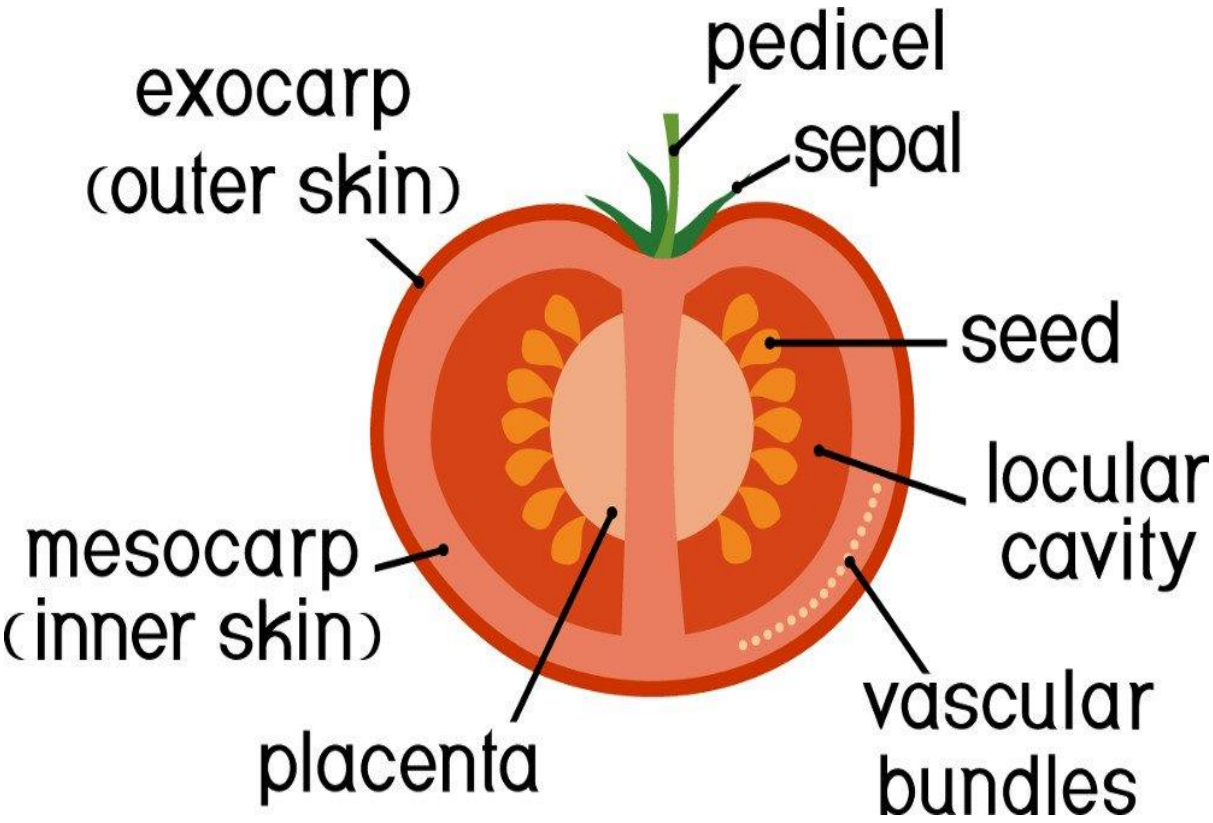
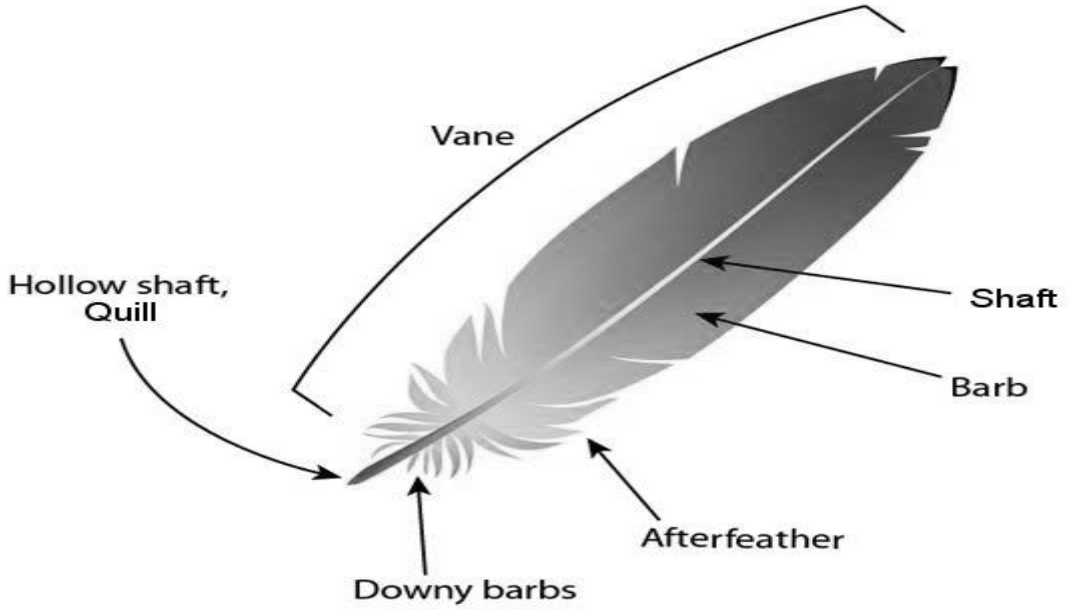
SENIOR SECONDARY BIOLOGY NOTES

(new curriculum)

WITH FOCUS ON PAPER II

(SPECIMENS AND MODEL ESSAYS)





CHRISTOPHER Z.M. KANYIMBO

BIOLOGICAL DRAWINGS AND MAGNIFICATION

Drawing Apparatus and Biological Diagrams

Drawing is one way of describing organisms or their parts and apparatus used in experiments

Characteristics of Good Drawings

- They should be large enough
- They should be accurate
- They should be neat. Do not shade unless you are told
- They are drawn to scale
- Labelling lines should not cross each other and do not use arrows
- They are drawn using free hand not a ruler
- They are drawn in pencil

Student Activity: Drawing a Leaf

Collect a leaf from a plant such as mango, guava, bean or avocado pear and do the following:

1. Draw a large neat diagram of the leaf and label the following parts: petiole, mid rib, leaf margin, lamina and apex.
2. Measure and record the length of your
   a. Specimen (actual leaf)
   b. Drawing
3. Calculate the magnification of your drawing

Magnification = $\frac{size\ of\ drawing}{size\ of\ specimen}$

Example 1

Calculate the magnification of an object which is 12 cm long and its diagram or image is 60cm long.

Solution

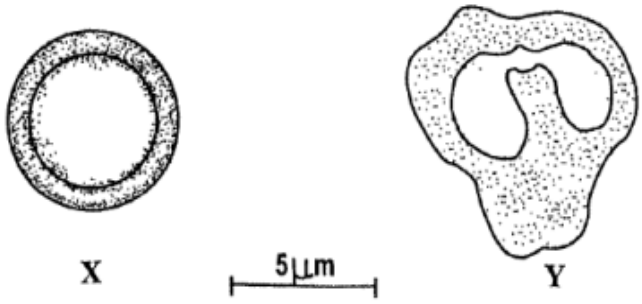
Magnification = $\frac{size\ of\ drawing}{size\ of\ specimen}$

$= \frac{60cm}{12cm}$

= x5

Example 2

The figure below shows blood cells labelled X and Y.



