) (i) What plant organs are specimens Q1, Q2, Q3 and Q4

……

(ii) State two reasons to support your answer in (a) (i)

……

……

(b) With reasons in each case, state the function of each specimen (organ) to the plant it was got from.

Specimen	**Function**	**Reason**
Q1		
Q2		
Q3		
Q4		

(c) Describe the arrangement of leaves on specimen Q1

……

……

……

(d) State three observable differences between Q1 and Q2

Specimen Q1	Specimen Q2

(e) Construct a simple dichotomous key to identify specimens Q1, Q2, Q3 and Q4.

……

……

……

……

……

……

(f) Remove (pluck off) the leaves of specimen Q2 and then make a well labelled drawing of the remaining part.

EXPERIMENT 34

You are provided with specimens A, B, C, D, and E which are plant parts.

(a) Observe specimens A, B, C, D, and E and record their characteristic features in reference to venation, lamina, and margins in the table below.

Specimen	Venation	Lamina	Margin
A			
B			
C			
D			
E			

(b) Using the information in the table in (a) above, construct a dichotomous key to identify specimen A, B, C, D, and E

……

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……

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……

……

(c) Using the observable features of specimen E, state three adaptations to its habitat.

……

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……

(d) With the leaf sheath opened, draw a well labelled drawing of specimen D.

EXPERIMENT 35

You are provided with specimen Q and R.

(a) Examine the specimens and state the differences between them using petals, sepals and stamens in the table below.

Part of plant	**Q**	**R**
Petals		
Sepals		
Stamens		

(b) From the structure of the pistil and stamens, suggest the type of pollination which is likely occur in specimen R, explain your answer.

……

……

……

……

……

(c) Using observable features, state the agent of pollination for Q and describe how the specimen is being adapted to the agent stated.

Agent ……

Adaptations

……

……

……

(d) Cut a longitudinal section of specimen R, draw and label one half of the specimen.

EXPERIMENT 36

You are provided with specimen S and T which are plant organs.

(a) Identify which part of the plant each specimen S and T is. Give three reasons in each case.

Specimen S ……...

Reasons:

……

……

……

Specimen T……...

Reasons:

……

……

……

(b) Specimens S and T are modified to perform some other functions other than their normal functions. Observe the specimens carefully and write two features on them and functions they are modified to perform.

Specimen	Features on the specimen	Function
S		
T		

(c) How are the specimens adapted to live successfully in their habitat?
Specimen S

……

……

……

Specimen T

……

……

……

(d) Make a well labelled drawing of specimen T in the space below. State your magnification.

EXPERIMENT 37

You are provided with specimens F and G which are reproductive parts of plants.

(a) Cut longitudinal sections through specimens F and G. Using a hand lens, examine one half of specimen F and describe the following parts on it.

(i) Calyx

……

……

(ii) Corolla

……

……

(iii) Stamens

……

……

(b) Examine specimens F and G and state the type of pollination which occurs in each specimen, giving a reason in each case.

(i) Type of pollination in F ……..

Reason……

……

……

(ii) Type of pollination in G ……..

Reason……

……

……

(c) State one advantage and disadvantage for the type of pollination which occurs in specimen F

(i) Advantage

……

……

……

(ii) Disadvantage

……

……

……

(d) Examine one section of specimen G, using a hand lens. Draw and label the section in the space provided. State your magnification.

3.5 ARTHROPODS

Arthropods belongs to phylum **arthropoda** and it is the largest group of invertebrates.
General characteristics of arthropods

- They have jointed limbs.
- They have segmented bodies.
- They possess an exoskeleton.

3.5.1 Classes of arthropods

Arthropods are divided into five main classes, namely

- **Insecta** e.g grasshopper, butterfly, ants. Bees etc.
- **Arachnida** e.g. spider, mites, scorpion, ticks etc.
- **Crustacean** e.g. crabs, Cray fish, lobster, water flea etc.
- **Diplopoda** e.g. millipedes.
- **Chilopoda,** e.g. centipedes.

Characteristics of class arachnida:

- They have four pairs of legs.
- They have two main body parts.
- They have no antennae.
- They have no compound eyes

Characteristics of class insecta

- They have three pairs of jointed legs all found on the thorax.
- They have three main body parts.
- They have a pair of antennae on the head.
- Majority have a pair of compound eyes on the head.
- They have exo-skeleton

Features of some common insects.

1. **Cockroach**
   Order: Dictyoptera
   Reason: Has hard outer wings.
   Habitat: Dark, dirty and damp warm places.
   Features on the head region
   - Head is oval shaped, and connected to thorax by short slender neck.
   - Has two compound eyes dorso-laterally positioned able to view a wide area.
   - Has a pair of long segmented and tapering antennae that are sensitive to touch and smell.
   - They possess biting mouth parts consisting of sharp serrated mandibles for chopping the food, maxilla for handling food during the feeding, labrum and labium which are lips.

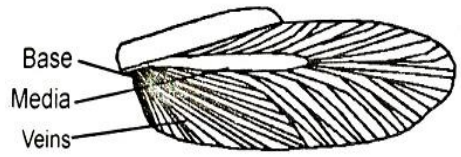
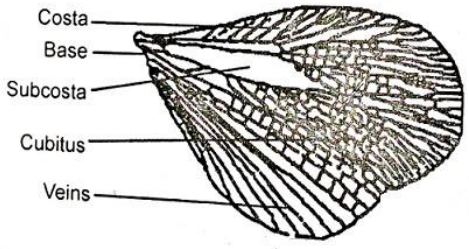
Features on the thorax

- Has three segments i.e prothorax, mesothorax and metathorax.
- Each segment bears a pair of legs. The hind leg have spines for protection, they are long and muscular and Z-shaped to provide enough lift force. The legs possess claws to grip on objects, glandular pads for moving on smooth surfaces. Legs are jointed for swift movement. The other legs are short for swift movement.
- The mosothorax and metathorax each possess a pair of wings.
- The outer wing is hard, narrow and oval in shape whose main function is to protect the inner wings used for flying.
- The inner wing is membranous and flexible supported by a system of veins. It is broad and triangular in shape providing a large surface area.
- Have two pairs of spiracle.

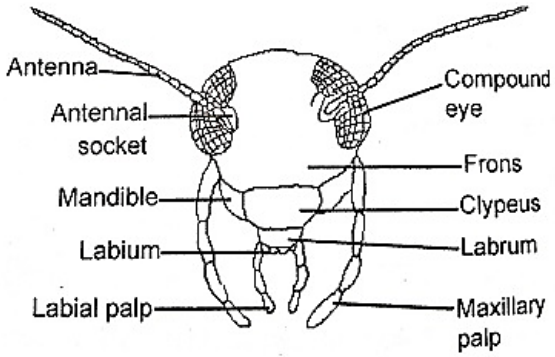
Features on the abdomen

- Has ten segments when which are dorso-ventrally flattened.
- Each segment bears a pair of spiracles.
- The last abdominal segment has a pair of jointed sensory structures called cerci.
- It is flat and broad.
- The ninth segment in males possess a pair of styles which are reproductive structures.
- In the females the seventh segment possess the ovipositor used for holding and depositing the egg case.

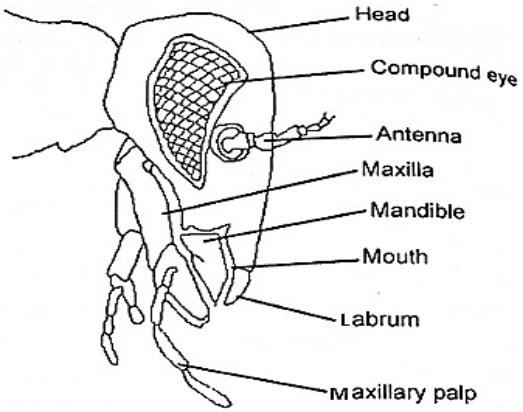
Differences between fore wings and hind wings

Fore wings	**Hind wings**
Are brown in colour and opaque	Are colourless and transparent
Are thick and stiff	Are thin, membranous and delicate
Are narrow shaped	Are broad shaped
Cover and protect hind wings not when in use	Used for flight
	

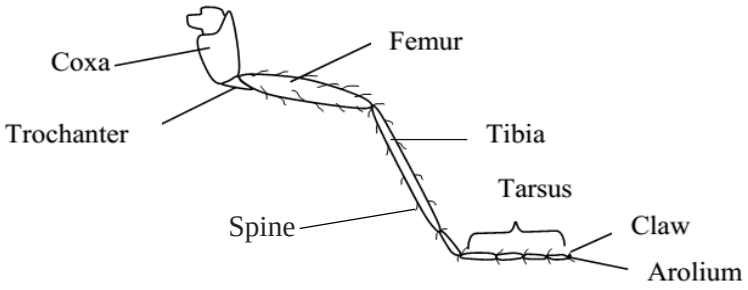
Anterior view of the head of a cockroach



Lateral view of the head of a cockroach



Drawing of hind leg of a cockroach



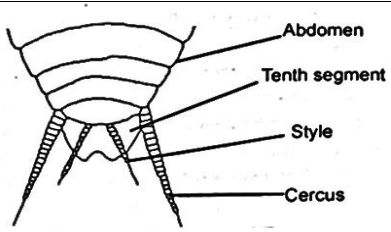
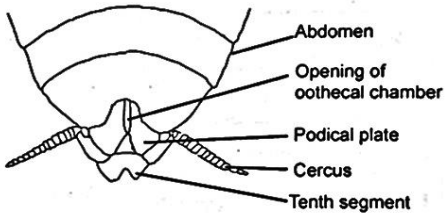
Adaptations of a cockroach to its habits and habitant

- They may be winged or wingless. Wings enable them to fly away quickly from enemies.
- They possess spines on their legs for defense.
- They have long jointed legs that they can use to run very rapidly from any potential danger.
- They are generally flat and oval in outline to enable them hide in very narrow crevices.
- They are brown or dark coloured allowing them not to be seen in darkness since they are largely nocturnal.
- They have a soft, slippery outer skin called cuticle which makes hem difficult to catch.
- They have long, highly sensitive antennae with sensory bristles which enable them to detect tiny amounts of food and moisture even in darkness.
- They have cerci which can sense minute air movements to enable a cockroach to rapidly detect and flee from potential danger.
- They have oily cuticle which protects them from dehydration.

