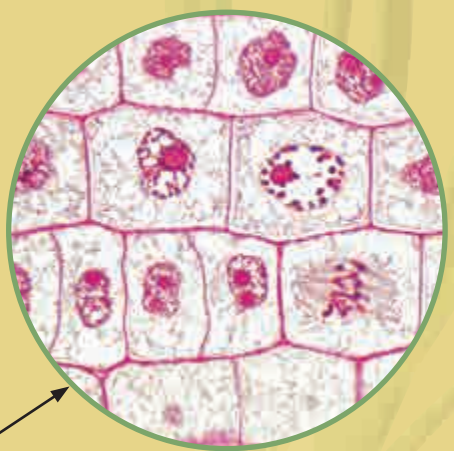
GOVERNMENT OF TAMILNADU

HIGHER SECONDARY-FIRST YEAR

BIO-BOTANY

PRACTICAL MANUAL



State Council of Educational Research and Training, Chennai - 06

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INTRODUCTION

Science learning is practical oriented and requires practical activities in the laboratory. As in any other science subject, practical have an important role in Botany too. The purpose of teaching botany is not only to acquaint the learner with terms, facts, concepts and principles but also to prepare them to understand these concepts by doing exercises relating to them. Practical work also gives students many opportunities to use their minds to discover laws and principles of science. It makes difficult and abstract concepts real, remove misconceptions, ignite, increase and sustain students interest in plant science through various practical activities. Self- experience not only eliminates doubts and misbeliefs in one's mind but also generates an interest in the subject. Therefore, the students should be adequately taught through practical activities to acquire useful practical skills in concepts.

THE OBJECTIVES OF BIOLOGY PRACTICALS

The objectives of biology practicals are to:

- develop practical skill for better understanding through first hand experience;
- demonstrate the principles covered in the theory;
- develop observational skill in the form of identifying and locating desired parts in specimen;
- develop manipulative skills in arranging and handling the apparatus and instruments and taking reading on them;
- collect material and to mount it to develop skill in preserving biological material and specimens;
- draw, label and record experimental results and interpret them;

Through practical work, not only the theoretical concepts are tested but also it trains the student in scientific method of learning.

INSTRUCTIONS TO STUDENTS

Students must attend all the practical classes. They must also remember that there is a great degree of co-ordination between theory class and practicals.

- The following are some of the items that they must bring to the Practical Classes.
  - Practical observation note book
  - Practical record

- ❖ Practical manual
- ❖ Drawing pencils of HB type
- ❖ Pencil sharpener
- ❖ Eraser
- ❖ A measuring scale
- ❖ A small sized clean white hand-kerchief
- ❖ A dissection box containing a pair of scissors, one scalpel with sharp edge, a pair of small forceps, a pair of dissection needles with plastic handle, a blade and a small sized painting brush.

- ➢ Come prepared with theory part of the practical subject.
- ➢ They should submit the practical records periodically for correction and valuation.
- ➢ Do not keep bags on the work table.
- ➢ They must maintain strict discipline and silence in the laboratory.
- ➢ They should write the date and experiment number in their observation note books.
- ➢ They should observe microscopic slides, specimens and draw labeled figures in their observation note books.
- ➢ After the practials are completed, they should ensure the proper arrangement of chairs, microscopes, etc. and clean the work table.
- ➢ A separate practical record for Botany and Zoology is to be maintained.
- ➢ Use only pencils for drawing and writing the notes in the interleaves of the record.
- ➢ Below the diagram, they should write the caption for the diagram in bold letters.
- ➢ While labeling different parts of the diagram, draw horizontal indicator lines with the help of a scale.

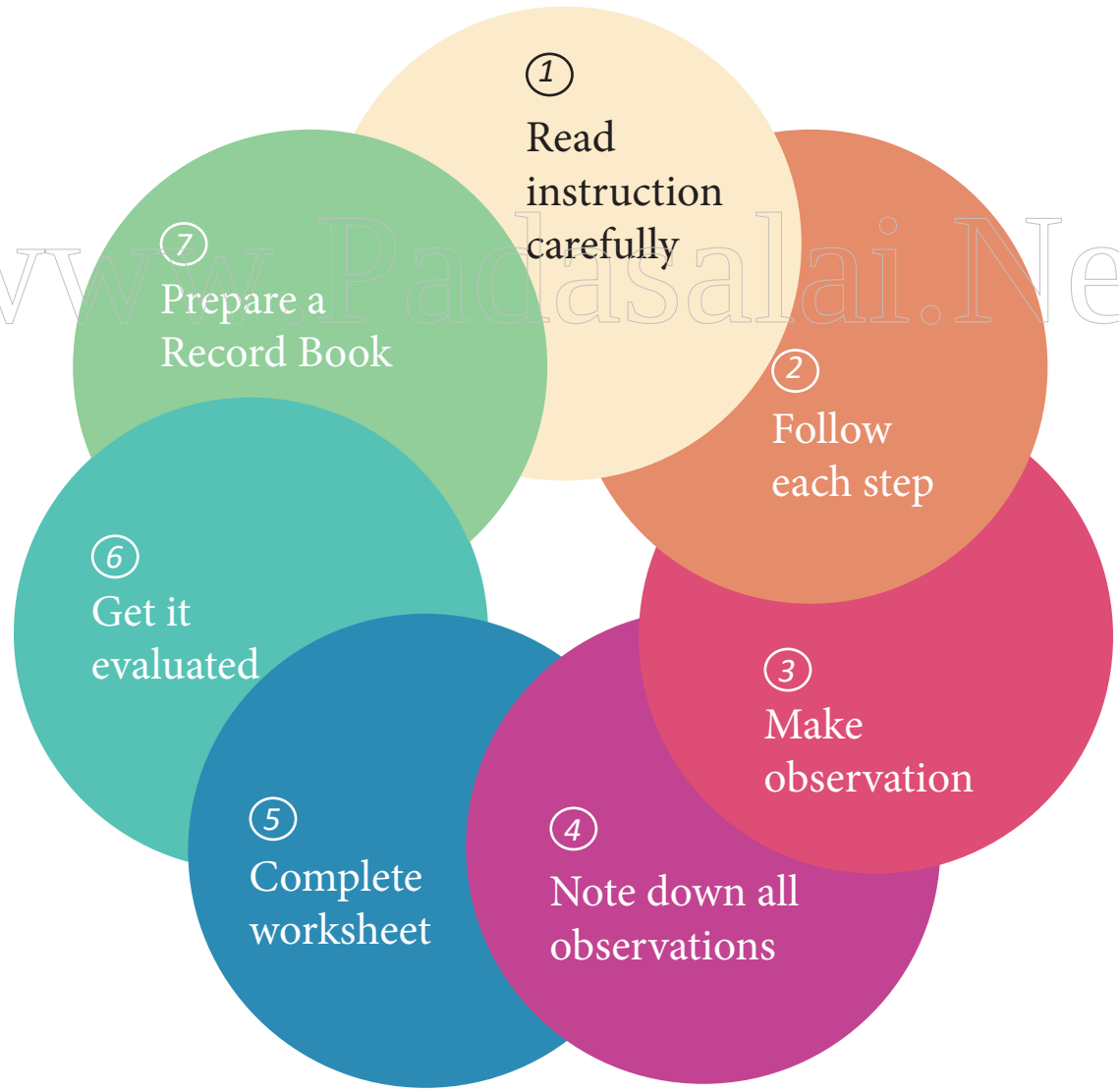
SAFETY IN THE LABORATORY

The following precaution and care should be taken while working in the biology laboratory:

- ➢ The students should be well aware of the exercise they are going to perform in the laboratory.
- ➢ The instruments, glassware and any other equipment should be kept clean at its proper place before and after its use.

- The microscope and other delicate instruments should be handled gently and properly and should be atleast 5 inches from the edge of the table to avoid its knocking off accidently.
- Do not throw any broken glassware in the sink. It should be thrown in the dust bin.
- Whenever working with the sharp instrument as blade / scalpel etc. be careful not to cut or puncture your skin.
- Do not inhale, never taste or apply stain or any chemical as it may harm.
- Never eat in the laboratory to avoid infection.

The steps involved in performing a practical are listed below in the chart to help students to do the practicals.



BASIC EQUIPMENTS USED IN BIOLOGY LABORATORY

Microscopes:

a. Dissection Microscope: Used to observe ground plan of T.S / L.S root, stem, leaf ovule and small organisms.

b. Compound Microscope: It consists of objective lens and ocular lens, which is used to magnify the object. The light entering into the microscope is adjusted by diaphragm.

Specimen slide placed on the stage is illuminated by light. It is observed through low power or high power by changing objective lens. Using coarse and fine adjustment fine details of slide can be studied.

Glassware:

Test tubes, Beakers, Flasks, Watch glass, Petri dishes, Slides, Cover slips, Reagent bottles, Pipette, Funnel and Graduated cylinder.