Using the scale given calculate the actual size of cell labelled **X**

Actual size= $\frac{\textbf{length of diagram}}{\textbf{measured lenght of scale}}$ **x given scale**

Length of diagram(longest axis) is 24 mm (2.4cm) and measured length of scale is 20mm (2 cm) and the actual scale given is 5µm (micrometres).

Substitutions and calculation of actual size

$= \frac{\mathbf{24\ mm}}{\mathbf{20mm}}\ \boldsymbol{x}\ \mathbf{5}\mu\boldsymbol{m}$

= 1.2 x 5µm

= 6µm

Therefore, the actual size of cell X is **6µm** (six micrometers)

SEEDS

Beans, maize, sorghum

characteristic	Beans (Phaseolus vulgaris)	Maize (Zea mays)	Sorghum (Sorghum bicolor)	Groundnut (Arachis hypogea)	Soya beans (Glycine max)	Rice (Oryza glaberrima)
Group of plants	Flowering	Flowering	Flowering	Flowering	flowering	flowering
Group of flowering	Dicot	monocot	Monocot	Dicot	dicot	monocot
Root system	Tap root	Fibrous	Fibrous	Tap	Tap	fibrous
Venation	Reticulate	Parallel	Parallel	Reticulate	Reticulate	parallel
Nutritive value	Protein Fibre Calcium Phosphorous Carbohydrates Magnesium	Starch Fibre Protein Magnesium Zinc Copper Vitamin B	Starch Dietary fibre Vitamin B	Lipids Protein Dietary fibre Vitamin B Vitamin C Vitamin E Minerals such calcium, iron, zinc, phosphorous	Lipids Proteins Vitamins B, C,E and K Minerals such as calcium, copper, iron, magnesium and zinc	Starch Dietary fibre Vitamins B,E,K, E,C Minerals such as calcium, iron, magnesium, copper, sodium

Bean Seed/soya/g/nut (legume)

External parts **internal parts**

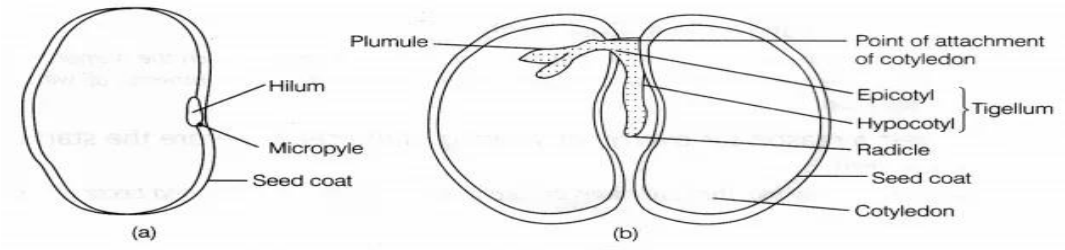


Fig. 2 Bean seed (a) Lateral view of whole seed (b) A mature embryo with its parts

Seed coat-protects inner parts of the seed

Micropyle-a hole closer to the hilum that allows air to enter for respiration of embryo.

Hilum-scar that marks point of attachment to the pod

Embryo-part of the seed that develops into a new plant. It consists mainly of the plumule (shoot) and radicle (root).

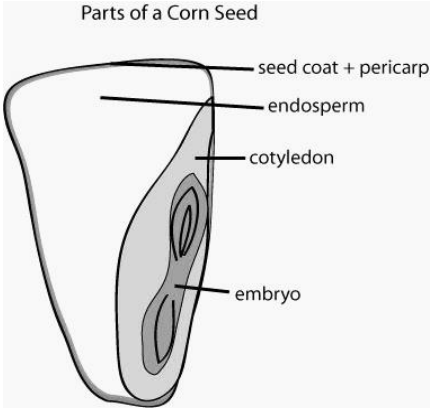
Plumule-develops into a shoot and produces first true leaves.

Radicle – it is an embryonic root. It develops into a root.

Cotyledon-also called seed leaf. It stores food for the developing embryo

Hypocotyl-develops into a stem

Maize/sorghum/rice seed (cereal seed)



Seedcoat+pericarp-protects the inner parts of the seed

Endosperm-stores food for the embryo

Embryo-develops into a new plant

Coleorhiza-a sheath that covers the radicle. It protects the radicle.

Scutellum- it is regarded as a cotyledon in monocots.

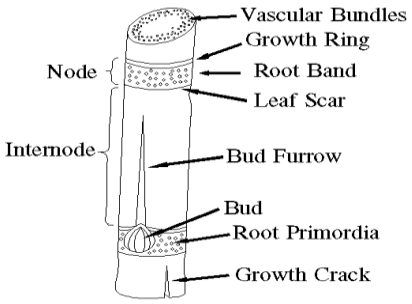
Reeds

- It grows in soils saturated with moisture
- They are monocots
- Its perennial
- Has rhizomes
- Both vegetative and sexual reproduction
- Used to make mats, fences, baskets
- Stems are hollow and cannot store water for the plant
- Are an invasive species that affects growth of other vegetation
- Cannot survive in dry habitats
- Parallel venation

Sisal

- Mostly found in savannah woodlands
- Stems and leaves are fleshy and can store water for use in dry season
- Leaves are thick and fleshy
- Reproduces vegetatively by suckers
- Fibrous root system
- Sisal fibre is used to make ropes, mats,baskets,etc.
- Are an invasive species that affects growth of other vegetation
- Can survive in arid or dry habitats
- Monocot
- Parallel venation

Sugarcane

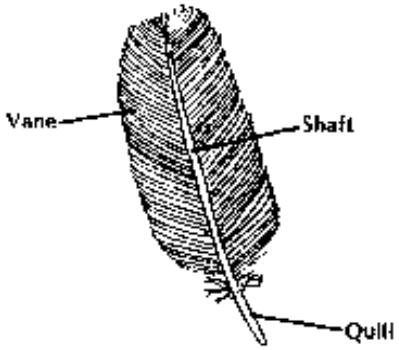


- It is a monocot
- Has parallel venation
- Fibrous root system
- Can be propagated using cuttings (vegetative propagation)
- Can also be propagated using seeds
- Has succulent stems that store water to survive dry spells
- Sugarcane contains the following nutrients: sucrose, dietary fibre, vitamin B_6 , Vitamin C, Vitamin $B_{9,}$ iron, calcium, phosphorous, magnesium
- Products from sugarcane include sugar, bagasse which can be used as animal feed and ethanol.

Cassava

- It's a perennial plant. It is drought resistant because it stores water in root tubers
- Nutrients include fibres, vitamins C and B1, minerals manganese and potassium, there is also starch
- Dicot
- Tap root system
- Digitate or palmate leaf arrangement
- Reticulate venation
- Produces seeds that are not viable
- Vegetative propagation

Flight feather



Function

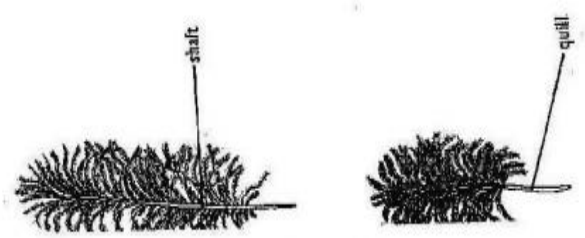
- Helps the bird in flying

Adaptations for flying

- It is light
- It has strong quill and shaft
- Closed vane that does allow air to pass through
- Broad and flat to create large surface are for creation of lift.