Identification of a cockroach's sex

In males, there is a pair of slender **styles** that are used to hold and manipulate the female during copulation.

In females, there is a pair of boat shaped structures called the **podical plates** used for holding eggs.

Differences between a male and female cockroach:	
Male	**Female**
1. Has a narrow abdomen	Has a broader abdomen
2. Lack ootheca	Has ootheca which develops after fertilization.
3. Has rod-shaped structures called styles on the 9th abdominal segments.	No styles on the 9th abdominal segment.
4. No podical plates.	Has podical plate for carrying eggs.
	

2. Housefly

Order: Diptera

Reason: Has a pair of wings.

Habitat: Dirty/filthy moist places/decaying organic matter.

Features on the head.

- Has two compound eyes
- Has three simple eyes called ocelli.
- Has a proboscis
- One pair of short antennae.
- Has a pair of short maxillary pulp.

Features on the thorax

- Has three segments.
- Each segment is hairy and each possess a pair of hairy legs.
- Mesothorax has a pair of membranous wings.
- Metathorax has a pair of haltares/balancers.
- Has two pairs of spiracles.

Adaptations of a housefly to its habits and habitant

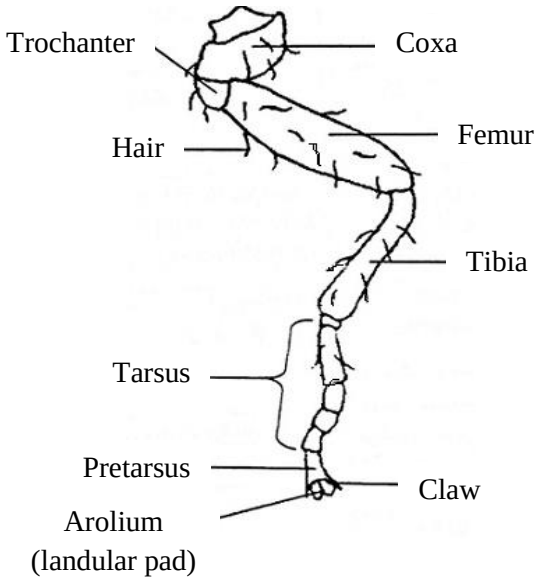
- Has hairy antennae for increased sensitivity.
- Membranous wings for flight.

- Tubular expanded proboscis for sucking liquid food and depositing of saliva.
- Large compound eyes for wide field of view.
- Curved/sharp/pointed claws for movement on rough surfaces.
- Sticky arolium for movement for moving on smooth surfaces.
- A pair of halteres for balancing during flight.
- Segmented body for flexibility during movement.
- Body covered with exoskeleton for protection against water loss/desiccation/mechanical damage.
- Has glandular pads on legs for moving on smooth surfaces.
- Has jointed limbs for flexibility during movement.

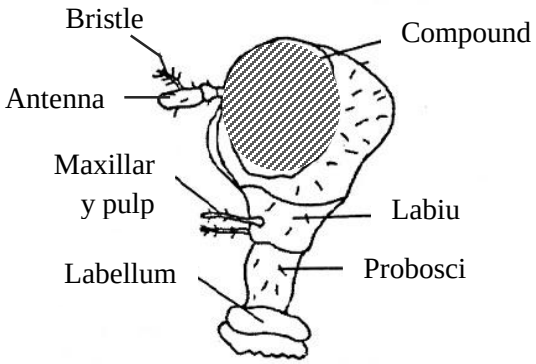
Adaptation of a housefly to its function as a vector

- Has hairy body for carrying germs to other areas.
- Has tubular proboscis through which germs contained in saliva are passed onto food
- Has wings for swift movement leading to easy transfer of the germs.

A drawing of a hind leg of a house fly



Drawing of lateral view of the head of a house fly:



3. **Grass hopper**
   Order: Orthoptera
   Reason: Has straight wings.
   Habitat: Grass

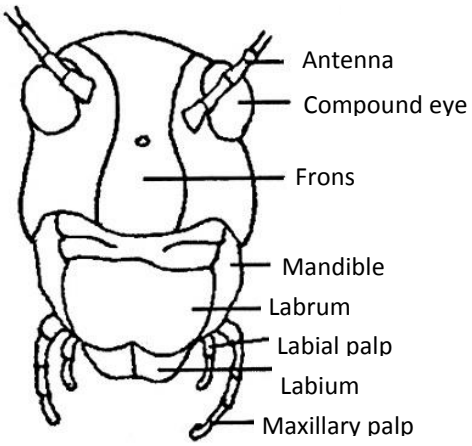
   Features on the head

   - Has a simple eye.
   - Has a pair of short antennae.
   - One pair of compound eyes.
   - Have powerful mouthparts with strong toothed mandibles.

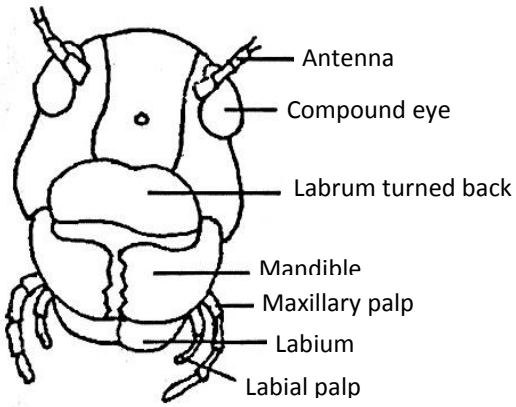
Adaptation of a grass hopper to its life in the habitat.

- Have a pair of antennae for increased sensitivity.
- Hard sharp mandibles for cutting solid food and defence.
- Curved/sharp/pointed claws for movement on rough surfaces.
- Sticky arolium for moving on smooth surface.
- Segmented body for flexibility during movement.
- Jointed maxillary palps to hold and push food into the mouth.
- Have dull coloured body to camouflage and avoid predators.
- Eyes are large and dorso-laterally positioned to see food in a wide area.
- Outer wings are hard to protect inner wings.
- Inner wings are wider for generating a big lift force in flight.
- Wings are veined for support in flight.
- Maxilla and labium are joined for flexibility.
- Jointed legs for flexibility during locomotion.

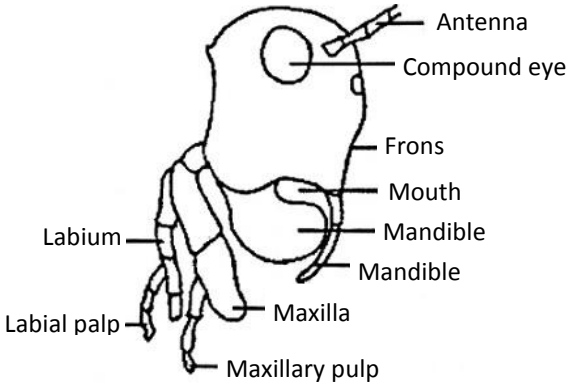
Drawing of anterior view of grasshopper head (All parts intact)



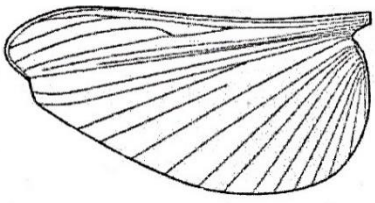
Drawing of anterior view of grasshopper head (Labrum lifted to expose mandibles)



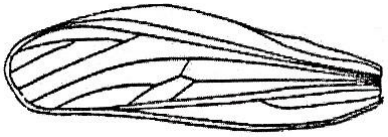
Drawing of lateral view of grasshopper head



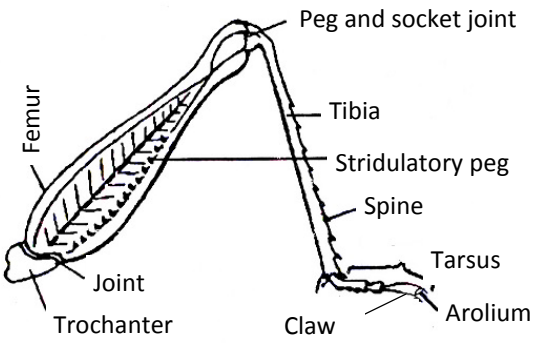
Drawing of hind (inner) wing:



Drawing of fore (outer) wing:



Drawing of hind leg of Grasshopper



4. **Worker Bee**
   Order: hymenoptera
   Reason: Has membranous wings.
   Habitat: Bee hive

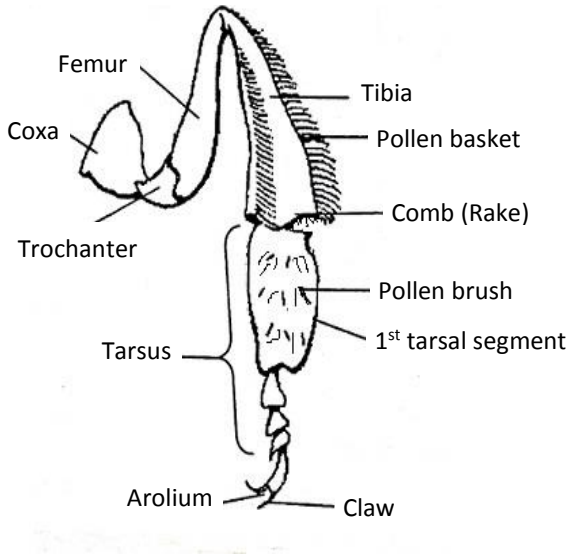
   Adaptations for successful survival of bees in their habitat

   - Possession of pollen baskets on limbs for carrying pollen grains.
   - Possession of pollen comb on their limbs for cleaning pollen off the body.
   - Possession of prongs on their limbs for removing the pollen from the pollen basket.
   - Hairy body for carrying the pollen grains.
   - Blunt mandibles for moulding wax and pollen grains.
   - Membranous wings for flight.
   - Spoon like tongue for lapping/sucking.
   - Segmented body for flexibility during movement.
   - Tubular expanded proboscis for sucking liquid food.
   - Large compound eyes for wide field of view.

   Structural adaptation of the worker bee to its function as a pollinator

   - Has hairy body to trap pollen grains.
   - Have membranous wings for swift movement leading to fast transfer of pollen.
   - Possession of pollen baskets on their limbs for carrying pollen grains.
   - Possession of prongs on their limbs for removing the pollen from the pollen basket.

Drawing of the hind limb of the worker bee:



5. **Termite**

   Order: Isoptera

   Habitat: Ant hill.

   Adaptations to the habitat

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

3.6 EXPERIMENTS:

EXPERIMENT 38

You are provided with freshly killed animals, **X** and **Y**. Study the specimens carefully and answer the questions that follow.

(a) i) Name the phylum and class to which specimens **X** and **Y** belong.

Specimen	Phylum	Class
X		
Y		

(b) Give three structural differences and similarities between specimens **X** and **Y**

Differences

Specimen X	Specimen Y
i)	
ii)	
iii)	

Similarities

i) ……

ii) ……

iii) ……

(c) Give one economic importance of each of the specimens **X** and **Y**

X:

……

Y:

……

(d) With the use of a hand lens, make a clearly labeled drawing of the head region showing the mouth parts of specimen **X**.

EXPERIMENT 39

You are provided with specimen R.

(a) Giving two reasons, in each case, state the phylum and class of the specimen.

i) Phylum

……

Reasons

……

……

ii) Class

……

Reasons

……

……

(b) Give two adaptations of each of the wings and limbs for their functions.

i) Adaptations of wings

……

……

ii) Adaptations of limbs

……

……

(c) Use a razor blade to cut one hind limb and one fore limb from the points of attachment to the body of the specimen. Stretch the limbs and by the help of a thread, measure their lengths.

i) Record the lengths in the space provided.

Length of fore limb ……cm

Length of hind limb ……/…….cm

ii) Work out the ratio of:

Length of fore limb**:** Length of hind limb

……

……

iii) What is the importance of this ratio in the life of the specimen?

……

……

……

(d) i) Cut off the remaining hind limb at the point of attachment to the body. Draw and label.

State the magnification of your drawing.

(iii) Cut off one outer wing from the point of attachment to the body. Draw but do not label. State your magnification.

EXPERIMENT 40

You are provided with specimens **C, D, E** and **F**. Using a hand lens examine the specimens and answer the questions that follow.

(a) Describe the mouth parts, wings and legs of each specimen.

Specimen	Mouth Parts	Wings	Legs
C			
D			
E			
F			

(b) State how the:

i) Mouth parts of specimens E and F are suited for the mode of life of the specimens.

Mouth parts of **E**.

……

……

……

Mouth parts of **F**.

……

……

……

ii) Wings of specimens **C** and **D** are suited for the mode of life of the specimens.

Wings of **C**

……

……

……

Wings of **D**

……

……

……

iii) Legs of specimens **D** and **E** are suited for the mode of life of the specimens.

Legs of **D**

……

……

……

Legs of **E**

……

……

……

(c) Remove the inner wing of specimen **D**. Draw and label the wing, stating your magnification.

EXPERIMENT 41

You are provided with specimens **P, Q, R** and **S.**

(a) (i) State the class of the specimens.

……

……

……

……

(ii) List the features you used to classify the specimens.

……

……

……

……

……

……

(b) Using a hand lens, examine the head region of the specimens and describe the observable characteristics of the eyes, antennae and mouth parts of the specimens.

Specimen	**Observable characteristics**
P	
Q	
R	
S	

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

……

……

……

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……

……

……

(d) In the space provided, draw the antenna of specimen **P**. Do not label but state your magnification.

EXPERIMENT 42

You are provided with specimens **A** and **B** which are animals living in different habitats.

(a) Using a hand lens, observe the specimens. For each specimen, describe the structural appearance of the mouth parts, body, wings and legs and state how each of these parts are suited for the mode of life of the animal, by completing the table below.

Specimen	Body part	Description of body part	Suitability to mode of life
A	Mouth parts		
	Body		
	Wings		
	Legs		
B	Mouth parts		
	Body		
	Wings		
	Legs		

(b) Draw the inner wing of specimen A. Do not label.

EXPERIMENT 43

You are provided with specimens **S** and **T** which belong to the same class.

(a) Giving three reasons, state the phylum of the specimens.

……

……

……

……

……

……

(b) Using a hand lens, observe specimen **T**. State how the structure of the head of **T** is suited for the habitat in which the specimen lives.

……

……

……

……

(c) Observe the thorax of both specimens **S** and **T** and state the structural differences between the thorax of the specimens.

……

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……

……

……

(d) From your observation of specimen **S**, state the structural characteristics which make the specimen suitable as a vector.

……

……

……

(e) In the space provided, draw and label the thorax of specimen **S** from the dorsal view. State the magnification of your drawing.

EXPERIMENT 44

You are provided with specimen A, B, C and D

(a) (i) Suggest two general taxonomical groups to which they all belong.

……

……

……

……

(ii) Basing on observed structures of the specimens give reasons to support your answer in (a) (i) above.

……

……

……

……

……

……

(b) (i) Using a hand lens, carefully examine and observe the characteristics of the head of each specimen. Write down your observe structural characteristics of the head of each specimen in the table below.

Specimen	**Characteristics**
A	
B	
C	

D	

(ii) Using characteristics in the table above, construct a dichotomous key for identity of the specimens above.

……

……

……

……

……

……

EXPERIMENT 45

You are provided with specimen O, P and Q. Using a hand lens observe them carefully.

(a) i) State the order to which specimens O, P and Q belong. Give one reason in each case.

O

Order

……..……..

Reason

……

……

P

Order ……..

Reason

……

……

Q

Order ……..

Reason

……

……

(b) state four structural differences between specimen O and P

Specimen O	Specimen P

(c) i) Record the observable features of the legs, wings and antennae in the table below.

Specimen	Legs	Wings	Antennae
O			
P			
Q			

ii) Using the observable features listed in table (c) i) above construct a dichotomous key to identify specimens O, P and Q.

……

……

……

……...……

EXPERIMENT 46

You are provided with specimen C and D.

(a) State the phylum and class of the specimens giving the observable characteristic features for your classification in each case.

i) Phylum ……

Characteristics features

……

……

……

……

iii) Phylum ……

Characteristics features

……

……

……

……

(b) Examine the specimens using a hand lens where necessary and explain the differences in structure of each of the following body parts.

i) Limbs

……

……

……

……

ii) Wings

……

……

……

……

(c) State the advantage of the position of the eyes in specimen C

……

……

(d) Remove the wings from specimen D. Draw and label the ventral side of the thoracic and abdominal regions of the specimen. State your magnification.

EXPERIMENT 47

Specimen F, G and H are freshly killed animals. Examine them using a hand lens and answer the questions that follow.

(a) Identify the phylum to which specimen F and G belong, giving reasons for your answer.