Tools for dissection:

Scalpel, Forceps, Needle, Brushes, Blade

Fixatives:

Formalin, F.A.A (Formalin-aceto-alcohol).), Ethanol and Acetone

Stains:

Safranin (used to stain lignified and cutinised cells)

Haematoxylin (used to stain nucleus)

Iodine (used to find starch)

Eosin (used to stain cytoplasm)

Acetocarmine (used to stain chromosomes)

Crystal Violet (used to stain bacteria)

Mounting agents:

Glycerine and Canada balsam

Reagents and Solutions:

Benedict's reagent, Biuret reagent, Fehling's solution, Starch solution, Iodine solution, and NaOH.

Indicators:

pH paper

Temperature measurement:

Thermometer

PREPARATION OF SLIDE

Basic techniques used in biology laboratory during the preparation of micro slide and demonstration of experiments.

How to take peel?

step: 1. Remove an intact leaf epidermal layer

step: 2. Use needle and forceps to separate out peel from leaf

step: 3. Keep the peeling on the slide, add drop of water or stain

step: 4. Observe through the microscope.

What is Smear?

A technique used to spread the cells uniformly on the slide from the sample or section.

step: 1. Section placed in stain

step: 2. Crushed with help of scalpel or another slide

step: 3. Slide gently heated over the flame, mounted with mounting medium

step: 4. Cover the slide with cover slip and seal with melting wax.

How to take Sections?

A thin and transparent section is cut with the help of sharp razor or blade. Sections are basically two types: Transverse Sections (T.S) and Longitudinal sections (L.S)

step: 1. Keep the material between thumb and first finger using pith

step: 2. Cut several thin sections using razor or blade

step: 3. Take out the section with the help of brush and place it in a watch glass containing water.

step: 4. select a thin floating section, avoid oblique/incomplete section.

Fixation:

Fixation is the technique adopted to kill the cells and stop the cellular activities. It also protects the cells from drying and decaying.

Some common fixatives: Formalin, Ethanol and FAA (Formalin-aceto-alcohol).

Procedures followed in Staining:

Staining is the technique used to view and differentiate the cells using specific dyes or Stains.

Some common Stains: Safranin, Haematoxylin, Iodine, Eosin, Acetocarmine and Crystal Violet.

Mounting:

Technique adopted to preserve the sections for longer period of time and also protect the section from drying.

Some common mounting media: Glycerine, DPX and Canada balsam.

Step: 1. Pore a drop of mounting medium on the section over the slide

Step: 2. Place the cover slip very gently over the slide

Step: 3. Avoid air bubbles while mounting

Step: 4. Wipe out excess mounting medium with blotting paper.

Know your Compound Microscope

Compound Microscope is an insdispensable instrument in a Biology laboratrory. Study the diagram of the microscope and compare it with an actual one in the laboratory.

Eye-Piece: Contains lenses to increase magnification

Body Tube: Holds lenses of eyepiece and objectives at proper working distance from each other

Nose Piece: Permits interchange of low and high powered objects

Coarse Adjustment: Moves body tube up or down to the correct distance from the specimen for focussing the object

Arm: Supports body tube and coarse adjustment.

Objective Lense: Contains lenses of different magnification as 10X, 40X etc.

Fine Adjustment: Permits exact focussing by moving stage or body tube up or down very slightly

Stage Clip: Hold slide firmly in place

Stage: Supports slide over hole that admits light from mirror below

Diaphragm: Regulates amount of light passing through the specimen

Mirror: Reflects light upward through diaphgram and hole in stage

Base: Firm support bearing weight of microscope

BIO-BOTANY PRACTICAL

MODEL QUESTION

I.	Identify the given slide 'A' and give any two reasons
II.	Identify the given specimen 'B' and give any two reasons
III.	Identify the family, dissect and display the given flower 'C'. Write the floral characters of essential parts, draw floral diagram and write floral formula.
IV.	Test the given sample solution 'D' for the presence of Reducing sugar (Glucose), Starch, Protein and Lipids Write the Principle and Tabulate the result.
V.	Write aim, procedure, observation and inference of the given plant physiological experiment setup 'E'.

MARKS ALLOTMENT-PRACTICAL EXAMINATION

I.	Identification- ½ Reasons (any two) – ½	(1)
II.	Identification – ½ Reasons (any two) – ½	(1)
III.	Identification ½, Dissection – ½, Floral character – ½, Floral Diagram – ½, Floral formula – ½	(2 ½)
IV.	Principle – ½, Test - ½, Table - ½ (Procedure, Observation, Inference)	(1½)
V.	Aim – ½, Procedure & Observation – ½, Inference – ½	(1 ½)
	Total	**7 ½ marks**
Record		**1 ½ marks**
Skill		**1 marks**
Maximum marks		**10 marks**

BIO-BOTANY PRACTICAL CONTENT

QUESTION No- I (A)

Note: Teacher must prepare a temporary slide using fresh specimen for demonstration during the practical hours. (If temporary slide preparation is not possible, permanent slides are allowed only during Board practical examination)

Preparation and Demonstration of Slides	
Exercise 1	Bacteria - Lactobacillus
Exercise 2	Fungi – Yeast and *Rhizopus*
Exercise 3	Algae - *Chlamydomonas, Volvox, Spirogyra, Oedogonium*
Exercise 4	Mitotic cell division Stages - Metaphase, Anaphase
Exercise 5	Plant Anatomical structure – Dicot – Root, Stem, Leaf and Monocot – Root, Stem & Leaf
Exercise 6	Plasmolysis and Deplasmolysis

QUESTION No- II (B)

Fresh or preserved specimens	
Exercise 7	*Agaricus* – Basidiocarp
Exercise 8	Foliose Lichen
Exercise 9	Phylloclade – *Opuntia*
Exercise 10	Special inflorescence – Cyathium
Exercise 11	Aggregate fruit – Polyalthia

QUESTION No- III (C)

Taxonomy - Flower Dissection	
Exercise 12	Fabaceae - *Clitoria ternatea*
Exercise 13	Solanaceae – *Datura metal*

QUESTION No- IV (D)

Bio molecules – Nutrient test	
Exercise 14	Test for reducing sugar-Benedict test
Exercise 15	Starch – Iodine test
Exercise 16	Protein –Biuret test
Exercise 17	Lipid –Saponification test

QUESTION No- V (E)

Plant Physiology Experiments	
Exercise 18	Potato Osmoscope
Exercise 19	Paper Chromatography
Exercise 20	Wilmott's Bubbler
Exercise 21	Demonstration of production of CO_2 during respiration
Exercise 22	Arc auxanometer

BIO - BOTANY PRACTICALS

I - Preparation and Demonstration of Slides

Note: Teacher must prepare a temporary slide using fresh specimen for demonstration during the practical hours. (If temporary slide preparation is not possible, permanent slides are allowed only during Board practical examination)

Aim: To study and identify the morphology of representative types of bacteria, fungi and Algae.

Principle: Morphology is the study of the characteristic features of the species. It could be a study of external or internal features. Morphological studies help in identification and classification of organisms.

Requirements: Buttermilk or curd, 100 ml sugar solution, crystals of yeast, bread mold, pond water, slide, cover slip to prepare temporary slides / Permanent slides of Bacteria, Yeast, *Rhizopus, Chlamydomonas, Volvox, Spirogyra, Oedogonium,* Compound microscope.

Exercise: 1

Bacteria (Lactobacillus)

Take sour buttermilk/curd and mount it on a slide to view lactobacillus.

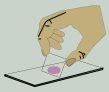
Diagnostic Features

- Unicellular, Prokaryotic, rod shape, Chemo organotrophic bacteria.
- Absence of membrane bound organelles like mitochondria, nucleus, golgi bodies, plastids, etc.,
- Mesosomes are present
- Involved in lactic acid fermentation.

Figure 1: Bacteria

Exercise: 2

a. Fungi – Yeast



Add few crystals of Yeast to 100 ml sugar solution. Leave it for 2 to 3 hours. Later mount a drop of solution on a slide to view it under a microscope.

Diagnostic Features

- Single celled, eukaryotic ascomycetes fungus
- Cells are oval or spherical in shape and colourless.
- Generally it reproduce by budding.
- Strings of connected budding cells form pseudo mycelium.

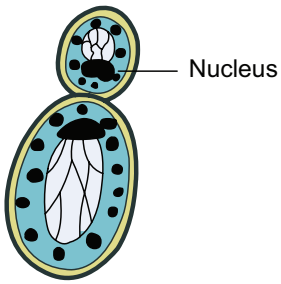
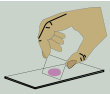


Figure 2a: Yeast

b. Fungi – *Rhizopus*



Use bread mold. The surface of bread pieces is covered with white or colourless upright branches with black tips are developed. Pick up few threads with the help of forceps and needle. Stain by using safranin and put them on the slide in a drop of glycerin. Cover with the coverslips and observe under the microscope.