NB: birds and fish face resistance to movement in air or water. This resistance is called drag. Drag is caused by water/air resistance and turbulence. Common adaptation to reduce drag is streamlined shape of their bodies.

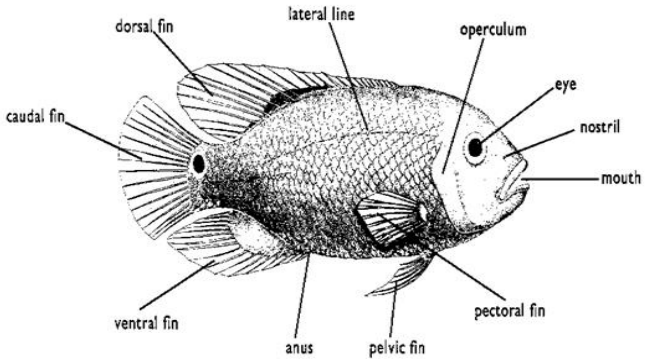
Down Feathers



Down feathers

These are fluffy feathers that cover the body of the body. Their function is to keep the bird warm.

Fish



- **Caudal fin (tail fin)-**causes propulsion (forward movement)
- **Dorsal and ventral fins**-control rolling of fish and yawing. They help the fish to be stable.
- **Swim bladder**-helps in buoyancy of the fish. When filled with air the fish becomes lighter and floats. When emptied the fish becomes denser and sinks downwards.
- **Scales**-reduce drag by producing a slimy substance (slime) and overlapping backwards.
- **Pectoral and pelvic fins**-they are used as brakes by the fish. Are also used to change direction of movement of the fish
- **Gill**s- these are structures used for exchange of gases or breathing in fish.
- **Lateral line**-a system of sensory organs used to detect movements or vibrations in water.

Characteristics of fish

- Their bodies are covered in scales
- They have fins for movement
- They have gills for gaseous exchange
- They are oviparous-they lay eggs
- They have external fertilization
- Fish are cold-blooded animals-ectothermic (their body temperature changes with that of their environment)

Nutrients found in fish

- Proteins
- Lipids
- Minerals such as calcium, magnesium and potassium
- Vitamins such as B_3 and vitamin D

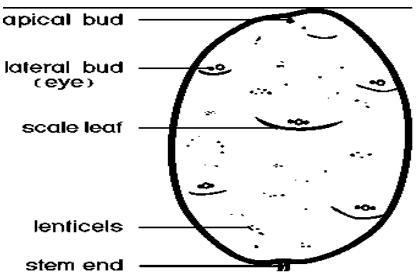
Fish face resistance when moving in water. This resistance to movement is called drag. Drag is caused by:

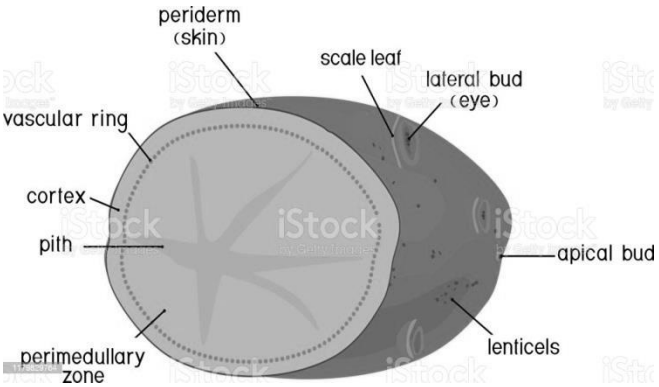
- Friction between water and the fish
- Turbulence (sucking force of water)

Adaptations of fish to overcome drag

- It has a streamlined shape that enables fish to cut through water easily
- It has scales overlapping backwards. This reduces water resistance to movement of fish
- It is covered in slime or mucus which makes the fish slippery and reduces friction with water.

Irish Potato

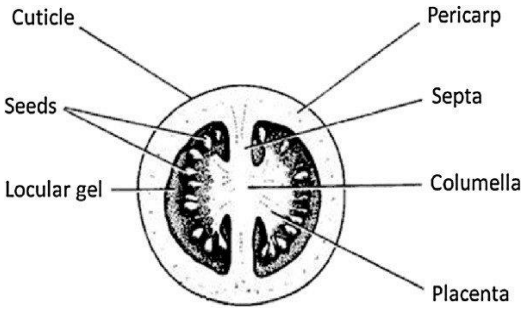




- Flowering plant (dicot)

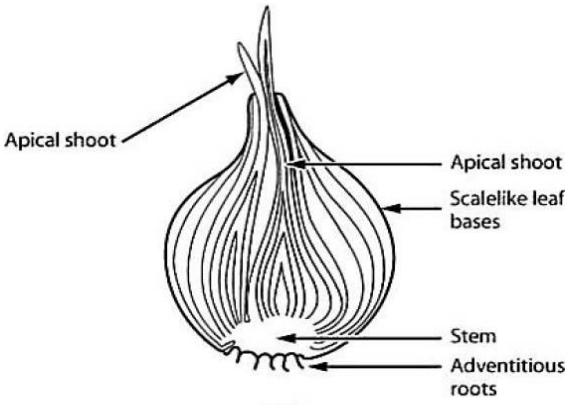
- Scientific name is Solanum tuberosum
- Reticulate venation
- Tap root system.
- Food nutrients (water, carbohydrates, vitamin B_6, Vitamin, dietary fibre, calcium, potassium, copper)

Tomato



- Flowering (dicot)
- Scientific name is Solanum lycopersicum
- Nutrients (dietary fibre, Vitamins A,B, C,E and K, carbohydrates, magnesium, potassium , phosphorous,water)
- Reticulate venation
- Tap root system

Onion bulb



- Has underground stem
- Has fibrous/adventitious root system
- Has fleshy and succulent leaves that store water hence can survive dry conditions
- Scientific name is ***Allium cepa***
- Contains the following nutrients: dietary fibre, water, Vitamin B1, B2, B3,vitamin C. Onions also contain the following minerals: calcium, iron, manganese, zinc, magnesium and phosphorous.
- It is a flowering plant

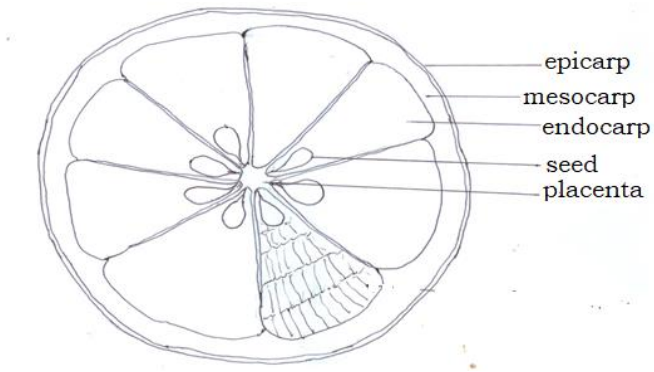
Citrus fruit (lemon, orange, tangerine)

- Scientific name for lemon is ***Citrus limon***
- Scientific name for orange is ***Citrus sinensis***
- Scientific name for tangerine is **Citrus tangerine**

Facts about citrus fruits

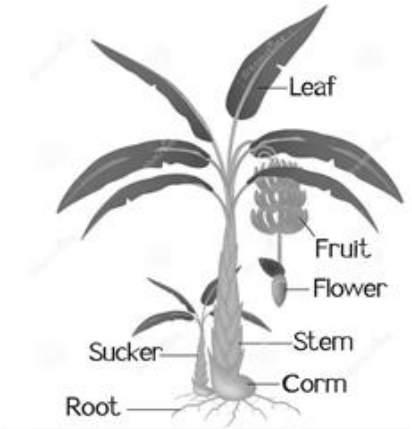
- Belong to flowering plants
- Are dicots
- Have reticulate venation
- Contain citric acid
- Have tap root system
- They contain the following nutrients: dietary fibre, vitamin C, Vitamin B(1,2,3,5,6, 9), calcium, iron, magnesium, manganese.