(i) Phylum of F……

Reason

……

……

(ii) Phylum of G……

Reasons

……

……

(b) Give the structural differences between specimen F and G

Specimen F	**Specimen G**

(c) Giving reasons suggest the habitat of specimen of;

i) **F**

……

Reason

……

……

ii) **G**

……

Reason

……

……

(d) Give the structural adaptations of specimen F to its habitat

…..……

……

……

(e) Suggest two structural adaptations of G as a vector

……

……

……

……

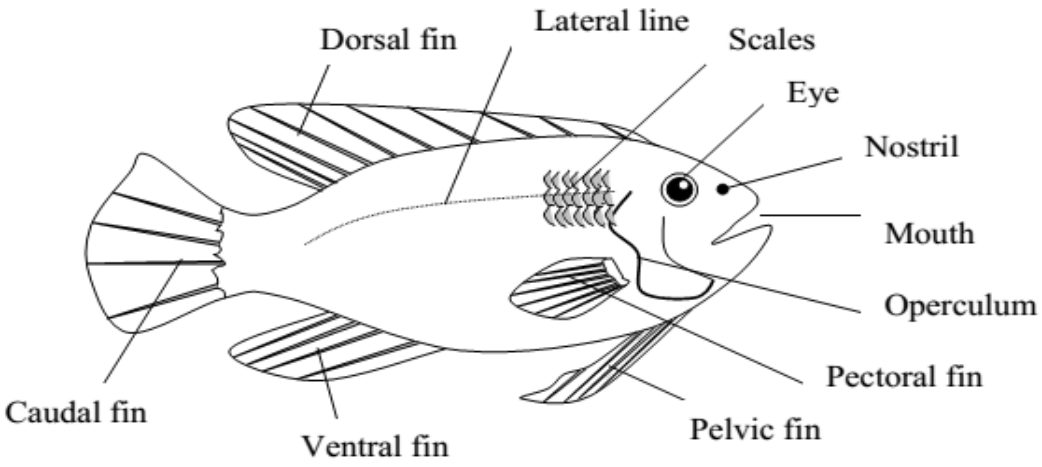
(f) Using a hand lens, study the head region including mouth parts of specimen G, draw and label the interior view. State your magnification.

3.7 FISH

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

- Has stream lined body which enables it to move easily in water.
- Has scales which overlap backwards and the slippery skin, this reduces friction.
- Has fins which enable it to move in water and stop it from rolling.
- Has gills for breathing in water.
- Has lateral line under the skin containing sensory cells which enable it to sense vibrations in water.
- Has a wide mouth to allow water and food to enter easily.
- Has scales that provide protection.
- Has silvery colour below and dark colour above for camouflage.

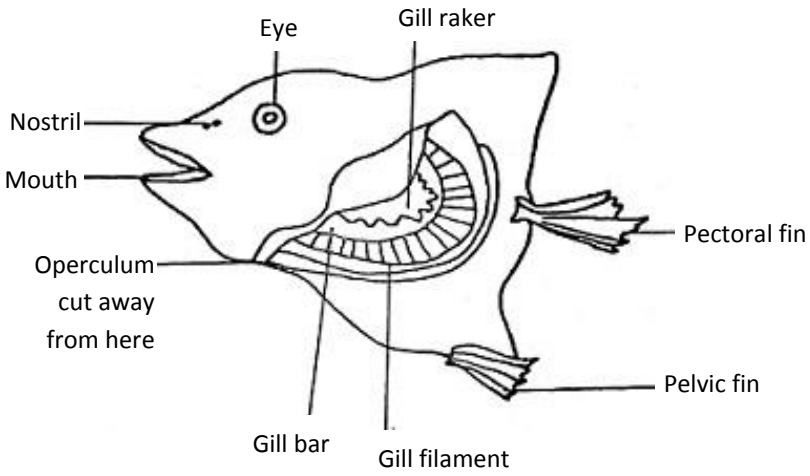
External structure of a fish:



Uses of the structures in fish

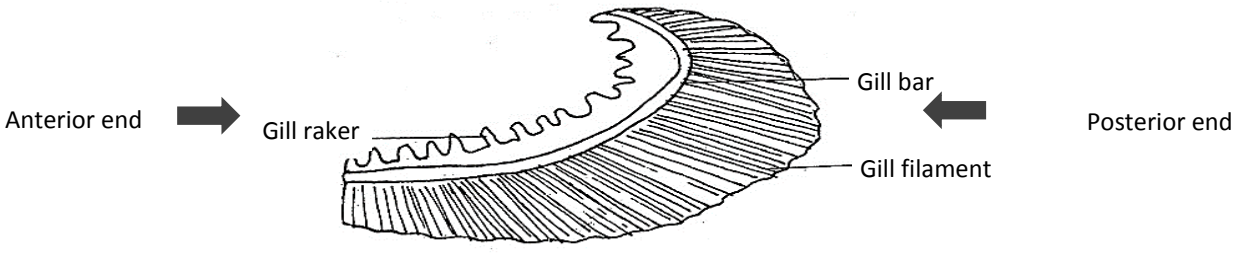
- **(i)** **Mouth:** For taking in food and also for breathing in current of water.
- **(ii)** **Operculum:** For breathing mechanism.
- **(iii)** **Scales:** Overlap each other and give protective covering.
- **(iv)** **Fins:** Give stability and control direction of movement during swimming.
- **(v)** **Dorsal and ventral fins:** Help in providing stability to the fish.
- **(vi)** **Lateral line:** It is to detect changes in water.
- **(vii)** **Caudal fin:** Helps in steering. The tail beats the water on either side.

Drawing of the head region with the operculum away to show gills:



3.7.1 THE GILLS

Drawing of a fish gill:



Functions of the parts

Gill filaments: These are sites for gaseous exchange.

Gill bars: These provides surfaces for attachment of gill filament and rakers.

Gill rakers: These protects gill filaments by filtering out large suspended particles in the water.

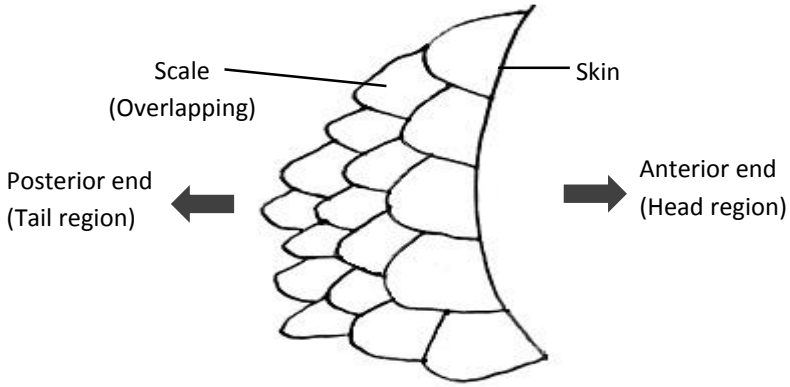
Adaptations of the gills

- Moist for easy diffusion of gases.
- Well supplied with blood capillaries for easy diffusion of air and nutrients.
- Have thin skin for easy diffusion of gases.
- Are numerous to increase surface area for diffusion of gases.

3.7.2 THE SCALES

These are bony plates made in the skin. The scales in the fish are used for protection and scales have overlapping arrangement.

Drawing of scales:



EXPERIMENT 48

You are provided with Specimen **W** which is an animal material, study it carefully and answer questions that follow:

(a)(i) Identify the Specimen

……

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

……

……

(b) (i) State the name of the habitat in which the specimen lives.

……

(ii) Name the features on the body of the specimen which enables it to move easily in the habitat named above.

……

……

……

(c) (i) Study the size, shape and possible movement of each type of fin on the body of the specimen and suggest their use to the specimen during movement (swimming)

……

……

……

(ii) Make well labeled drawings of the specimen fins and state the magnification for each.

(d) With reference to the body surface (skin) of the specimen, briefly describe how it's adapted to its environment.

……

……

……

……

(e) With the left side of the specimen facing you make a well labeled drawing of the head region. State your magnification.

(f) (i) Cut away the operculum to show the gills of the specimen. Examine carefully using a hand lens. Draw and label the structures observed.

(ii) Remove one gill, observe it carefully, draw and label its lateral view.

(iv) State the observed features of the gill that make it suitable for its functions.

……

……

……

(v) State how these features make the gill suitable for its functions

……

……

……

(vi) How is the gill protected in the living organism?

……

……

(vii) State the adaptations of the gills for their functions

……

……

……

(g) (i) Remove one scale observe it under a microscope. Draw and label.

(ii) Remove the scales of one side of the skin of the specimen. Draw and indicate the posterior and anterior ends of your drawing.

(h) Classify the specimen giving reasons according to the taxa below;

(i) Kingdom

……

Reasons

……

……

(ii) Phylum

……

Reasons

……

……

(iii) Class

……

Reasons

……

……

EXPERIMENT 49

Specimens K, L and M are animal skins.

(a) Giving a reason, state the class of the animals from which specimen K and L are obtained.

……

……

……

……

(b) From thee structures of specimens, state two functions of specimens K and L and one function of M.

(i) Functions of K and L.

……

……

(ii) Function of M

……

……

(c) (i) Using a sharp razor blade cut off three strands of hair from the base, from specimen K, measure and record the length of each strand in cm in the table below. Repeat procedure to obtain length of the hair strands from specimen L. Work out the average of the hair from each specimen and record in the table below.

Specimen	1st hair (cm)	2nd hair (cm)	3rd hair (cm)	Average (cm)
K				
L				

(ii) From your observation of specimens K and L and your results in (c) (i) state two structural differences between them.