Diagnostic Features

- Saprophytic fungus commonly grow on bread (Zygomycetes)
- Aseptate, coenocytic mycelium
- Asexual spore producing structure called sporangium which bears sporangiospores.

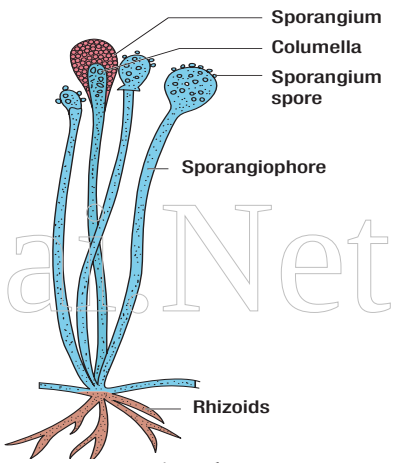
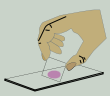


Figure 2b: *Rhizopus*

Algae



Collect the green pond water. Put 2 drops of water on a slide and mount it to see the algae.

Exercise: 3

a. *Chlamydomonas*

Diagnostic Features

- Motile, unicellular green alga.
- Presence of cup shaped chloroplast. The anterior side of the chloroplast contains a tiny spot called stigma or eyespot.
- The anterior part of thallus bears two whiplash flagella. Each flagellum originates from a basal granule or blepharoplast.

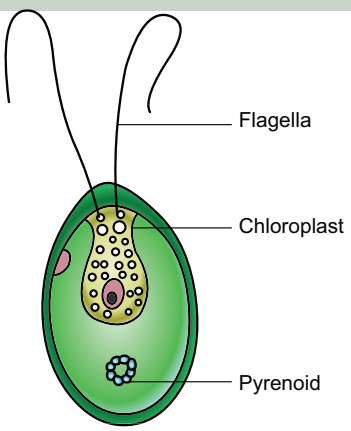


Figure 3a: *Chlamydomonas*

b. *Volvox*

Diagnostic Features

- Motile and Colonial, green alga.
- 500 to 5000 cells arranged to form hollow sphere. This kind of habit is called Coenobium.
- Each cell in the colony connected by thin strands of cytoplasm.

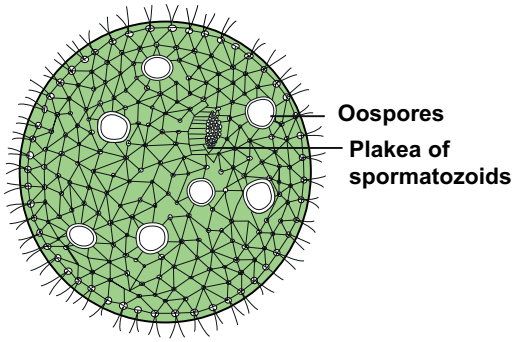


Figure 3b: *Volvox*

c . *Spirogyra*

Diagnostic Features

- Unbranched, filamentous green alga.
- Spiral shaped Chloroplast
- Cylindrical cells are arranged one above the other.
- Nucleus is present at the centre of the cell.

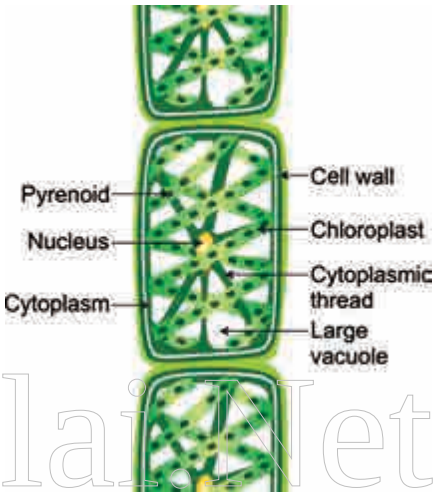


Figure 3c: *Spirogyra*

d: *Oedogonium*

Diagnostic Features

- Filamentous, unbranched, green alga.
- Cells of the filament attached end to end form uniseriate row.
- Presence of reticulate chloroplast.
- Presence of cap cells on the young dividing cells.
- Three types of cells Basal cell (Hold fast), Middle cell and Apical cell.

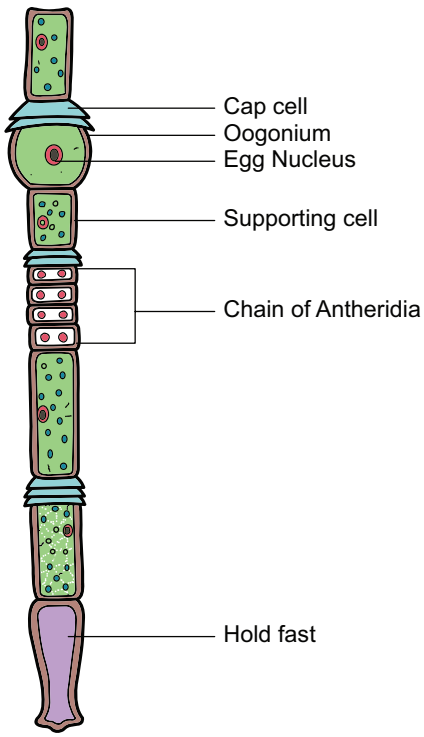


Figure 3d: *Oedogonium*

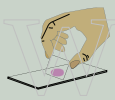
Exercise: 4

Mitosis in onion root tip

Aim: To study and identify the mitosis stages – Metaphase and Anaphase.

Principle: Somatic growth of both plants and animals takes place by increase in the number of cells. The cells divide mitotically wherein number of chromosomes remains unchanged in the daughter cells from that in the maternal cells. Cells from the growing root-tips and apex of shoot buds are suitable for mitotically dividing cells. In animals mitotically dividing cells can be easily scored from the bone marrow of a vertebrate. The cell from the epithelium of gills in fishes and from the tail of growing tadpole larvae of frog are also good sources for scoring the mitotically dividing cells.

Requirements: Onion root, HCl, Safranin stain, slide, Coverslip, Permanent slides Compound microscope.



1. Cut the tip 5 to 8 mm from the tip of the freshly sprouted onion root. Discard the rest of the root.
2. Wash them in water on a clean microscope slide.
3. Place one drop of 1N HCl on the root tip and add 2-3 drops of Safranin/ Acetocarmine stain to the slide.
4. Warm the slide gently over the alcohol lamp for about one minute. (Do not allow the slide to get hot to the touch).
5. Carefully blot the excess stain with a blotting paper.
6. After (10 to 20 seconds) put one or two drops of water and blot them carefully using blotting paper.
7. Again put a drop of water on the root tip and mount a cover slip on it avoiding air bubbles.
8. Squash the slide with your thumb using a firm and even pressure. (Avoid squashing with such force that the cover slip breaks or slides).
9. Observe it under a compound microscope in 10x objective. Scan and narrow down to a region containing dividing cells and switch to 40x for a better view.

a. Mitosis – Stage : Metaphase

Diagnostic features:

- The spindle fibres attached to the kinetochore region of centromere of chromosomes
- Chromosomes are arranged at the equator region of the cell (metaphase plate)
- Chromosomes are distinctly visible in this stage.

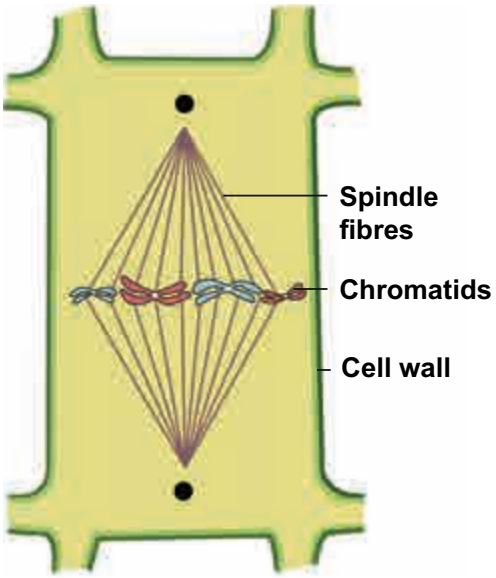


Figure 4a: Metaphase

b. Mitosis – Stage : Anaphase

Diagnostic features:

- Each chromosome splits and two daughter chromatids begin to move towards opposite poles.
- Shortening of spindle fibre and longitudinal splitting of centromere creates a pull which divide the chromosomes.