Cross-section of a citrus fruit



NB: when juice extracted from a citrus fruit is added to fresh milk the milk coagulates or thickens or solidifies due to the citric acid in the juice.

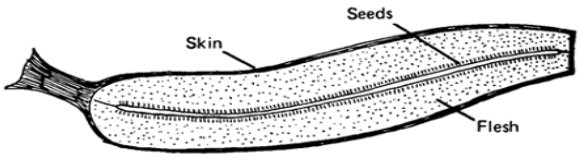
Banana



- Common scientific name is ***Musa paradisiaca***
- It is a flowering plant
- It is a monocot
- It is propagated vegetatively
- It is rich in carbohydrates such as starch
- Provides dietary fibre
- It provides vitamins such as B_1, B_2, B_9 and C

- It contains minerals such as iron, manganese, magnesium, zinc, potassium.
- It is used as food and also in wine making
- Its underground stem is called a corm

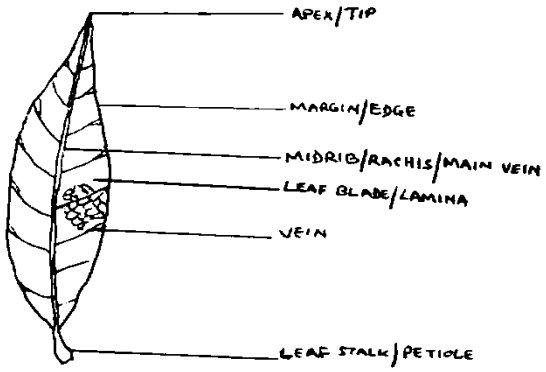
The structure of banana fruit



Grass (such as stargrass and elephant grass)

- Grasses belong to flowering plants
- They are monocots
- They have fibrous root system
- They have parallel venation
- Their leaves are narrow

Leaf



Functions of a leaf

- It manufactures food for the plant
- It acts a storage organ for the plant
- It acts as a site for exchange of gases

Adaptations of the leaf for photosynthesis

- It has stomata for that help in exchange of gases
- Has chlorophyll for absorbing light energy needed for photosynthesis
- It is broad to trap as much light as possible for photosynthesis
- It has a network of veins to transport water to leaf and transport food manufactured by the leaf

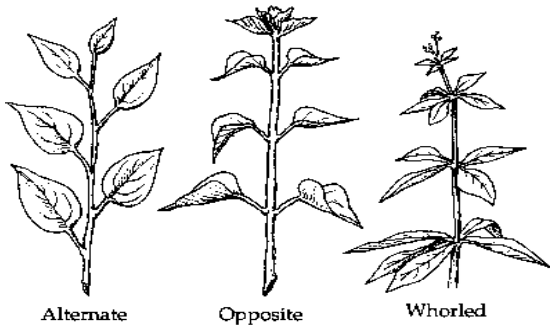
Adaptations of the leaf for exchange of gases

- It has stomata that facilitate exchange of gases
- It is has thin lamina which helps faster diffusion of gases
- It is broad which increases surface area for exchange of gases
- It has air spaces in the spongy mesophyll that facilitate exchange of gases.

TYPES OF LEAVES

Leaves can be described in various ways. They can be described in terms of attachment, venation and form.

Leaf Attachment



This the way leaves are attached to the stem.

Alternate attachment: this is the leaf attachment when one leaf appears at a node.

Opposite attachment: this is leaf attachment when there are two leaves at a node.

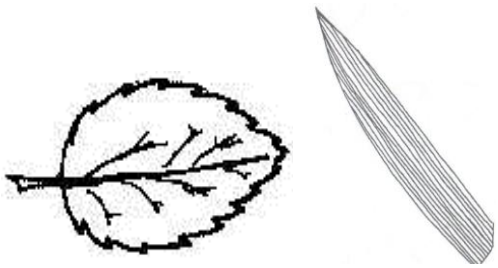
Whorled attachment: this is leaf attachment when there are more than two leaves at a node.

In monocotyledonous plants the leaves do not have petioles like typical dicotyledonous leaves. Instead the leaves consist of sheath and blade. The sheath connects the leaf to the stem by completely surrounding the stem.

Leaf form

A leaf can be simple or compound based on form

Simple leaf



A simple leaf is a leaf that has a single leaf blade and leaf stalk. Examples of simple leaves are mango, guava and hibiscus leaves.

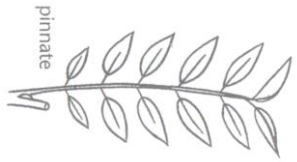
Leaf forms

Leaves also differ in form. There are two main forms: simple leaves and compound leaves.

a. Compound Leaf

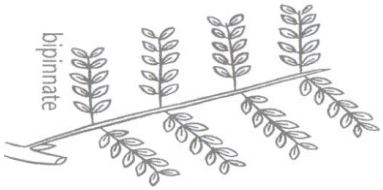
A compound leaf is a leaf whose leaf blade is divided is divided into several leaflets. Compound leaves can show different leaf arrangements. The arrangements include pinnate, bipinnate, digitate and trifoliate.

i. Pinnate Leaf Arrangement



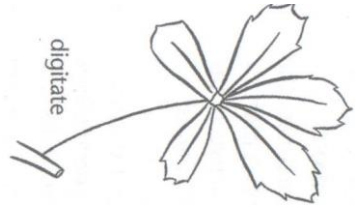
A pinnate leaf has leaflets which are arranged in pairs opposite each other along the leaf stalk. Examples of plants with pinnate arrangement are cassia and cendrella.

ii. Bipinnate Leaf Arrangement



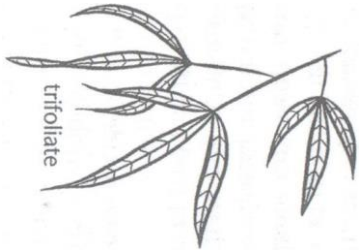
A bipinnate leaf has pinnate leaflets arranged opposite each other along the main leafstalk. Jacaranda is an example of a plant with bipinnate leaf arrangement.

iii. Digitate Leaf Arrangement



A digitate leaf has leaflets which radiate out from the end of a leafstalk like the fingers of a hand. An example of plant with digitate arrangement is cassava.

iv. Trifoliate Leaf Arrangement

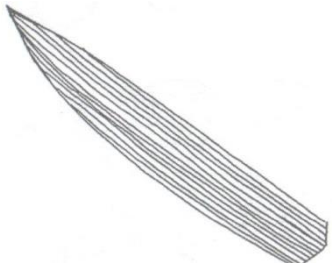


A trifoliate leaf consists of three leaflets such as in bean plants.

Leaf venation

Venation is the arrangement of veins and vein lets in the lamina of the leaves. There are two types of venation:

a. Parallel venation



This is type of venation where veins run parallel to each other within a lamina. All monocots like maize, millet and all grasses have parallel venation.

b. Reticulate or network venation

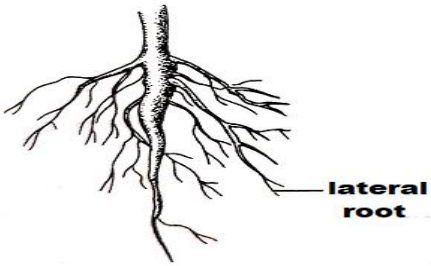
This is the type of venation where veins form a network. All dicots like beans and groundnuts have reticulate venation.