……

……

……

……

(iii) From the structural differences between specimens K and L suggest the relative size of the animals from which the specimens were obtained.

……

……

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……

(d) (i) Examine specimen M and state two structural adaptations of its function.

……

……

……

……

(ii) Draw and label specimen M indicating on your drawing the direction where the head of the animal would be. State our magnification.

(iii) What is the significance of having the head in the direction you have indicated?

……

……

……

EXPERIMENT 50

You are provided with specimen Y_2

(a) (i) Identify specimen Y_2.

……..

(ii) Give reasons for identity

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……

……

……

(b) (i) suggest the habitat in which the specimen lives

……

……

……

……

(ii) State the features on the specimen which makes it adapted to the habitat.

……

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……

……

(c) Remove one scale from specimen Y_2. Examine, bend and try tearing it.

(i) Describe the structure of the scale

……

……

……

……

(ii) State the functions of the scales to the specimen

……

……

……

……

(iii) How are the scales adapted to the functions?

……

……

……

……

(d) (i) Draw a portion of specimen Y_2 with at least five scales in the space below.

Indicate with an arrow which side of your diagram would be nearest for the head of the organism.

(ii) What is the advantage of this arrangement of scales to the organism?

……

……

(e) Cut off the operculum to show the gills of specimen Y_2. Using a hand lens examine the gills carefully.

(i) State the functions of the gills to the organism.

……

……

(ii) State four ways in which the gills are adapted for the function stated above.

……

……

……

……

(f) Draw a labeled diagram showing a lateral view of the gill. Indicate anterior and posterior ends. State the magnification

(g) State the functions of the parts of the gill.

……

……

……

……

3.8 BONES

3.8.1 VERTEBRAL COLUMN

Vertebral column forms the central support structure for the body. It consists of 33 individual vertebrae, separated by discs of cartilage. The discs allow movements like bending forward, backwards and sideways and act as shock absorbers. The vertebrae are named according to the region of the vertebra where it is found.

In humans, the vertebrae include:

- **Cervical vertebra.**
- **Thoracic vertebra.**
- **Lumbar vertebra.**
- **Sacral vertebra.**
- **Caudal vertebra.**

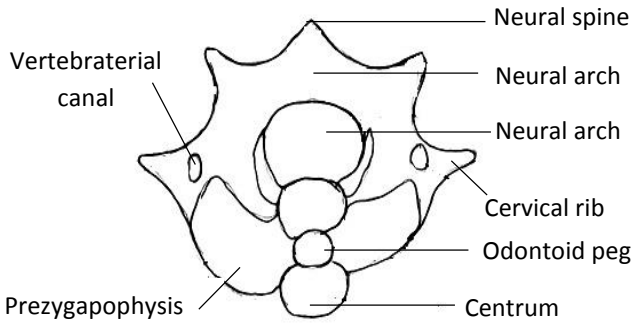
1. Thoracic vertebra

These are found in the thoracic region. There are 12 thoracic vertebrae in the humans and rabbits.

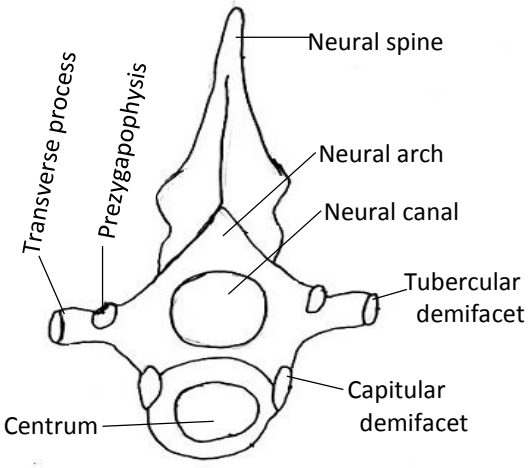
Characteristics of thoracic vertebra

i) Has a long neural spine.
ii) Has a large centrum.
iii) Possess a large neural canal
iv) Has a large neural arch.
v) Has tubercular facet on transverse process.
vi) Has short transverse processes.
vii) Has a pair of articular facets.

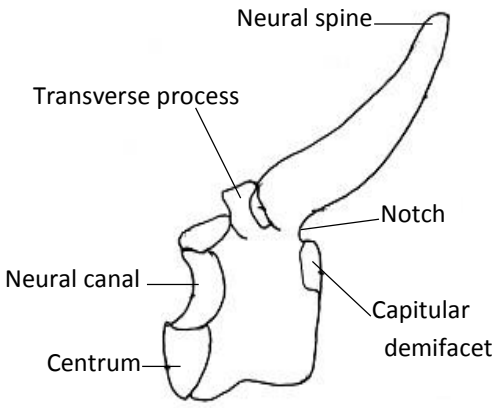
Drawing of anterior view of axis vertebra



Drawing of anterior view of thoracic vertebra:



Drawing of lateral view of thoracic vertebra:



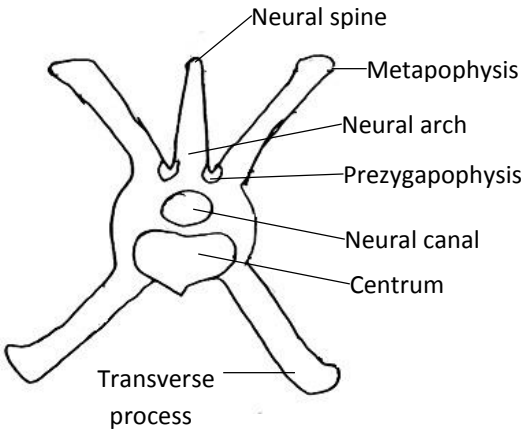
2. Lumbar vertebra

These are found in the abdominal region. There are 5 lumbar vertebrae in man and seven in rabbit. They provide the only support for the trunk in the abdominal region.

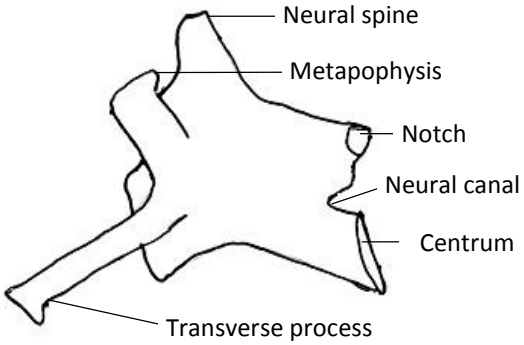
Characteristics of lumbar vertebra

i) Has long transverse processes
ii) Has extra processes called metapophysis.
iii) Has a large centrum than cervical and thoracic vertebra.
iv) Has a broad neural spine.
v) Has a small neural canal.

Drawing of anterior view of lumbar vertebra:



Drawing of lateral view of lumber vertebra:



Differences between thoracic and lumbar vertebrae.

Thoracic vertebra	**Lumbar vertebra**
Has long neural spine	Has short neural canal
Has small centrum	Has large centrum
Has short transverse process	Has long transverse process
Has fewer projections	Has many projections
Has a wide neural spine	Has narrow neural spines
Has no anapophysis	Has anapophysis
Has demifacets	Has no demifacets
Has a narrow neural arch	Has wider neural arch

Similarities between thoracic and lumbar vertebrae.

- Both have neural canal.
- Both have neural spine.
- Both have transverse process.
- Both have arches, facets and centrum.

3. Cervical vertebrae

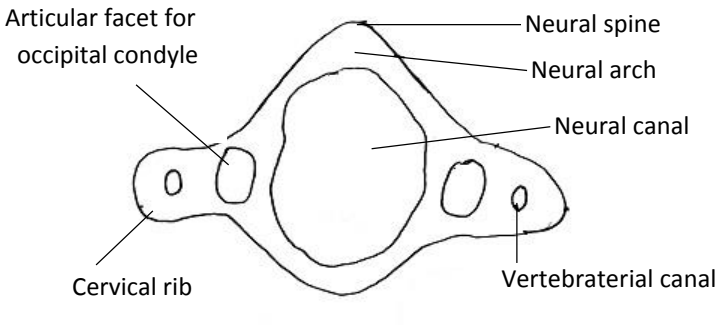
This is found in the neck region. There seven cervical vertebrae in man.

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.

(a) Atlas

This is the first cervical vertebra

Drawing of anterior view of atlas vertebra



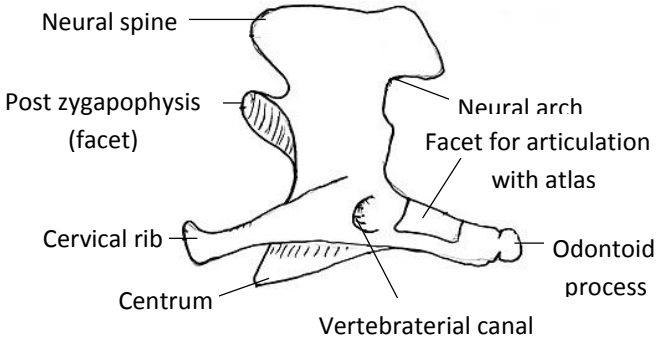
Characteristics of atlas

(i) Has very large neural canal.
(ii) It has no centrum.
(iii) Has flat broad transverse process for muscle.
(iv) Has two large facets.
(v) Has a small ridged neural spine.