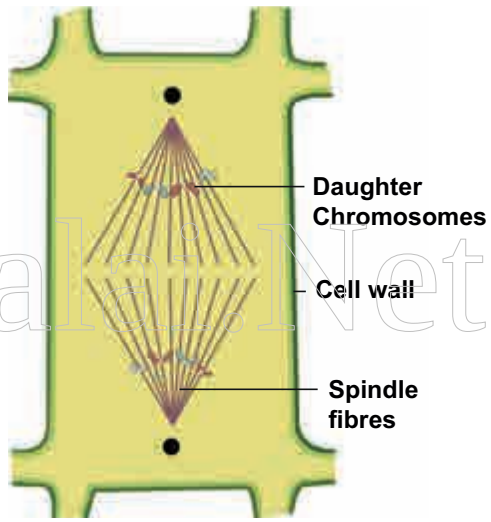


Figure 4b: Anaphase

Exercise: 5

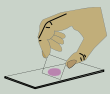
Plant anatomical structures
(Dicot-Root, Stem and Leaf, Monocot- Root, Stem and Leaf)

Aim: To study and identify the T.S of dicot root, dicot stem, dicot leaf, monocot root, monocot stem and monocot leaf.

Principle: A group of tissues performing a similar function, irrespective of its position in the plant body, is called a tissue system. The three types of tissue system in plants are: Epidermal tissue system, Ground tissue system and Vascular tissue system. In different parts of the plants, the various tissues are distributed in characteristics patterns. This is

best understood by studying their internal structure by cutting sections either transverse or longitudinal or both of the part to be studied.

Requirements: Small twigs of locally available dicot and monocot plants, glycerine, safranin, slides, cover slip, brushes to prepare temporary slides and permanent slides of T.S. of Bean root, T.S. of Maize root, T.S. of Sunflower stem, T.S of Maize stem, T.S of Sunflower leaf, T.S of Grass leaf.



Start cutting transverse sections of material placing it in between pith. Select the thinnest section of the material with the help of a delicate brush. Take a clean watch glass with water, transfer thin sections of the material. Put a few drops of safranin stain in the watch glass with water. Leave it for 3-5 minutes. Drain off stain and wash with water if necessary. Put the thinnest section in the centre of the slide. Put a drop of glycerine over the material. Cover it with a coverslip with the help of needle. Observe it under a compound microscope after staining and mounting.

a. Dicot Root (T.S)

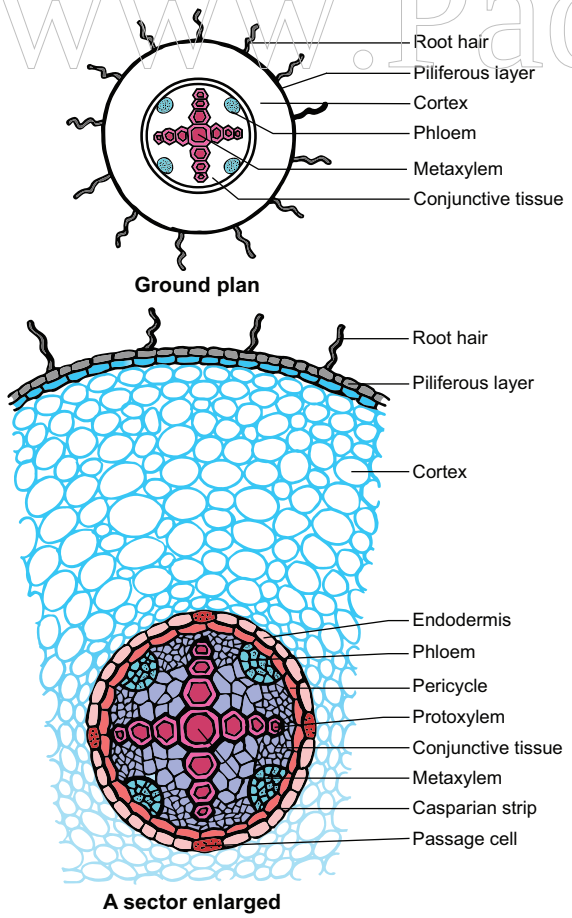


Figure 5a: T. S of Dicot root (Bean root)

b. Dicot Stem (T.S)

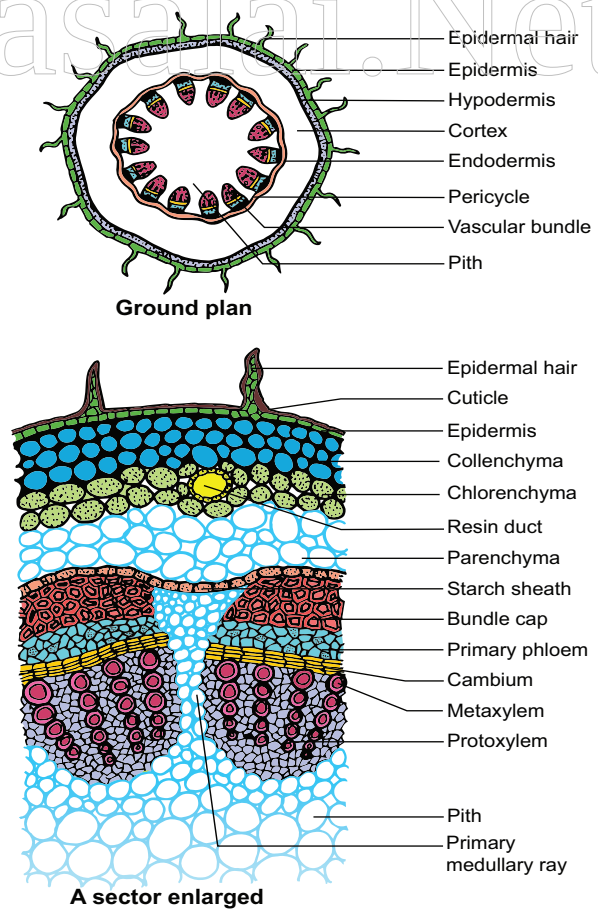


Figure 5b: T.S of Dicot stem (Sun flower stem)

Dicot Root (T.S)

Diagnostic features:

- Radial vascular bundle, exarch and tetrarch xylem.
- Parenchymatous conjuctive tissue is present.
- Pith is absent.

Dicot Stem (T.S)

Diagnostic features

- Cortex differentiated, hypodermis made up of collenchyma cells.
- Conjoint, Collateral and Open vascular bundle (Cambium present)
- Vascular bundle arranged like a ring, wedge shaped vascular bundle.
- Presence of pith and primary pith rays.

c. Dicot Leaf (T.S)

Diagnostic features

- Conjoint, Collateral and closed vascular bundle.
- Mesophyll tissue differentiated into upper palisade parenchyma and lower spongy parenchyma. (Dorsiventral leaf)
- Stomata are more in number on the lower epidermis.
- Stomata surrounded by bean shaped guard cells.

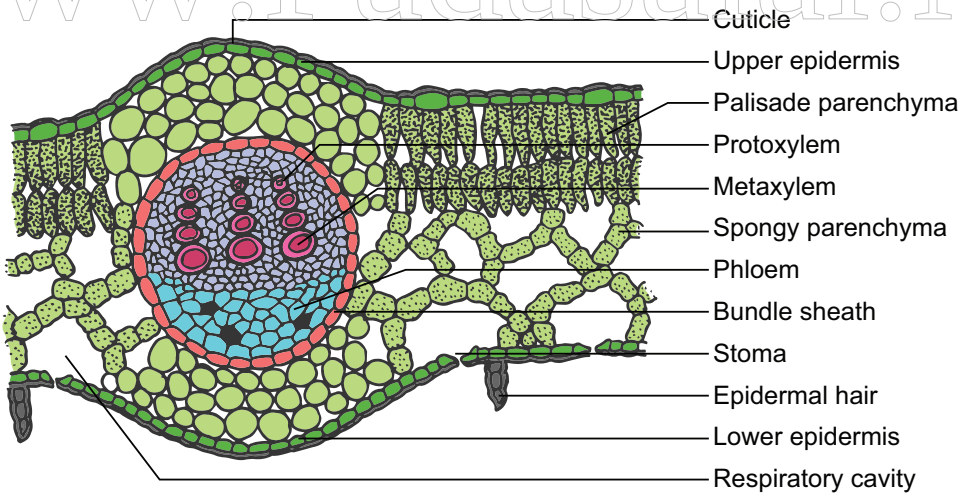


Figure 5c: T.S of Dicot leaf (Sun flower leaf)

d. Monocot Root (T.S)

Diagnostic features:

- Radial vascular bundle, exarch and Polyarch xylem.
- Pith is Present.

e. Monocot Stem (T.S)

Diagnostic features

- Conjoint, Collateral and Closed vascular bundle. (Cambium absent)
- Skull shaped and scattered vascular bundle.

- Sclerenchymatous conjuctive tissue is present.
- Pith absent, homogenous ground tissue.
- Ground tissue is not differentiated into cortex and pith. Hypodermis made up of Sclerenchyma cells.