ROOT SYSTEM

There two main types of root system in flowering plants:

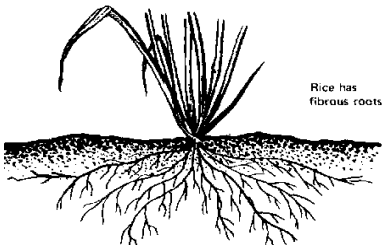
- Tap root system
- Fibrous root system

Tap Root System



In tap root system there is a clearly identifiable main root. Secondary roots develop from the primary roots. Tap roots are associated with dicotyledonous plants.

Fibrous Root System



This root system does not have a main root. All roots develop from the base of the stem. All monocots have a fibrous root system.

OSMOSIS

Plant tissues are used to investigate osmosis. When plant cells are placed in distilled water they gain water by osmosis. When the cells are placed in concentrated solution they lose water to the concentrated solution by osmosis. Potato strips are usually to investigate osmosis.

Concentration (%)	Length of potato strip before putting in solution	Length after 10 minutes in solution	flexibility
0	20mm	23mm	Rigid. Not flexible (difficult to bend)
25	20mm	19mm	Flexible(easy to bend)
50	20mm	15mm	Very flexible

When potato strips are put in distilled water (0% concentration), the strips absorb water and become rigid and gain length.

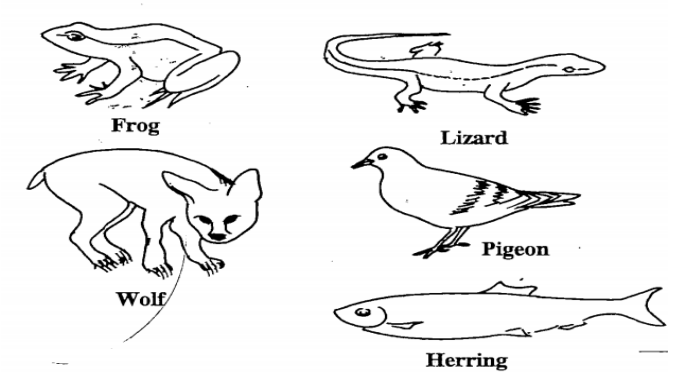
When strips are put in a salt solution the cells in the strips lose water. The strips lose length and flexible. The cells become flaccid hence they are easy to bend

DICHOTOMOUS KEY

- It is a biological key used for identifying organism
- It is arranged in steps made up of a pair of statements that are numbered using Arabic numerals e.g. 1, 2, 3, etc.
- It divides organisms into groups depending on whether they have or do not have certain features in common.

Example 1

The figure below is a diagram of five animals. Use it to construct a dichotomous key that can be used to identify the animals.



Solution

1. Has legs ……. See 2
Has no legs……. Herring

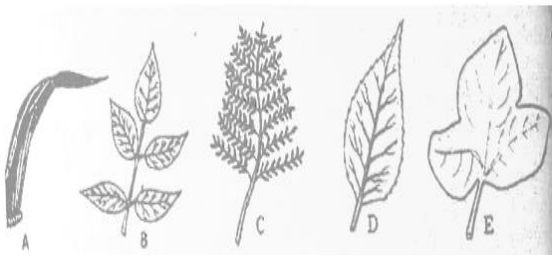
2. Has tail……. See 3
Has no tail…… See 4

3. Has visible ears…….. Wolf
Has no visible ears….. Lizard

4. Has beak…….. Pigeon
Has no beak…….…. Frog

Example 2

Study the leaves drawn below. Construct a dichotomous key to identify the leaves.



1. With simple leave…….. See 2
With compound leave…….see 4

2. With parallel venation..…… A
With reticulate venation…. See 3

3. With serated margins…….. D
With divided margins…….. E

4. Pinnate leaf…….. B
Bipinnate leaf…….. C

FOOD TESTS

A. TEST FOR STARCH

Crush the foodstuffs to form fine particles. Put the crushed particles in test tube and add water to dissolve. Add few drops of iodine.Dark blue colour indicate presence of starch and brown colour indicates absence of starch in the foodstuff.

B. PROTEIN TEST (BIURET'S TEST)

Crush the foodstuff to form fine particles and place the crushed food in a test tube. Add water to dissolve the food nutrients. Add 5ml of sodium hydroxide to the food solution. Then add 5ml of copper sulphate solution to the mixture. A purple colour shows that protein is present.

C. TEST FOR REDUCING SUGARS

Crush the foodstuffs to form fine particles and place the crushed foodstuffs in a test tube. Add some water to dissolve the food. Add 2-3 drops of Benedict's solution to the food solution. Heat the mixture for some time.

Brick red colour indicates presence of reducing sugars

D. TEST FOR NON-REDUCING SUGARS

Crush the foodstuff to be tested into fine particles and place in a test tube. Add some water to dissolve the food. Add 3ml of hydrochloric acid. Add 3ml of sodium hydroxide. Add 2-3 drops of Benedict's solution. Heat the mixture for some time. Brick red colour shows presence of non-reducing sugars

E. TEST FOR LIPIDS

Smear or rub the foodstuff on a clean piece of plain paper and wait. If translucent spot appears then lipids are present

OR

Ethanol Test (Emulsion Test)

Chop the food into small pieces. Mix the chopped food with a little ethanol in the test tube. Put some water into another test tube. Pour a little of the ethanol from the first test tube into the water. Observe the results. If the liquid stays clear then there is no lipid. If the water goes cloudy white then there is lipid in the food.

F. TESTING FOR VITAMIN C

Put 1 cm^3 of DCPIP solution in a test tube. Cut the lemon into two and squeeze the juice into a smaller beaker. Using a dropper slowly add drops of the lemon juice into the DCPIP solution. Observe the results. The DCPIP solution becomes colourless or remains dark blue. If the DCPIP solution becomes colourless then it means lemon juice contains vitamin C. If it remains dark blue it means lemon juice does not contain vitamin C.

MODEL ESSAYS (PAPER II)

1. **Describe an investigation that you can carry out to show that light is necessary for photosynthesis. In your essay include procedure, expected results and conclusion.**

Take a potted plant and put it in the dark for 24 hours to destarch it. Pluck one leaf and test it for starch to make sure the plant has been destarched. Cover part of both sides of the leaf using black sello tape or aluminium foil.

Leave the plant in the sun for about 5 hours. Pluck the leaf and remove the aluminium foil and test the leaf for starch.

Areas which received light turn blue-black with iodine to show that photosynthesis took place in those parts since cells receive light. The part which was covered is brown to show that photosynthesis did not take place since light is unable to the cells in the covered parts.

The results indicate that light necessary for photosynthesis.

2. **Describe an investigation you can carry out to show that carbon dioxide is necessary for photosynthesis**

Leave the plant in the dark for 24 hours. Choose two leaves on the plant. Put one leaf in a flask containing potassium hydroxide solution. Potassium hydroxide solution absorbs or removes carbon dioxide. Leave the leaf attached to the plant.

Put another leaf in a flask containing sodium bicarbonate solution. Sodium bicarbonate produces extra carbon dioxide. Place the plant in sunlight for 5 hours. Pluck the chosen leaves and test them for starch.