(b) Axis vertebra

This is the second vertebra.

Drawing of lateral view of axis vertebra:



Characteristics of axis

(i) Has a relatively smaller neural canal than atlas.
(ii) Has a large flat centrum.
(iii) Has smaller transverse processes.
(iv) It has two facets.

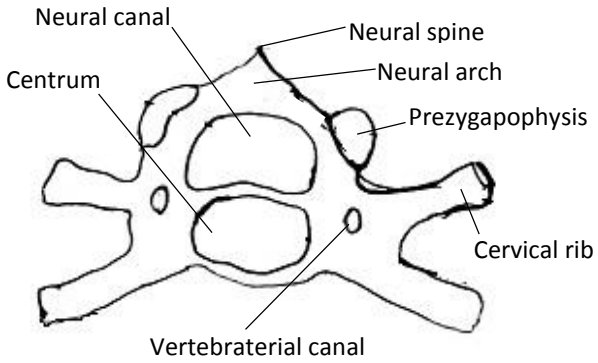
Differences between the atlas and axis vertebrae.

Atlas	Axis
Has no centrum	Has centrum
Has no neural spine	Has neural spine..
Has odontoid fossa	Has odontoid peg.
Has prominent process	Has no prominent process.

Similarities between the atlas and axis vertebrae

i) Both have transverse processes.
ii) Both have vertebraterial canals.

Drawing of anterior view of cervical vertebra



(c) Cervical vertebra

Characteristics of cervical vertebra

i) It has a small neural spine.
ii) Has a large neural canal.
iii) Has a small centrum.
iv) Has transverse processes that form two parts called cervical ribs.
v) Has vertebraterial canals

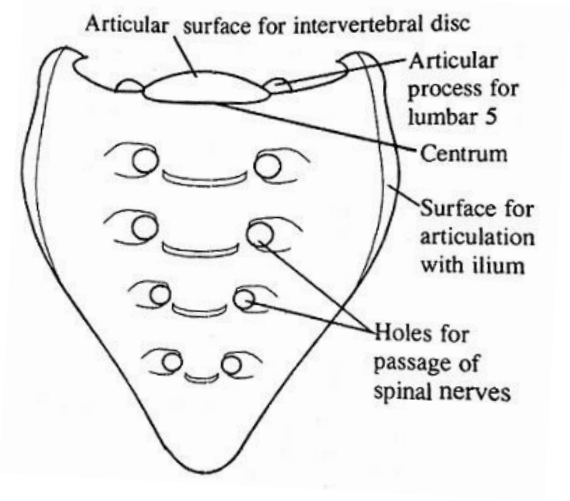
4. Sacral vertebra

These are located in the lower abdomen. They are five in man and four in rabbit. In adult mammals they are fused together to form a rigid body structure called sacrum.

Characteristics of sacral vertebra

(i) Each vertebra has a large centrum
(ii) Has a narrow neural canal.
(iii) Has reduced neural spine.
(iv) First sacral canal has large and wing like transverse processes.

Anterior view of sacral vertebra:



5. Caudal vertebra

These are found in the lower abdomen. There are four vertebrae in man which are fused together to form coccyx which is functionless. In rabbits, there are sixteen.

Characteristics of caudal vertebra

(i) Have no neural arch.
(ii) Have no transverse processes.
(iii) Have no neural canal and spine
(iv) Entire bone consists of centrum only.

Functions of parts of vertebra

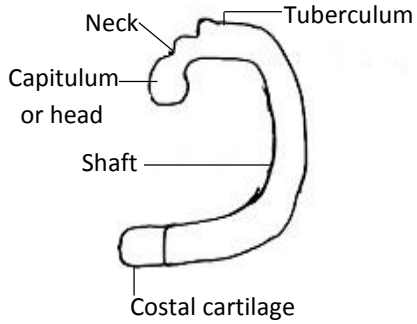
Part	Function
Neural spine	For attachment of muscles
Transverse process	For attachment of muscles and articulation with ribs.
Centrum	For articulation with other vertebrae
Neural canal	For protecting spinal cord
Neural arch	For passage and protection of spinal cord
Vertebraterial canal	For passage of blood vessels of the neck
Facets	For articulation with other vertebrae and ribs in the thoracic vertebrae.

3.8.2 RIB

It is long curved bone which form part of the rib cage.
Characteristcs of a rib

(i) It has costal cartilage.
(ii) It has a neck
(iii) It has a head
(iv) It has shaft which is thin and flat
(v) It has tuberculum.

Drawing of the rib

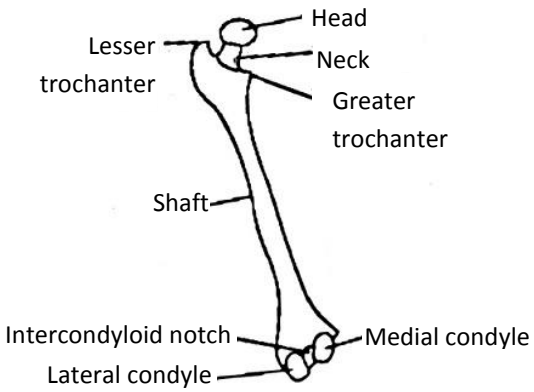


3.8.3 APPENDICULAR SKELETON

This consists of four limbs attached to two bony girdles namely pectoral (shoulder girdle) and pelvic girdle.

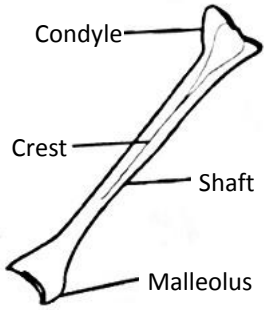
1. **Femur**
   It has a distinct head, which fits into the acetabulum of pelvic girdle to form a hip joint.
   It has trochanter near the head for which provide surface for muscle attachment.
   It has two knobs at the distal end.

Drawing of left Femur (posterior view):



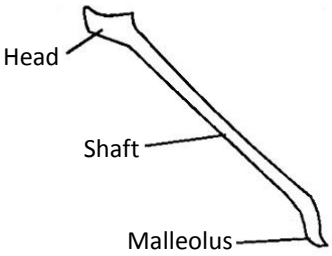
2. **Tibia**
   This is the inner and larger bone in the lower leg, extending from the knee to the ankle.
   It has two grooves into which condyles of the femur fits.

Drawing of left Tibia:



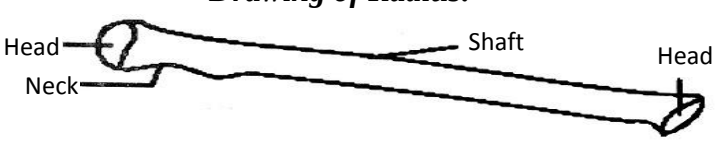
3. **Fibula**
   This is the outer and narrower bones in the human lower leg between the knee and ankle.
   It has unfused proximal end.

Drawing of left Fibula:

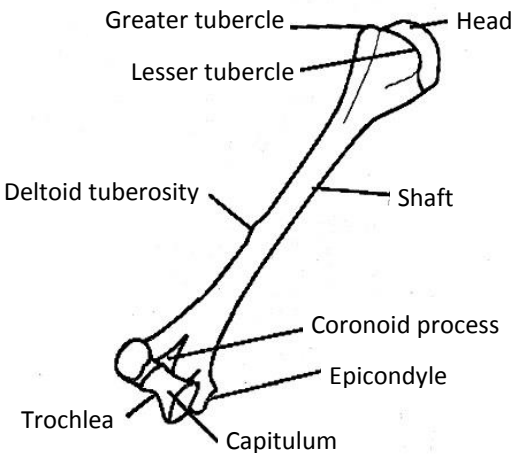


4. **Humerus**
   The upper (proximal) part of humerus ends in a distinct head which fits in glenoid cavity of scapula.
5. **Ulna**
6. **Radius**

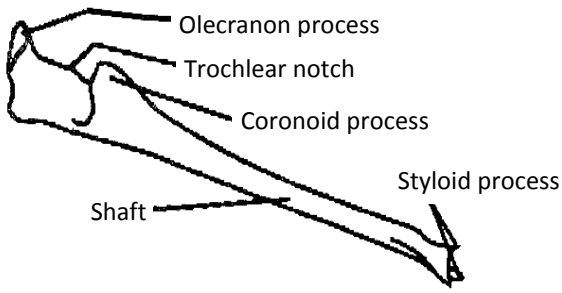
Drawing of Radius:



Drawing of Humerus:



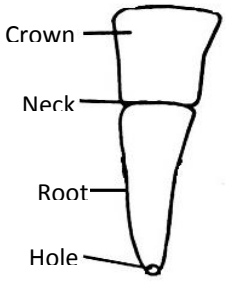
Drawing of Ulna:



3.8.4 TEETH

There are majorly four type of teeth i.e incisors, canines, premolars and molars.

Drawing of Incisor:



1. Incisor

These are front teeth in both upper and lower jaws of humans.