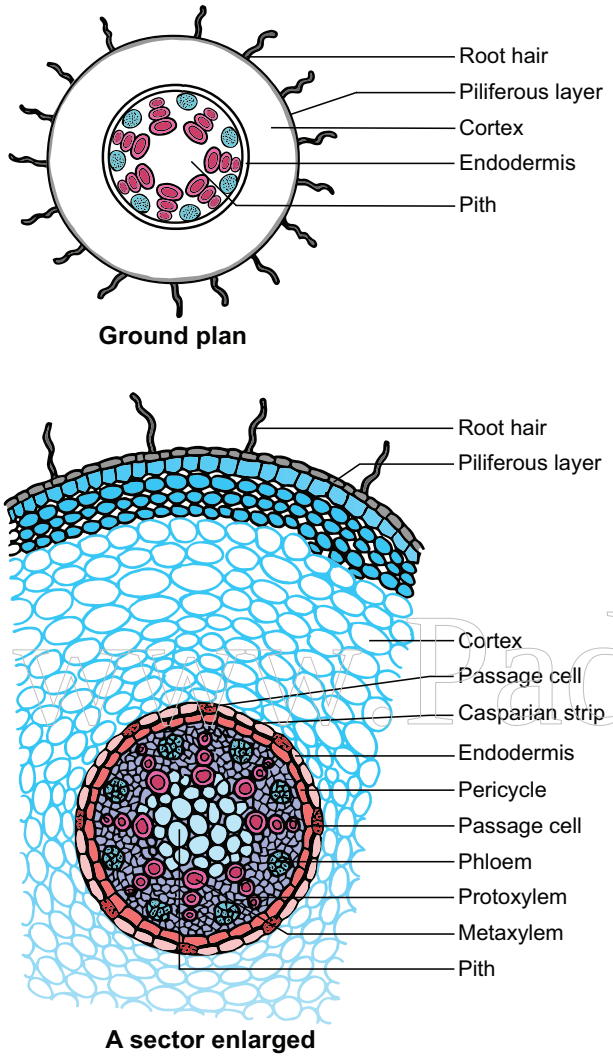


Figure 5d: T.S of Monocot root (Maize root)

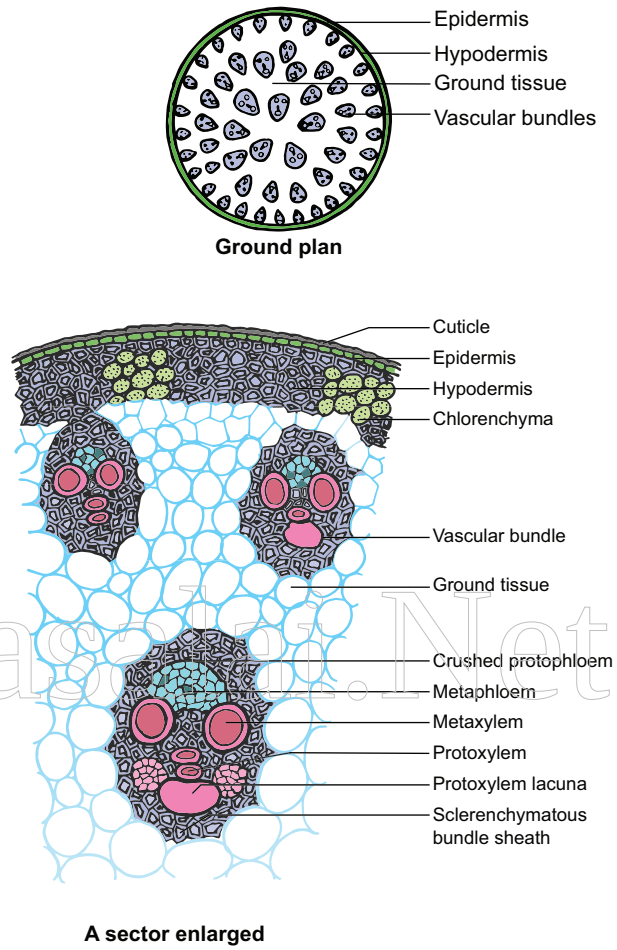


Figure 5e: T.S of Monocot stem (Maize Stem)

f. Monocot Leaf (T.S)

Diagnostic features:

- Conjoint, Collateral and closed vascular bundle.
- Mesophyll is not differentiated into Palisade and Spongy parenchyma. (Isobilateral leaf)
- Number of Stomata are more or less equal on both epidermis, Stomata surrounded by dumb-bell shaped guard cells.

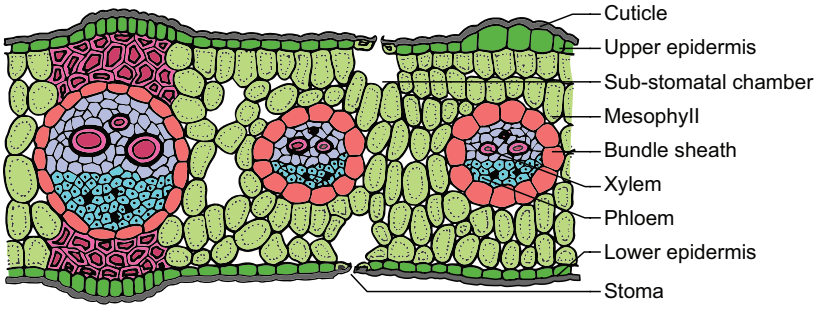


Figure 5f: T.S Monocot leaf (Grass leaf)

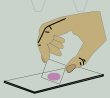
Exercise: 6

Plasmolysis and Deplasmolysis

Aim: Study of plasmolysis in epidermal peel of leaf.

Principal: Living cells are generally turgid due to the presence of water. When cells are immersed in hypertonic solution, shrinkage of protoplasm takes place with visible separation of plasma membrane from the cell walls. This is called plasmolysis and occurs due to exosmosis, a phenomenon in which water from the cells moves into the surrounding medium which is hypertonic, that is more concentrated than the cell sap.

Requirements: Leaves of *Tradescantia*, 70% sugar solution, slide, cover slip, needle, petri dish / watch glass, microscope.



Peel off a small segment from lower epidermal surface of the *Tradescantia* leaf. This can be done by tearing the leaf obliquely with a single jerk or scraping it with blade. Dip it in 70% of sugar solution for 5 minutes. Later mount the peel on a slide to observe plasmolysis.

Again dip the same peel in water for 5 minutes. Later mount it and observe it under the microscope for deplasmolysis.

Diagnostic features: Plasmolysis

- Cell membrane is pulled away from the cell wall.
- Cells becomes flaccid due to loss of water by exosmosis, when a plant cell is kept in a hypertonic solution.

Diagnostic features: Deplasmolysis

- It is reverse of plasmolysis.
- It is swelling of shrinked protoplasm to regain its original unplasmolysed shape when cell is placed in hypotonic solution. It is a type of endosmosis.

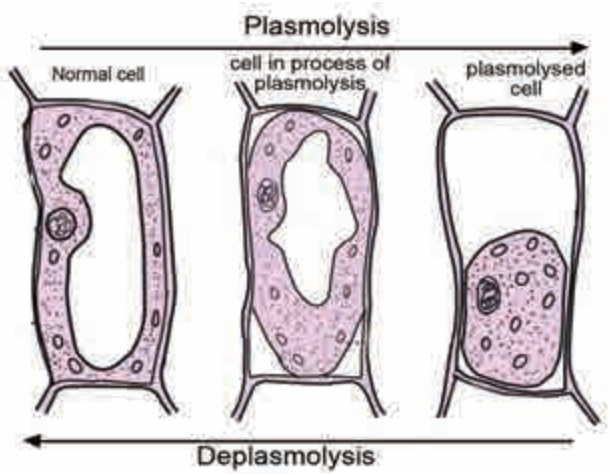


Figure 6: Different Stages of Plasmolysis and Deplasmolysis in a plant cell

• II. Fresh or preserved specimens

Aim: To study and identify the morphology of representative types of Fungi and Lichen,.

Principle: Morphology is the study of the characteristics features of the species. It could be a study of external or internal features. Morphological studies help in identification and classification of organisms.

Requirements: Specimens of Basidiocarp of *Agaricus*, Foliose Lichen.

Exercise: 7

Agaricus - Basidiocarp

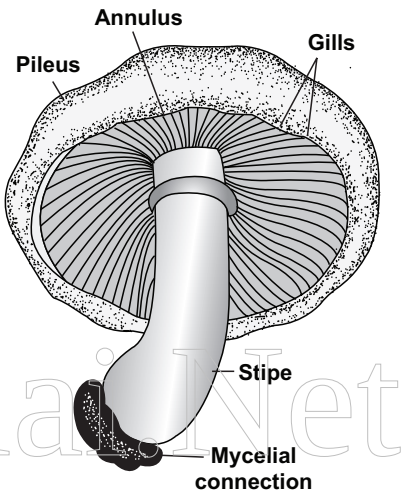


Figure 7: Basidiocarp of *Agaricus*

Diagnostic features:

- *Agaricus* fruit body (Basidiocarp) consist of stipe, annulus, pileus and gills.
- Fertile region of gills is known as hymenium. It possess club shaped basidium and sterile hyphae called Paraphysis.
- Basidium exogenously produces four basidiospores.