The leaf from a flask containing potassium hydroxide remains brown hence no starch is present. The leaf from flask containing sodium bicarbonate turns blue-black hence starch is present.

The results indicate that carbon dioxide is necessary for photosynthesis.

3. **Describe an investigation you can carry out to show that chlorophyll is necessary for photosynthesis**

Take a potted plant with variegated leaves and place it in the dark for twenty four hours to destarch it.

Take the plant and put it in the sun for five hours. Pluck one leaf from the plant and test it for starch and observe the results.

You will observe that the parts that were green will turn blue black to indicate presence of starch in those parts. This means photosynthesis took place in the green parts which have chlorophyll.

The white parts turn brown in colour to indicate absence of starch. This means photosynthesis did not take place in those parts because they do not have chlorophyll.

The results show that chlorophyll is necessary for photosynthesis.

4. **Describe how you can test for starch in a leaf**

Pluck a fresh leaf from a plant. Place the leaf in boiling for few minutes. The leaf is placed in boiling water to kill the cells and to break the cuticle and make the leaf more permeable to iodine.

Take the leaf and boil it in ethanol using a water bath since ethanol is flammable. The ethanol is used to remove chlorophyll from the leaf. Removal of chlorophyll makes any colour changes very visible.

Take the leaf and place it in warm water for few minutes. This is done to wash off the ethanol and to soften the leaf since it becomes brittle after boiling it in ethanol.

Take the leaf from the warm water and spread it on a white tile. The white tile makes the colour changes very visible. Put few drops of iodine solution on the spread leaf and observe the results.

The leaf can turn brown or dark blue in colour where iodine has been applied. Dark blue colour colour shows that starch is present in the leaf. Brown colour which is colour of iodine means there is no starch in the leaf.

5. **Describe an investigation you can carry out to show green leaves contain different types of pigments. In your essay include procedure, expected results and conclusion.**

Collect fresh green leaves. Chop the leaves into small pieces or crush them using pestle or mortar. Place the crushed leaves into a small glass beaker. Add ethanol to half fill the beaker.

Place the small beaker in the larger beaker with water (water bath). Heat the larger beaker. Heat the larger beaker until the alcohol turns green. This that shows the pigments in the leaves have dissolved in ethanol.

Remove the alcohol mixture from the beaker. Filter the mixture it into another small beaker. Cut a small strip of filter paper 3cm wide and 10cm long. Stick it to a glass rod using sello tape. Suspend the filter paper strip into a container with the coloured ethanol such that the tip of the paper touches the mixture.Allow the strip to absorb the coloured ethanol for 30 minutes. Observe the colours formed on the strip from the bottom.

The first colour to appear is green which is called chlorophyll, second colour is orange which is called carotene and the final pigment to appear is yellow which is called xanthophyll.

The results show that fresh green leaves contain different types of pigments.

6. **Describe how you can estimate population of grasshoppers in a school playground**

Use the sweep net to capture as many grasshoppers as possible. Mark and count all the grasshoppers you have caught. Release the grasshoppers back into the field.

After a day capture as many grasshoppers as possible from the field. Count and record the number of grasshoppers in the second catch.Count and record the number of grasshoppers which are marked in the second catch.

Estimate the population of grasshoppers by multiplying number of grasshoppers in the first catch by number of grasshoppers in the second catch divided by number of marked grasshoppers in the second catch.

7. **Describe how you can estimate population density of grasshoppers in a school playground**

Use the sweep net to capture as many grasshoppers as possible. Mark and count all the grasshoppers you have caught. Release the grasshoppers back into the field.

After a day capture as many grasshoppers as possible from the field. Count and record the number of grasshoppers in the second catch.Count and record the number of grasshoppers which are marked in the second catch.

Estimate the population of grasshoppers by multiplying number of grasshoppers in the first catch by number of grasshoppers in the second catch divided by number of marked grasshoppers in the second catch.

Calculate the population density by dividing the population by the area of the school playground.

8. **Describe how you can estimate population of a small plant called Tridax procumbens**

Identify the field in which the plant is found. Estimate the size of the selected area in square metres. Throw the quadrat randomly into the selected area. Count and record the number of Tridax procumbens against quadrat throws.

Calculate the number of organisms in each quadrat. Calculate the appropriate number of organisms in the whole area by multiplying average number of organisms in a quadrat by total area of the field divided by area of the quadrat.

NB: To calculate population density you divide the population by the area of the field.

9. Describe an investigation you can carry out to show the effects of the following on rate of transpiration:

Wind speed

Cut and fix two leafy shoots to potometer. The cutting and fixing should be done under water to make sure no air bubbles are trapped in the apparatus. Take the shoots and place them in similar conditions such as similar temperature and lighting.

Take a fan and place it close to one shoot and switch it on. The fan increases the speed of air around the leaves of the shoots and reduces humidity around the leaves. Leave the set ups for few hours and observe the results

The shown blown by the fan registers a higher transpiration rate than the one without the fan. This is because the fan prevents accumulation of water vapour around the leaf hence reducing humidity leading to faster rate of transpiration.

The results indicate that wind speed affects the rate of transpiration.

Humidity

Cut and fix two leafy shoots to potometer. The cutting and fixing should be done under water to make sure no air bubbles are trapped in the apparatus. Cover one shoot tightly with a transparent plastic paper. Leave the other shoot uncovered.

Take the shoots and place them in equal environmental conditions. Leave the set ups for few hours and observe the results

The shoot that was covered shows lower rate of transpiration than the shoot which was not covered registers a faster rate of transpiration. The plastic bag traps water vapour evaporating from the leaves causing high humidity around the leaves hence reduced rate of transpiration.

The results show that humidity affects rate of transpiration

Temperature

Cut and fix two leafy shoots to potometer. The cutting and fixing should be done under water to make sure no air bubbles are trapped in the apparatus.

Take the shoots and put them in the open. One shoot should be placed under shade while the other shoot should be placed under hot direct sunlight. Leave the set ups for few hours and observe the results.

The shoot in the sun will register a faster rate of transpiration than the one under shade. This is so because the heat from the sun heats the shoot directly hence raising temperature leading faster rate of transpiration.

The results show that temperature affects rate of transpiration.

Light intensity

Cut and fix two leafy shoots to potometer. The cutting and fixing should be done under water to make sure no air bubbles are trapped in the apparatus. Take the shoots into a room with an electric bulb.

Place one shoot directly under the bulb (it receives more light). Place the other shoot away from the bulb (it receives less light) but in the same room.

Leave the set ups for few hours. Observe the results after few hours

The shoot directly under the bulb registers a faster rate of transpiration since it's stomata open more due higher light intensity. The shoot placed away from the bulb registers slower rate of transpiration since stomata open less due to lower light intensity.

The results indicate that light intensity affects rate of transpiration.

10. **Describe the investigation you can carry out to show the effect of temperature on digestion of coagulated milk by pepsin. In your essay include procedure, expected results and conclusion.**

Take three test tubes and label them A, B and C. Place samples of coagulated milk in each of the three test tubes. Add $1cm^3$ of pepsin enzyme solution to each test tube.

Place test tube A in a water bath at 37℃ which is equivalent to body temperature. Take test tube B and place it in cold water or put in a fridge. Boil the contents of test tube C. Take samples from each test tube and test them for protein.

In test tube A proteins are not present because they have been digested by pepsin since the temperature is conducive for action of pepsin. In test tube B proteins are present because pepsin is inactivated by low

temperature. In test tube C proteins are also present because pepsin is denatured by boiling as the enzyme is exposed to very high temperature.