Characteristics of incisor

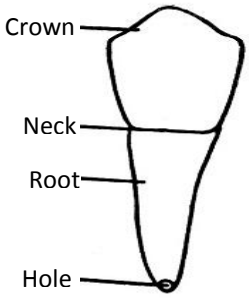
(i) It has a crown which is chisel-like in shape with sharp ridged edges.

(ii) It has one root.

Use

It is used for cutting and biting foo into smaller pieces. It some mammals like cats they are also used for holding prey.

Drawing of Canine:



2. Canine

These are found next to the incisors. They are usually larger than incisors in size.

Characteristics of canine

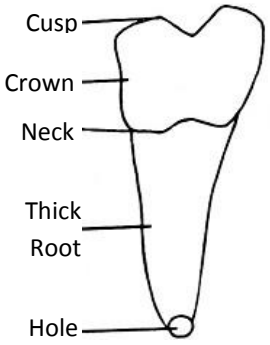
(i) Has a conical and sharp pointed crown.

(ii) It has one root.

Use

It is used for tearing food especially fresh.

Drawing of Premolar:



3. Premolar

It is found behind canine.

Characteristics of premolar

(i) It has a flat crown with a broad surface for grinding of food.

(ii) It has two cusps which enhance grinding of food.

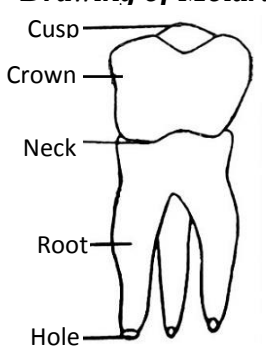
Use

It is used for grinding and chewing food.

4. Molar

It is found in the back of the mouth behind the premolar.

Drawing of Molar:



Characteristics of molar

(i) It has a wide crown top to provide large surface area for grinding and crushing of food.

(ii) It has four cusps to allow grinding and crushing of food.

(iii) It has two or three roots for fixing the tooth firmly in jaw to allow grinding of food.

Use

It is used for grinding and crushing of food.

EXPERIMENT 51

You are provided with specimens **W**, **X** and **Y.** Study them carefully and answer questions that follow.

(a) Identify the specimens

W……

X……

Y……

(b) (i) Give the characteristics of specimen **W**

……

……

(ii) Give 5 differences between **W** and **X**

……

……

……

……

……

(c) (i) Identify 5 parts of specimen **X** and give their functions

……

……

……

……

……

(ii) State the function of specimen **X**

……

(iii) Give 4 differences between **X** and **Y**

……

……

……

……

(d) Make well labeled drawings of the following

(i) Side view of specimen **W**

(ii) Anterior view of **X**

(iii) Posterior view of **X**

(iv) Anterior view of **W**

(v) Posterior view of **W**

(vi) Anterior view of **Y**

(vii) Posterior view of **Y**

EXPERIMENT 52

You are provided with specimens Q1, and Q2 which are from different mammals.

(a) (i) Suggest with reasons the identity of each specimen.

Specimen	Identity	Reason.
Q1		
Q2		

(ii) State at least two observable similarities and two differences between specimen Q1 and Q2

Similarities

……

……

Differences

Q1	Q2
(i)	
(ii)	

(b) (i) With a reason classify the mammals from which specimens Q1 and Q2 were obtained.

Mammal

……

……

Reason

……

……

(ii) For each of the specimens Q1 and Q2, give two adaptations to the feeding habits of the mammals named above.

Q1

……

……

Q2

……

……

(b)Make a large labeled drawing of specimen Q1 (indicate the observable features only)

EXPERIMENT 53

You are provided with specimens **K** and **L** which are from the same mammal.

(a) Identify each specimen.

i) **K**……

ii) **L** ……

(b) Giving a reason in each case, state the part of the body from where each specimen was obtained.

K

……

Reason

……

……

L

……

Reason

……

……

(c) Using observable features, state **two** functions of the specimens.

i) Function

……

……

Observable features

……

……

ii) Function

……

……

Observable feature

……

……

(d) State three structural differences and similarities between specimen **K** and **L**

i) Differences:

K	L

ii) Similarities:

1.……

2.……

3.……

(e) Draw and label specimen **L** in the space below. State your magnification.

EXPERIMENT 54

You are provided with specimens P_2 and Q_2 which are structures from the same animal.

(a) Giving reasons identify the specimens

(i) **P_2**

……

Reasons

……

……

(ii) **Q_2**

……

Reasons

……

……

(b) Giving a reason in each case state the functions of the specimens

(i) Function of P_2

……

……

(ii) Function of Q_2

……

……

(c) Outline the similarities and differences between the specimens

Similarities

……

……

……

……

……

……

Differences between P_2 and Q_2

P_2	**Q_2**

(d) Suggest the diet of the animal from which specimens Q_2 was obtained

……

(e) Make a well labeled drawings of the specimens. State the magnification.

Specimen P_2

Specimen Q_2

EXPERIMENT 55

You provided with specimen R_2 and S_2 which are from the same animal

(a) Identify the specimens and give reasons for the identity

Specimen R_2

……..……..

Reasons

……

……..

Specimen S_2

……..……..

Reasons

……

……..……

(b) Giving a reason in each case, state the part of the body from where each of specimen was obtained.

Specimen R_2

……..……..

Reasons

……

……..……

Specimen S_2

……..

Reasons

……

……

(c) Using observable features state four functions of specimens.

(i) Function ……..

Reason……

……..……

(ii) Function ……..

Reason……

……..……

(iii) Function ……..

Reason……

……..……

(iv) Function ……..

Reason……

……..……

(d) State six structural similarities and five differences between R_2 and S_2

(i) Similarities

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(ii) Differences

R_2	**S_2**

(e) Draw and label the anterior view of the specimens R_2 and S_2. State your magnification.

R_2

S_2

EXPERIMENT 56

You are provided with specimens U and V obtained from the same animal (mammal).

(a) Identify specimens U and V giving reasons in each case.

(i) U

……..……..

Reasons

……

……

(ii) V

……..…….

Reasons

……

……

(b) Giving reasons, suggest the diet of the animal from which specimens U and V were obtained.

Diet……..……..

Reasons

……

……

(c) Using observable features, suggest the function of each specimen to the animal.

(i) Functions of U

……

Observable feature

……

……

(ii) Functions of V

……

Observable feature

……

……

(d) State three structural differences between specimen U and V

Specimen U	Specimen V

(e) Draw and label specimen U in the space below

3.9 FEATHERS

These are structures that cover the entire body structure of the birds.

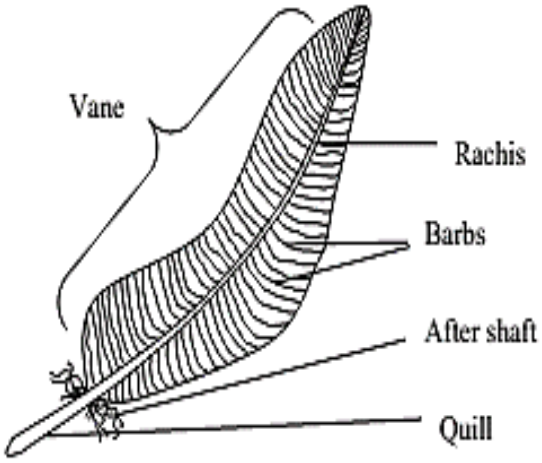
Function of feathers to birds.

(i) They protect the skin from abrasion, rain and direct sunrays.
(ii) They assist in maintenance of body temperature or regulating body temperature by insulating against heat loss.
(iii) They are used in flight
(iv) They are for camouflage to avoid predators.
(v) They are for courtship. Feathers are used to attract the opposite sex in birds.
(vi) They are for sensation, i.e. they collect sound waves

STRUCTURE OF A TYPICAL FEATHER

A typical feather consists of the following parts:-

1. **The shaft**. This is the framework or axis of the feather. The shaft is divided into the quill and rachis.
2. **The quill**. This is a cylindrical structure pointed at the end. It has two openings at its ends called inferior umbilicus and superior umbilicus.
3. **The rachis**. This extends from the superior umbilicus of the quill. It provides attachment of the vanes.
4. **The vane**. This is a feathery flat blade attached to the rachis. It consists of structures called barbs. The barbs have smaller parallel projections called barbules.
   The barbules strengthen the feather by making interlocking connections with each other.



3.9.1 TYPES OF FEATHERS

1. Quill feather/contour feather.

Location: These are found on the tail and wing.

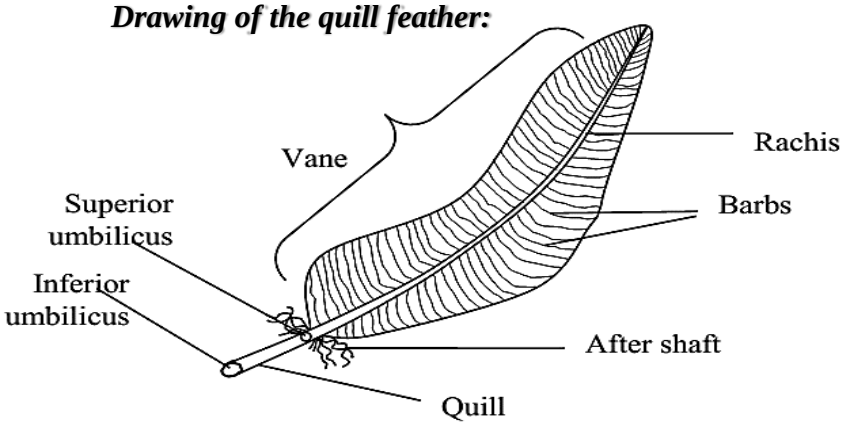
Characteristics

- They have a hard strong hollow quill.
- They have a large vane.
- They have a small after shaft.
- Their vanes consist of barbs and interlocking barbules.
- They have two holes, i.e. the inferior umbilicus and superior umbilicus.
- They have a large and long shaft.