Exercise: 8

Foliose Lichen

Diagnostic features:

- Symbiotic association of algae and fungi, leaf like thallus. (Foliose).
- Alagalpartner (phycobiont) provide nutrition, Fungal partner (Mycobiont) provide protection and absorption of water.
- Indicator of SO_2 pollution, pioneer species in xerosere succession.

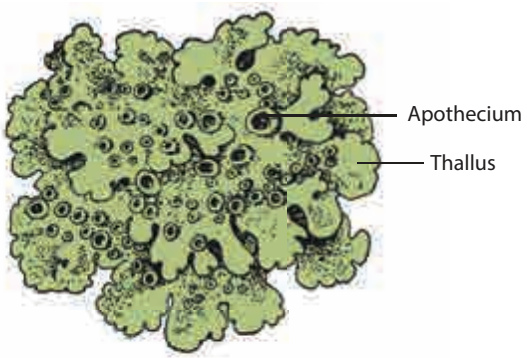


Figure 8: Foliose Lichen

Exercise: 9

Phylloclade - *Opuntia*

Aim : To study modifications of stem

Principle: The stem is the central axis that provides supports to all the aerial parts of the plant. Besides,in some plants these also help in perennation, vegetative propagation, food storage, photosynthesis etc. through various modifications.

Requirements: Specimen of *Opuntia*

Diagnostic features:

- It is a green, flattened stem.
- Phylloclade (Cladophyll) is the stem modification, perform the function of leaves.
- Leaves are modified into spines for xerophytic adaptation.

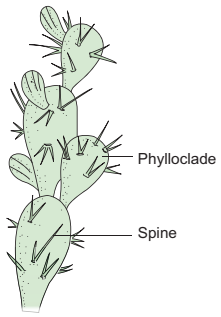


Figure 9: Phylloclade - *Opuntia*

Execise: 10

Special inflorescence- Cyathium

Aim: To study and identify the special type of inflorescence

Principle: Group of flowers arising from a branched or unbranched axis with a definite pattern. The inflorescences do not show any of the development pattern types are classified under special type of inflorescence. Function of inflorescence is to display the flowers for effective pollination and facilitate seed dispersal.

Requirements : Fresh specimen of cyathium inflorescence.

Diagnostic features:

- Special type of inflorescence consists of small unisexual flowers.
- Centrally located single female flower surrounded by male flowers.
- Male flower represented by only stamen and female flower represented only by pistil.
- Involucre protect flowers and consist of nectar.

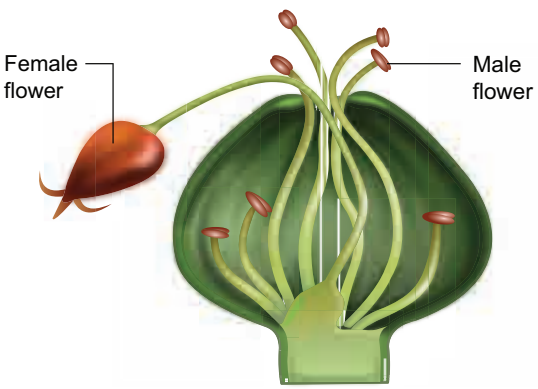


Figure 10: Cyathium inflorescence

Exercise: 11

Aggregate fruit - Polyalthia

Aim : To study and identify aggregate fruit type.
Principle: Fruit is a fertilized and ripened ovary. Fruits are classified into various types as, simple fruits, aggregate fruits and multiple fruits. Aggregate fruits develop from a single flower having an apocarpous pistil, each of the free carpel is develops into a simple fruitlet. A collection of simple fruitlets makes an aggregate fruits.
Requirements: Fresh specimen of polyalthia fruit.

Diagnostic features:

- Aggregate fruit develops from Single flower multicarpellary and apocarpous ovary.
- A collection of simple fruitlets makes aggregate fruit.

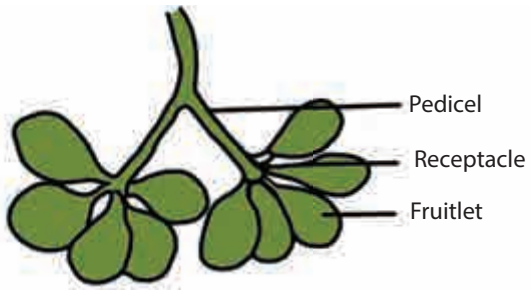


Figure 11: Aggregate fruit - Polyalthia

IV - Plant Taxonomy - Flower Dissection

Aim : To study, identify, dissect and describe flowering plants of families Fabaceae, Solanaceae.
Principle: Taxonomy deals with identification, nomenclature and classification of organisms. Bentham and Hooker's system of classification is universally used for classification of plants. Field identification of plants is based primarily on morphological features particularly the floral characters.
Requirements: Locally available plant specimens of Clitoria ternatea and Datura metel. Each specimen should have at least a small branch with a few internodes, leaves, flowers and fruits; glass slides, cover glass, petridish, blade, needles, brush, hand lens, dissecting microscope and compound microscope.

Exercise: 12

Fabaceae – *Clitoria ternatea*

Systematic position

Kingdom : Plantae
Clade : Angiosperms
Clade : Eudicots
Clade : Rosids
Order : Fabales
Family : Fabaceae

Floral characters:

Inflorescence : Solitary and axillary cyme.

Flower : Bractate, bracteolate, bisexual, zygomorphic, pentamerous and hypogynous.

Calyx : Sepals 5, synsepalous, Valvate aestivation, odd sepal is anterior in position.

Corolla : Petals 5, apopetalous, Papilonaceous corolla and descendingly imbricate.

Androecium : Stamens 10, diadelphous, (9) + 1.

Gynoecium: Monocarpellary, unilocular and ovules on marginal placentation, Superior ovary.

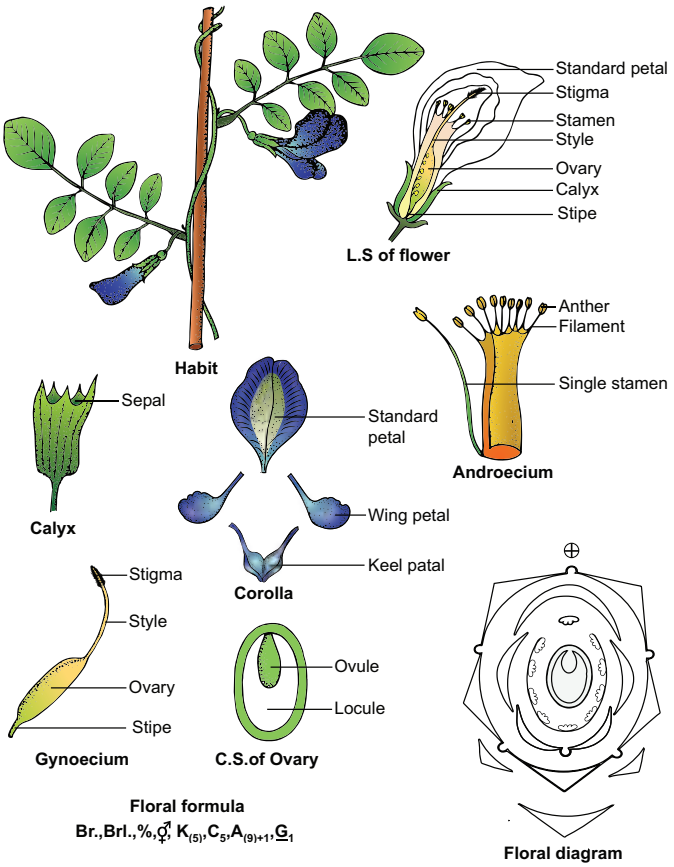


Figure 12 : *Clitoria ternatea*

Exercise: 13

Solanaceae – *Datura metel.*

Kingdom : Plantae
Clade : Angiosperms
Clade : Eudicots
Clade : Asterides
Order : Solanales
Family : Solanaceae

Floral characters

Inflorescence: Solitary and axillary cyme.
Flower: Bractate, ebracteolate, bisexual, actinomorphic, pentamerous and hypogynous.
Calyx: Sepals 5, synsepalous, Valvate aestivation, persistent calyx and odd sepal posterior.
Corolla: Petals 5, Synpetalous, twisted aestivation and plicate.
Androecium: Stamens 5, epipetalous and alternipetalous.
Gynoecium: Bicarpellary, syncarpous and superior ovary, bilocular due formation of false septum looks tetra locular.