From the results above one can conclude that temperature affects digestion of coagulated milk by pepsin.

11. Describe an investigation that you can carry out to show the effect of pH on digestion of starch by amylase enzyme. In your essay include procedure, expected results and conclusion.

Take three test tubes and label them A, B and C. Put $1cm^3$ of starch solution in each test tube. Add 3 drops of hydrochloric acid in test tube B. Hydrochloric acid creates acidic conditions. Add few drops of sodium hydroxide solution in test tube C. Sodium hydroxide creates alkaline conditions. Add $1cm^3$ of amylase solution to test tubes B and C. Leave the set ups for 20 minutes and test the contents of the test tubes for starch.

In test A contents turn blue black to show presence of starch. This is because A is a control set up and no enzyme, acid and base were added. In test tube B contents turn blue black to show presence of starch. This is because amylase fails to work in acidic pH. In test tube C the contents turn brown to show presence of starch. The starch has been digested by amylase which works best in alkaline pH.

The results show that that pH affects digestion of starch by salivary amylase.

12. Describe an investigation you can carry out to show the effect of particle size on enzyme activity. In your essay include procedure, expected results and conclusion.

Cut three pieces of liver and shape them into three cubes measuring 2cm x 2cm x 2cm. Put 10ml of hydrogen peroxide into three test tubes. Label the test tubes A, B and C. Cut one cube into four equal pieces; crush the second cube using pestle and mortar until it forms fine pieces. Set the stop watch.

Place the whole liver cube into test tube A and start the stop watch. Record the time taken for the foam produced to move up and reach the mouth of the test tube. Repeat the procedure with the cut pieces which are placed in test tube B. Record the time for the foam to reach the mouth of the test tube. Repeat the procedure with the crushed or pounded pieces placed in test tube C.

The liver tissues contain an enzyme called catalyse that breaks down hydrogen peroxide into water and oxygen. The foam is produced by oxygen as it is eliminated from test tubes. In test tube A the foam takes a long time to reach the mouth of the test tube. In test tube B the foam takes less time to reach the mouth of the test tube faster than in A. In test tube C the foam takes less time to reach the mouth of the test tube faster than in both A and B.

The results show that particle size affects enzyme activity.

13. Describe an investigation you can carry out to show that liver tissue contains an enzyme that breaks down hydrogen peroxide

Cut a piece of liver and crush it into small pieces. Put 50ml of hydrogen peroxide solution in two test tubes. Place the crushed liver pieces into one of the test tubes. Leave the set ups for few minutes.

You will observe bubbling and foaming developing and rising in the test tube to which liver pieces were added. The catalyse enzyme in liver tissues breaks down hydrogen peroxide into water and oxygen. The release of oxygen causes bubbling to occur. The test tube with just hydrogen peroxide with and no liver tissues shows no foaming or bubbling as hydrogen peroxide is not broken down.

The results show that the liver tissue contains an enzyme that breaks down hydrogen peroxide.

14. Describe an investigation you can carry out to show the effect of exercise on pulse rate

Working in pairs, take the pulse by placing three fingers firmly on your partner's wrist. Do not press too hard. Shift the position of these fingers until you feel some movement against your fingers. This is the pulse.

Count the number of times you feel these beats in a minute and record them in a table. Repeat the procedure. Ask your partner to walk round the classroom block. Take the pulse and record.

Then the student should run around the classroom block. Take the pulse again and record.

Compare the pulse rate at rest to pulse rate after exercise. The pulse rate is lower at rest than after exercise

The results show that pulse rate increases with physical exercise

15. **Describe an investigation you can carry out to show the effect of one-sided illumination on a growing shoot. In your essay include procedure, expected results and conclusion.**

Take two potted seedlings. Place one seedling in a box with a small hole at the level of the seedling.

Place the other seedling in identical situation but on a slowly rotating clinostat. The rotating clinostat ensures that all sides of the shoot are equally illuminated.

The shoot on the clinostat continues to grow upwards since there is equal distribution of auxins. The shoot without clinostat changes direction of growth and grows towards light since auxins accumulate more on the darker side. The cells on the darker side grow faster causing the shoot to bend and grow towards light.

The results show that one-sided illumination causes shoots to bend towards light.

16. **Describe an investigation you can carry out to show roots respond to the stimulus of water. In your essay include procedure, expected results and conclusion**.

Place the porous pot at the centre of the basin or trough. Pour the sand or saw dust into the basin so that it surrounds the clay pot. Sow the seeds about 3cm deep into the dry sand or saw dust and 5cm around the pot. Do not water the dry sand or saw dust.

Fill the pot with water. Some of the water will drain out into the surrounding sand. After 2-3 days carefully scoop out the sand from around each germinating seed and observe the direction of growth of the radicles.

The radicles will grow towards the wet sand around the clay pot. This shows positive geotropism.

The results show that roots grow towards a water source.

17. **Describe an investigation you can carry out to show the part of the shoot that responds to light. In your essay include procedure, expected results and conclusion**.

Take three potted seedlings. Cover the tip of one seedling with aluminium foil. Cover the middle of the seedling with aluminium foil. Leave the third seedling untampered with.

Put the seedlings in a cardboard. Illuminate the seedlings from one side. Leave the apparatus for some days.

After some days the shoot with covered tip continues to grow upright. The shoot with covered middle and the one which is not tampered with bend towards light.

The results above show that the tip of the shoot is the part that responds to light.

18. **Describe an investigation you can carry out to show how roots respond to the stimulus of gravity. In your essay include the procedure, expected results and conclusion**.

Pin the seedlings to two large corks. Place the corks in the mouth of the jars. Leave one set up in horizontal position so that radicles are placed horizontally.

Place the other set up on a clinostat. Place the set up in darkness to eliminate phototropic responses. Leave the set up for about two days

The radicles of seedlings on the clinostat continue to grow horizontally since there is equal distribution of auxins. The radicles on the stationary jar grow downwards as more auxins accumulate on the lower side and slow down growth of cells. There is faster growth of cells on the upper side of radicle causing them curve downwards.

The results show that gravity causes radicles to grow downwards.

19. **Describethe investigation you can carry out to show the effect of exercise on breathing rate**

Students must be put in pairs. One student in a pair must count the number of breaths for 5 minutes of their partner while the partner is standing.

Calculate the breathing rate per minute and record. Let the student skip twenty times with the rope. Count the number of breaths for 5 minutes of the student after skipping.

Calculate the breathing rate per minute and record the breathing rate. Compare the breathing rate at rest to the breathing rate after exercise.

This shows that exercise increases breathing rate.

20. **Describe an investigation you can carry out to show the effect of time of the day on memory. In your essay include procedure, expected results and conclusion.**

Write down two lists of 20 words on two separate sheets. Memorise the list of words on one sheet in the morning for 5 minutes.

Write down the number of words you can remember from the sheet at noon. In the evening after school try to memorise the words on the second sheet for 5 minutes. Write down the number of words you can remember from the second sheet before going to sleep.
More words memorised in the morning were recalled than those memorised in the evening after school. In the morning are fresh after resting at night.

The results show that time of the day affects our ability to memorise or record information.

21. **Describe an investigation that you can carry out to show the effect of practice on hitting the target. In your essay include procedure, expected results and conclusion.**

Make a mark on the dart board. Aim the mark using arrows/ball. Take ten attempts (1st round) and count number of hits to target you make.

Continue for about ten rounds (100 attempts). Record the number of hits to the target you make in each round.