Functions of the quill feathers

(i) They are used in flight.
(ii) They protect the skin of the bird.
(iii) They insulate the bird's body against heat loss.
(iv) They provide an air proof surface effective at breaking against air during flight.

Drawing of the quill feather:



Adaptations to flight

- Has a hollow quill, making it light, thus reducing weight.
- Has a broad vane thus offering a large surface area for beating air
- Has a strong rachis to provide firm attachment for vanes.
- Has a smooth vane to provide a stream lined body which reduces friction during flight.

2. The covert feather

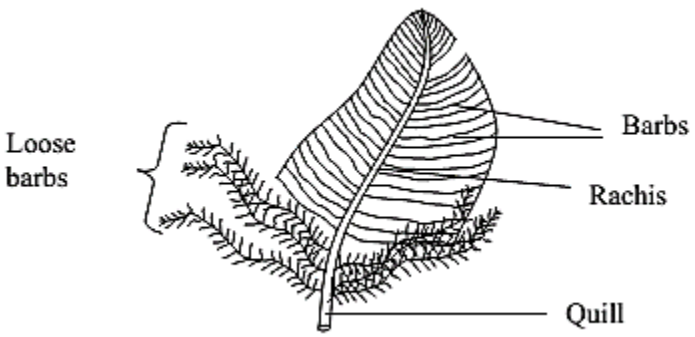
***Location*:** These are found around the neck and the upper side of the body

Characteristics:

- It is smaller than the quill feather.
- It has a large after shaft.
- It has a short vane.
- It has a soft quill.

Function: They help in temperature regulation by covering the body to prevent heat loss. They also give the body shape and colour.

Drawing of the covert feather:



Adaptations to its functions

- Has a curved surface which gives the bird its shape.
- Has a fluffy after shaft to insulate the body.
- Have interlocking barbs and a smooth vane that make the bird water proof.

Similarities between quill and contour feathers

- Both have a quill
- Both have barbs at the base of the rachis
- Both have vanes inter locked by barbs

Differences

Quill feathers	Contour feathers
Has a stiff rachis	Has a flexible rachis
Has a long vane	Has a short vane
Has a long quill	Has a short quill
Barbs closely interlocked	Less interlocked barbs

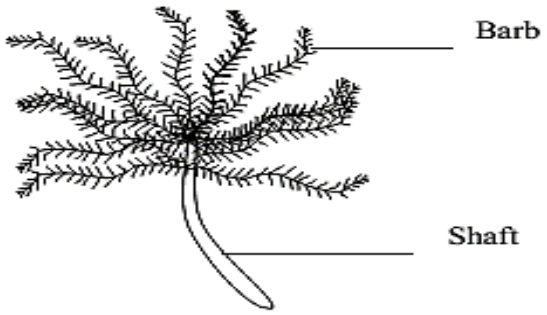
3. Down feathers

***Location*:** These are found all over the body especially on the abdomen and between covert and flight feathers.

Characteristics:

- It is smaller than the quill and covert feathers.
- It is soft and fluffy.
- It has a short and small quill.
- It has no vane but instead it has free barbs.

Structure of the down feather



Function: It insulates the body against heat loss.

4. Filo plumes

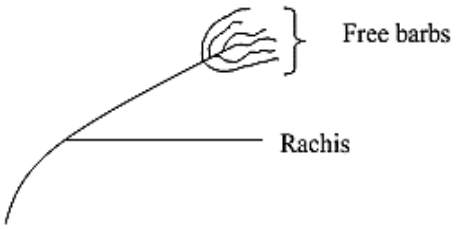
***Location*:** These are found sparsely distributed all over the body amongst other feathers.

Characteristics:

- They are long and hair-like feathers.
- They have a long rachis.
- They have a thread-like shape.
- They have few free barbs at one end

Function. These feathers are for sensation.

Structure of the filoplume



EXPERIMENT 57

You are provided with specimens **P** and **Q**. Study them carefully and answer questions below.

(a) (i) Identify each of the specimens; state the function and its location on the organism.

Specimen	Identity	Function	Location
P			
Q			

(ii) List four observable features of specimen **P** that make it suitable for its functions.

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(iii) (i) Take specimen **Q** between your fingers; brush it towards its base. State your observation

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(ii) Brush specimen **Q** towards its tip. State your observation.

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(iv)(i) Name the possible functions of the broad flat part of specimen **Q**.

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(ii) Give the function of the last part near the base of specimen **Q**.

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(v) (i) Using a hand lens, study specimen **Q** carefully, draw and label. State your magnification.

(ii) Explain your observation when you look at the vane through the lens.

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(vi) Outline the adaptations of specimen **Q** to its functions.

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(vii) State 4 differences and 3 similarities between **P** and **Q.**

Differences

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Similarities

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(viii) How is the organism from which P and Q were obtained is adapted for fligh?

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EXPERIMENT 58

You are provided with specimens R, S and T which are animal structures.

(a) Examine the specimens and describe the structure of each of them.

(i) R

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(ii) S

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(iii)T

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(b) Explain how the structure of each specimen described in (a) suits its functions.

R

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S

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T

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(c) In the space below draw and label specimen S. state your magnification.

EXPERIMENT 59

You are provided with specimens T_2, U_2 and V_2 obtained from the same animal.

Carefully study them and answer questions that follows.

(a) Identify each of the specimens

T_2 ……..

U_2 ……..

V_2 ……..

(b) State the phylum and the class of the animal from which these specimens were obtained.

Phylum ……

Class ……

(c) Where would you find each of the specimens on the organism from which they were obtained?

T_2 ……..

U_2 ……..

V_2 ……..

(d) Give five structural differences and three similarities between specimen T_2 and U_2.

Differences

Specimen T_2	Specimen U_2

Similarities

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(e) Give five functions of the specimens to the organisms from which they were obtained.

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(f) Make a well labeled diagram of specimen T_2. State the magnification.

CHAPTER FOUR

4.0 SOIL

Experiments can be based on: - water retention by the soil, capillarity of soils, determining soil texture and sedimentation of soil particles.

EXPERIMENT 60

You are provided with soil samples A_3, B_3 and C_3 put $100cm^3$ of soil sample A_3 into a measuring cylinder.

- Measure $100cm^3$ of water and add to the soil in the cylinder.
- Stir the mixture with a glass rod and leave it to settle.
- Read and record the volume of the resulting mixture in the table below.
- Repeat the experiment with samples B_3 and C_3.

	Soil sample		
	A_3	B_3	C_3
Volume of soil(cm^3)			
Volume of water(cm^3)			
Volume of mixture(cm^3)			

(a) From the table calculate

(i) The volume of air in

Sample A_3

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Sample B_3

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Sample C_3

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(ii) The percentage of air in

Sample A_3

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Sample B_3

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Sample C_3

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(b) From your results in a (a) state the identity of the three soil samples

A_3……

B_3……

C_3……

(c) (i) Plug a funnel with cotton wool. Measure 100cm^3 of sample A_3 and carefully pour it into the funnel.

- Place the funnel on a measuring cylinder and add 100cm^3 of water onto the soil sample.
- Start a time clock when the first drop appears out of the funnel.
- After five minutes remove the funnel, read and record the volume of water collected in the space below
- Repeat the experiment with soil samples B_3 and C_3

Soil sample	Volume of water after 5 minutes
A_3	
B_3	
C_3	

(ii) From your results in (c) (i), calculate the percentage of water retained by each soil sample.

A_3

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B_3

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C_3

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(d) (i) From your results which of the three soil samples is best for farming?

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(ii) Give two reasons for your answer

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EXPERIMENT 61

You are provided with soil samples A, B and C. Carry out the following tests and answer the questions that follow.

(a) Put 50cm^3 of each of the soil samples separately in the measuring cylinders provided and shake gently until it is properly leveled. Add 50cm^3 of water and record the initial volume of soil, total volume of water and soil and the final volume of water and soil.

Soil sample A:

Volume of soil, V_1 ……..…..cm^3

Total volume of soil and water, V_2 added ……cm^3

Final volume of soil and water, V_3 after 3 minutes……...…cm^3

Calculate the percentage of air in soil sample A

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Soil sample B:

Volume of soil, V_1……..….. cm^3

Total volume of soil and water, V_2 added ……cm^3

Final volume of soil and water, V_3 after 3 minutes……...…cm^3

Calculate the percentage of air in soil sample A

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Soil sample C:

Volume of soil, V_1 ……..….. cm^3

Total volume of soil and water, V_2 added ……cm^3

Final volume of soil and water, V_3 after 3 minutes……...…cm^3

Calculate the percentage of air in soil sample A

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