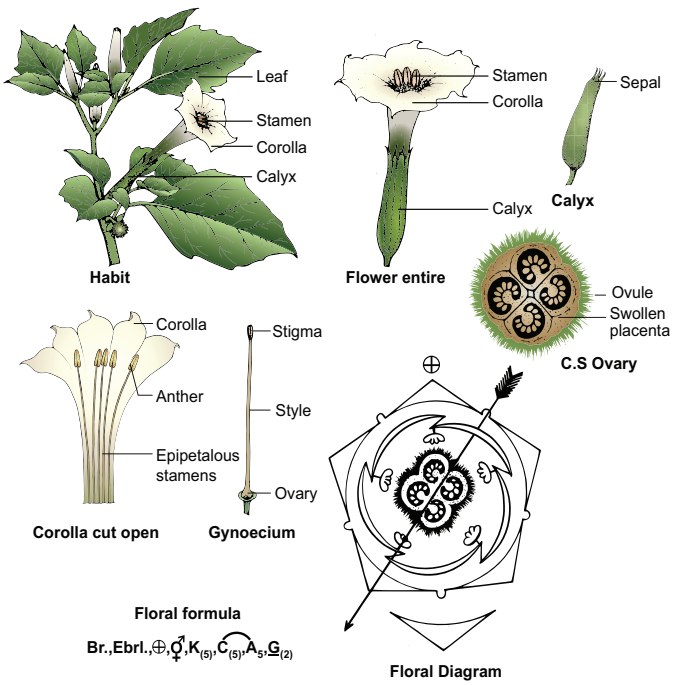


Figure 13 : *Datura metel*

V - Bio molecules-Nutrient test

Exercise: 14

Test for reducing sugar – Benedict reagent test

Aim:

To detect the presence of reducing sugar.

Basic Principle:

1. Aldoses and Ketoses are reducing sugars. Glucose is the reducing sugar and sucrose is the non-reducing sugar.
2. When reducing sugar is heated with an alkaline solution of Copper (II) sulphate (Benedict's solution) reduces Cu^{2++} into Cu^{+} forming brick red precipitate of Copper (I) oxide.

Requirements:

Test tube, test tube stand, test tube holder, Samples for test- Fruit juices of apples/ banana/ leaves of onion, sugar cane extract, milk etc., Benedict's solution, spirit lamp, water bath.

Procedure:

1. Take 1 ml of sample solution in a clean test tube
2. Add 1 ml of Benedict's solution
3. Keep the test tube in the boiling water bath.
4. Appearance of brick red colour depends on concentration of reducing sugar.

Table:

Procedure	Observation	Inference
1ml of sample solution + 1ml of Benedict's solution, Heated	Appearance of brick red colour	Reducing sugar is present (Glucose is the reducing sugar)

Exercise: 15

Test for starch – Iodine test

Aim:

To detect the presence of starch in the given sample solution.

Basic Principle:

1. Starch is the storage polysaccharide of plants.
2. It consist of two component a. amylose (linear, unbranched polymer, soluble in water) b. amylopectin (a branched polymer)
3. Amylose portion of starch react with Iodine (Potassium iodide) produces deep blue-black colour.

Requirements:

Test tube, Iodine solution, Extract of sample foodstuff (potato, rice, wheat or maize grains).

Procedure:

1. Take 1 ml of sample solution in a test tube.
2. Add 1 ml of Iodine (Potassium iodide).
3. Appearance of blue-black colour.

Table:

Procedure	Observation	Inference
1ml of sample solution + 1ml of Iodine solution	Appearance of deep blue-black colour	Starch is present

Exercise: 16

Test for protein – Biuret test

Aim :

To detect the presence of proteins.

Basic Principle:

1. Proteins are polymer of amino acids. (Polypeptide).
2. Amino group of one amino acid binds with carboxylic group of another amino acid to form peptide bond. (NH-CO linkage)
3. In alkaline medium $CuSO_4$ reacts with peptide bond and gives a purple colour .
4. All proteins do not contain the same amino acids, and hence they do not respond to all colour reactions. (Biuret test is for peptide bond in the molecule of a protein, xanthoproteic test is specific for protein containing aromatic amino acids).

Requirements:

Test tube, NaoH, $CuSO_4$ solution, milk/albumin of egg / gram seed extract.

Procedure:

1. Take 2 ml of sample solution.
2. Add 1 ml of sodium hydroxide solution.
3. Add 1 or 2 drops of 1% copper (II) sulphate and mix it well.
4. Appearance of Purple colour (Increase with increase in concentration)

Table:

Procedure	Observation	Inference
2 ml of sample solution + 1 ml of Sodium hydroxide + 1 or 2 drops of 1% Copper (II) sulphate and mix it well.	Appearance of Purple colour	Protein is present

Exercise: 17

Test for Lipids – Saponification test

Aim:

To detect the presence of fats (lipid) in different plants and animal materials.

Basic Principle:

1. Lipids are esters of fatty acid and alcohol
2. Lipids are not soluble in water and soluble in organic solvent like benzene, ether and chloroform.
3. Major groups of lipids are triglycerides, phospholipids, Steroids and Waxes.
4. Soapy appearance due break down of ester bonds by NaOH.

Requirements:

Test tubes, test tube stands, NaOH, oil/ghee/butter.

Procedure:

1. Take 1 ml of sample solution in a test tube.
2. Add 1 ml of 5% NaOH and mix it well.
3. Appearance of soapy solution.

Procedure	Observation	Inference
1 ml of sample solution + 1ml 5% NaOH solution and mix it well.	Appearance of Soapy solution	Lipid is present

VI - Plant Physiology Experiments.

Exercise: 18

Potato osmoscope experiment

Aim: To prove osmosis by Potato osmoscope.

Requirements: Peeled potato tuber, concentrated sugar solution, water, beaker,

Procedure:

1. Take a peeled potato tuber and make a cavity inside with the help of a knife.
2. Fill the cavity with concentrated sugar solution and mark the initial level.
3. Place this setup in a beaker of pure water.
4. After 10 minutes observe the sugar solution level and record your findings

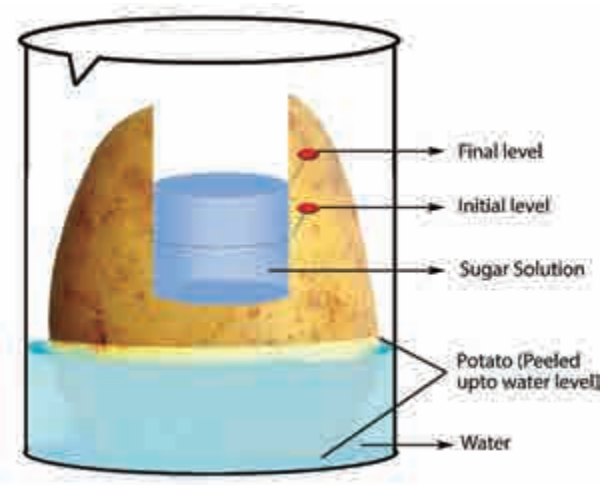


Figure 14: Potato osmoscope experiment

Observation: The level of sugar solution increased in the cavity of the potato tuber.

Inference: It is proved that the increase in the level of sugar solution is due to osmosis.

Exercise: 19

Paper chromatography experiment

Aim:

To separate and study the photosynthetic pigments (chloroplast pigments) by paper chromatography method.

Requirements:

Fresh spinach leaves, chromatography paper (whatman No.1), a wide long test tube, a split cork, mortar & pestle, petroleum ether, acetone, funnel, beaker, filter paper, capillary tube, sand etc.,

Procedure:

1. Grind a few spinach leaves with little fine sand and about 5 ml of acetone in a mortar and pestle. Filter it to get acetone extract of the leaf pigments.
2. Take a narrow strip of chromatographic paper (Whatman No.1). Cut one end of the strip into a narrow notch.
3. Put a drop of the pigment extract in the middle of the strip near the notch with the help of capillary tube. Allow the drop to dry and repeat till four or five drops are placed on the paper.