At the beginning there were few hits on the target. As rounds continued hits on target increased. Exposure to one stimulus for repeated times make the brain to coordinate repeated activities faster and more accurately.

The results show that practice increases accuracy in hitting the target.

16. **Describe investigations that can be carried out to show the effect of the following on growth of microorganisms: temperature, pH and humidity**

Temperature

Take distilled water and boil it to kill all microorganisms in it. Make a glucose solution by mixing the distilled water and the glucose. Take three test tubes and label them A, B and C

In test tube A put 40ml of glucose solution and add a spatula full of yeast powder. The yeast represents microorganism. Place the test tube in a hot water bath maintained at 35℃. Observe what happens after twenty minutes.

In test tube B place 40ml of glucose solution and add a spatula full of yeast powder. . Place the test tube in a rack and put it on the bench. The setup is exposed to room temperature which is about 25℃.

In test tube C place 40ml of glucose solution and add a spatula full of yeast powder. Put the test tube in a cold room or refrigerator or a beaker with ice cubes. Observe what happens.

Test tube A has the greatest bubbling with frothing spilling over. This is because the temperature is very conducive for yeast to grow very well. In test tube B there is bubbling with less frothing compared to A. In test tube C there is no bubbling and frothing at all. This means yeast cannot grow in cold temperatures.

The results above show that temperature affects growth of microorganisms.

NB: the yeast is killed when is boiled and fails to grow.

pH

Take distilled water and boil it to kill microorganisms in it. Make a sugar solution by mixing the distilled water

with the sugar. Take two test tubes and label them X and Y

Place 40ml of sugar solution in X and add a spatula full of yeast. Add 5ml of hydrochloric acid to the mixture to create acidic pH.

Place 40ml of sugar solution in Y and add a spatula full of yeast. Add 5ml of sodium hydrogen carbonate solution to the mixture to create alkaline pH.

Place both X and Y in a water bath of about 35℃ Observe what happens. In test tube X bubbling and frothing are observed. In test tube Y there is no bubbling and frothing. This shows that yeast grows better in acidic pH and fails to grow in alkaline pH.

The results above indicate that growth of microorganisms is affected by pH.

Moisture

Take two slices of bread. Take one slice of bread and dry it in the sun or by blowing it with air.

The other slice should be splashed with some water to moisten it. Do not apply a lot of water.

Place the slices in different dry containers and put them on the bench in the laboratory and leave them for two days. Observe what happens after two days

The moist bread develops moulds that grow on it. The dry bread does not develop moulds because it has no moisture.

The results above show that moisture is necessary for the growth of microorganisms.

17**. Describe an investigation you can carry out to show that the following are present in exhaled air:**

i. carbon dioxide

Take a small plastic bottle with a plastic cover. Take lime water and put in the plastic bottle so that it is half full.

Make two sizeable holes on the bottle cover. Then seal the bottle containing lime water with the cover with the holes.

Take a long straw and push it through one of the holes in the cover of the bottle so that it dips into the lime water.

Blow air through the straw into the lime water for some minutes. Observe what happens to the lime water.

The results will show that the lime water changes to milky white in colour with time. Lime water turns milky white it comes into contact with carbon dioxide.

The results above indicate that carbon dioxide is present in exhaled air.

ii. water vapour

Take a mirror and place it before your face. Take a deep breath and then blow out air over the mirror several times.

Wait for few minutes. You will see the mirror becoming cloudy. This shows that water vapour has condensed on the mirror. Take cobalt chloride paper wipe it onto the mirror. Observe what happens.

The cobalt chloride turns pink. This shows that exhaled contains water since cobalt chloride turns pink in presence of water.

The result above shows that exhaled air contains water vapour.

22. Describe an investigation you can carry out to show the distribution of stomata in a leaf. In your essay include procedure, expected results and conclusion.

Using a tip of scalpel, peel off a small piece of skin from upper surface of a leaf. Pull off a thin skin from the leaf. Place the skin on the microscope slide and cover it with a drop of water.

Place a coverslip on top and mount it on a microscope. Examine it using lower objective lens of the microscope. Count the number of stomata that are observed.

Repeat the procedure with a skin from the lower surface of the leaf. Compare the number of stomata on the upper and lower surfaces of the leaf.

You observe more stomata on the lower surface than on the upper surface of the leaf.

The results show that the lower surface of a leaf has more stomata that the upper surface.

23. Describe an investigation you can carry out to show distribution of microorganisms in different around the school.

With the help of your teacher prepare an agar solution by dissolving the agar and boiling it to kill any micro-organisms.Clean about four petri-dishes with soap and disinfectant. Fill each petri-dish with warm agar solution.

Cover the petri dishes and label them A, B, C and D. Allow the solution in each of the petri-dishes to cool and harden. Keep the petri-dish labelled A tightly covered in a cupboard. Do not open it at all. Moisten one of your hands and then move the hand over several surfaces in your class or laboratory.

Open petri-dish B and move your already dirty hand to make a line across the agar medium. Close the petri-dish. Open petri-dish C and place it outside the class for few minutes. Close it and take it to the laboratory.

Take a piece of cotton wool and moisten it. Go to the toilet and using cotton wool wipe some parts of the door or wall of the toilet. Open petri-dish D slightly and touch the nutrient agar using the moist cotton wool and close it. Put the petri-dishes in a warm place in the laboratory. Leave the petri-dishes for 48 hours and observe the results

Different colours are going to appear on the nutrient agar in the petri-dishes B, C, and D. In A there is going to be no any colony because the agar is sterilized. The different colours on the agar represent different colonies of micro-organisms. The agar with more colours shows that it has more micro-organism. This means micro-organisms are differently distributed in different places.

The results indicate that microorganism are distributed differently in different places in the school.

24. Describe an investigation that you can carry out to show that unwashed contains more microorganisms than washed hands.

Prepare an agar solution by dissolving the agar and boiling it to kill any microorganisms. Clean two petri dishes with soap and disinfectant. Cover the petri dishes and label them A and B. Allow the nutrient agar to cool and harden.

Open petri dish A and move your unwashed hand over the nutrient agar and make a line across the nutrient agar. Close the petri dish.

Wash your hands using soap. Open petri dish B and move your washed hand over the agar to make a line across the nutrient agar. Close the petri dish.

Leave the petri dishes for forty eight hours and observe the results.

More different colours appear in the line made with unwashed hand in petri dish A. Less different colours appear in the line made by washed hands in petri dish B. The different colours represent the different colonies of microorganisms.

The results above show that unwashed hands contain more microorganisms than washed hands.

25. Describe an investigation you can carry out to show that transpiration in leaves affects water uptake in plants

Take three test tubes. Fill the test tubes with water until they are three quarters full. Take three seedlings of the same age. One of the seedlings must be dry. Remove some leaves from the second seedling so that only two leaves remain. Leaves the leaves of the third seedling intact.

Place each of the seedlings in their own test tubes. Pour some oil on top of the water in the test tubes with seedlings. The oil prevents evaporation of water from the test tubes.

Leave the set ups for few hours and observe the results. You will observe that the level of water in the test dry with dry seedling does not change because it's dead. The test with seedling with two leaves will register some decrease in water level. The seedling with all leaves registers a very big decrease in water level.

This means that as a plant loses water through transpiration in leaves the seedlings absorb water from the test tubes. A plant with more leaves lose more water through transpiration as a result it absorbs (uptakes) more water to replace the water that transpires.

One can conclude that transpiration in leaves affects water uptake in plants.

THE END