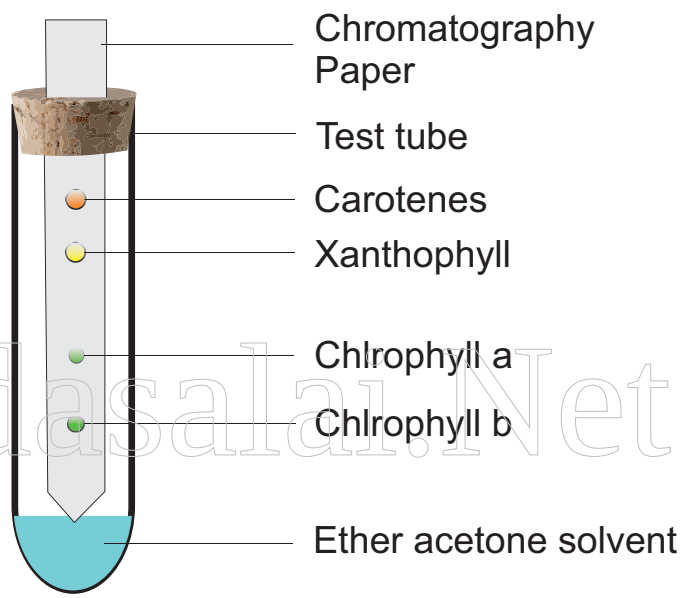


Figure 15 : Paper chromatography experiment

4. Take the test tube and pour about 5 ml of ether acetone solvent (9 ether : 1 acetone) in it. Now hang the pigment extract loaded chromatographic strip in the test tube with the help of a split cork, in such a way that the loading spot lies about 1 cm above the solvent level.
5. Make the cork air tight and place the test tube undisturbed for some time, when solvent rises about 3/4th of the strip, take out the strip carefully and let it dry.

Observation:

After one hour observe the chromatographic paper. The Photosynthetic pigments being separated into four distinct bands. Different leaf pigments can be identified by their colours.

Carotene	Xanthophyll	Chlorophyll a	Chlorophyll b
Yellow Orange	Yellow	Bluish Green	Greenish Yellow

Inference:

Photosynthetic pigments chlorophyll b, chlorophyll a, xanthophyll and carotenes are separated on the chromatographic paper. Presence of different photosynthetic pigments in chloroplast is proved.

Exercise: 20

Wilmott's bubbler experiment

Aim :

To determine rate of photosynthesis by Wilmott's bubbler

Requirements :

Wilmott's bubbler apparatus, Hydrilla twig, water.

Procedure :

1. Fill the bottle with water and insert Hydrilla twig into the wider part of the tube
2. Hydrilla plant should be cut inside the water to avoid entry of air bubbles
3. Fix the tube with jar which acts as water reservoir
4. Keep the apparatus in sunlight
5. Count the bubbles when they are in same size.
6. Repeat the experiment in different light intensity.

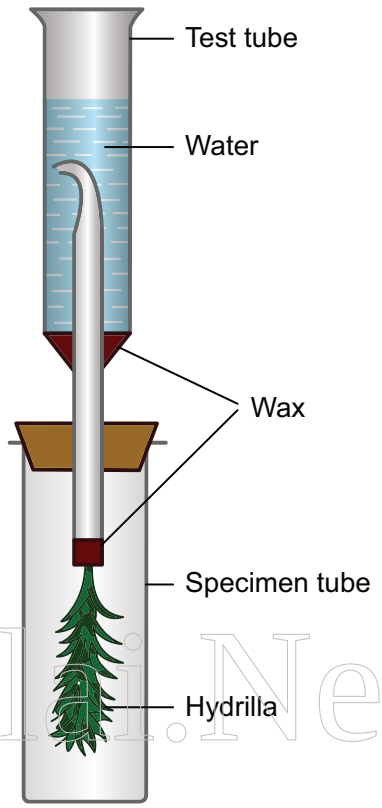


Figure 16 : Wilmott's bubbler

Observation :

When there is an increase in photosynthesis, bubble count also increased.

Inference :

Rate of photosynthesis increases with increase of light intensity is proved

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Exercise: 21

Experiment to demonstrate the production of CO_2 in aerobic respiration.

Aim:

To prove carbon dioxide is released by germinating seeds during respiration.

Requirements:

A conical flask, cork, beaker, a twice bent glass tube, a small test tube, thread, water KOH, germinating seeds of bean / gram/ groundnut seeds.

Procedure :

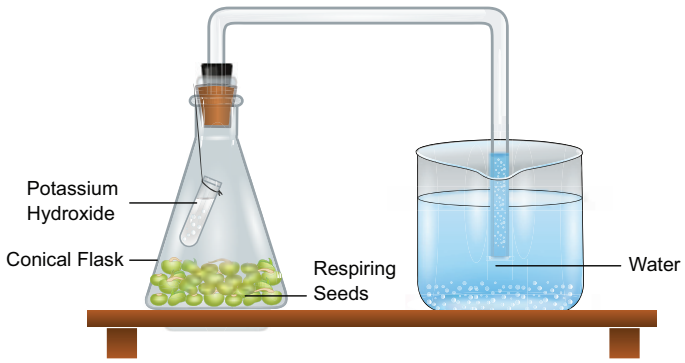

Figure 17: Demonstration of production of CO_2 during aerobic respiration

1. Take a definite quantity (i.e 10 gm) of germinating seeds of bean/gram/groundnut in the conical flask and hang a small test tube containing Potassium hydroxide (KOH) crystal inside the flask with the help of a thread.
2. Introduce one end of the bent glass tube into the conical flask through the cork. Dip the free end of the tube in a beaker containing water.
3. Make the apparatus air tight and fix the apparatus with the help of a stand.
4. Note the initial level of water in the bent glass tube and keep the apparatus undisturbed.

Observation :

After two hours the level of water rises in the glass tube.

Inference :

Carbon dioxide released by the germinating seeds is absorbed by KOH solution. It creates vacuum, to fill up the vacuum water raised in the tube. Liberation of carbon dioxide during respiration by germinating seeds is proved.

Exercise: 22

Arc auxanometer experiment

Aim:

To measure the growth of a plant in length by Arc auxanometer

Requirements:

Arc auxanometer, potted plant, weight, thread,

Procedure:

Arc auxanometer which consists of a small pulley to the axis of which is attached a long pointer sliding over a graduated arc.

One end of a thread is tied to the stem tip and another end to a weight passes over the pulley tightly. Note down the initial reading of the pointer. Keep the set up for a week.

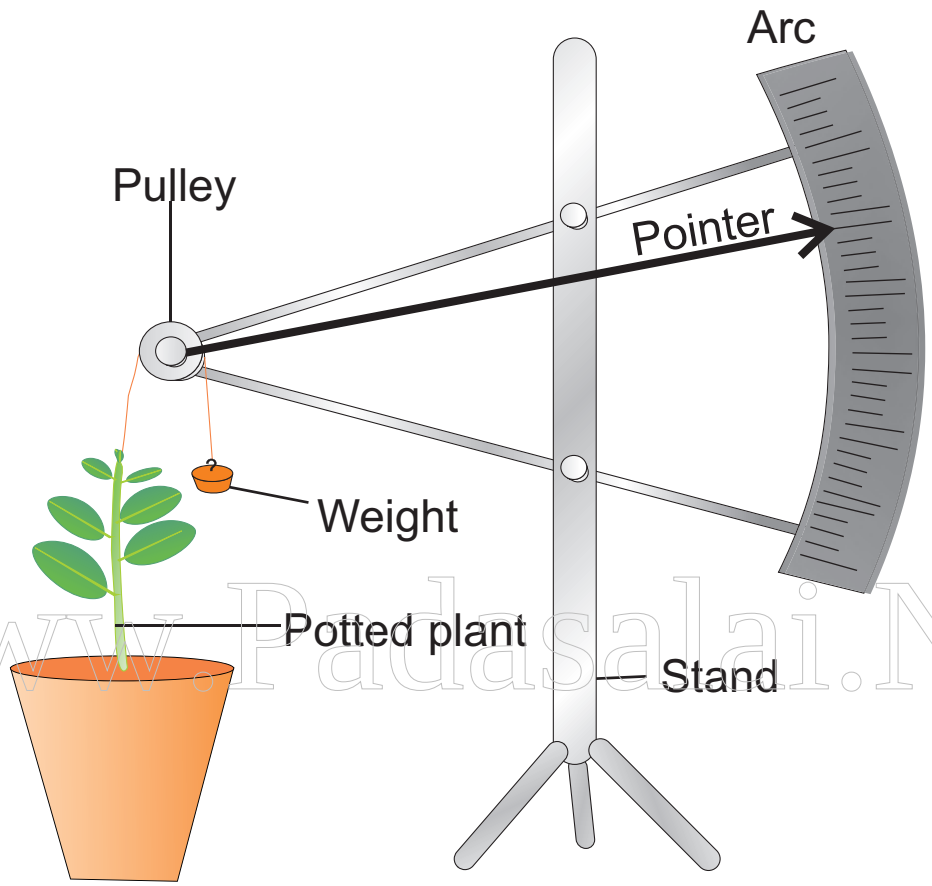

Figure 18 : Arc auxanometer experiment

Observation :

The stem tip grows in length, the pulley moves, and the pointer slide over the graduated arc. The distance travelled by the pointer is noted down.

Inference :

Actual growth in length is calculated with help of this formula.

$$\text{Actual growth in length} = \frac{\text{Distance travelled by the pointer} \times \text{radius of the pulley}}{\text{Length of the pointer}}$$

Bio - Botany - Class XI
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